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Section I. Fundamental Concepts and Theories

This section serves as the groundwork for this comprehensive reference book by addressing central theories essential to the understanding of instructional design. Chapters found within these pages provide a tremendous framework in which to position instructional design within the field of information science and technology. Insight regarding the critical integration of global measures into instructional design is addressed, while crucial stumbling blocks of this field are explored. The chapters comprising this introductory section, the reader can learn and choose from a compendium of expert research on the elemental theories underscoring the instructional design discipline.

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Section V. Organizational and Social Implications

This section includes a spacious range of inquiry and research pertaining to the behavioral, emotional, social and organizational impact of instructional design around the world. From case studies in Africa to studies of gaming on developmentally disabled and learning disabled children to plagiarism and community collaboration, this section compels the humanities, education, and IT scholar all. Section 5 also focuses on hesitance in some faculty members' integration with instructional design, a growing issue among those involved with education who are already forced to "wear many hats" at the higher education level. With more than 20 chapters, the discussions on hand in this section detail current and suggest future research into the integration of global instructional design as well as implementation of ethical considerations for all organizations. Overall, these chapters present a detailed investigation of the complex relationship between individuals, organizations and instructional design.

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Section VII. Critical Issues

Section 7 details some of the most crucial developments in the critical issues surrounding instructional design. Importantly, this refers to critical thinking or critical theory surrounding the topic, rather than vital affairs or new trends that may be found in section 8. Instead, the section discusses some of the latest developments in cognitive load, social constructivist and pedagogy theories, as well as new approaches in faculty development, learning with visualizations, and implications of anonymity online. This section also asks unique questions about the role of business intelligence in developing countries and in linguistic confusion across cultures. Within the chapters, the reader is presented with an in-depth analysis of the most current and relevant issues within this growing field of study.

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Preface

Instructional design integrates the burgeoning field of Information Technology with the global development of educational theory and practice. Through development and analysis of cognitive load and learning design theories, and ADDIE, Gagne, and constructivist models, instructional design has advanced greatly since its inception during World War II.

The constantly changing landscape of instructional design makes it challenging for experts and practitioners to stay informed of the field's most up-to-date research. That is why Information Science Reference is pleased to offer this three-volume reference collection that will empower students, researchers, and academicians with a strong understanding of critical issues within instructional design by providing both extensive and detailed perspectives on cutting-edge theories and developments. This reference serves as a single, comprehensive reference source on conceptual, methodological, technical, and managerial issues, as well as providing insight into emerging trends and future opportunities within the discipline.

Instructional Design: Concepts, Methodologies, Tools and Applications is organized into eight distinct sections that provide wide-ranging coverage of important topics. The sections are: (1) Fundamental Concepts and Theories, (2) Development and Design Methodologies, (3) Tools and Technologies, (4) Utilization and Application, (5) Organizational and Social Implications, (6) Managerial Impact, (7) Critical Issues, and (8) Emerging Trends.

Section 1, ***Fundamental Concepts and Theories***, serves as a foundation for this extensive reference tool by addressing crucial theories essential to the understanding of instructional design. Chapters such as *Contemporary Instructional Design* by Robert S. Owen and Bosede Aworuwa and *Instructional Design Methodologies* by Irene Chen lay a foundation to some of the more basic and essential fundamentals of the field. Other chapters such as *History of Distance Learning Professional Associations*, also by Irene Chen, give detailed, yet brief summaries of the history of the instructional design developments. Also of note, the final two chapters in section 1, *Using Games to Teach Design Patterns and Computer Graphics* by Pollyana Notargiacomo Mustaro, Luciano Silva, & Ismar Frango Silveira; and *Using Video Games to Improve Literacy Levels of Males* by Stephenie Hewett give introduction to a few video and serious game applications in the instructional design field.

Section 2, ***Development and Design Methodologies***, presents in-depth coverage of the conceptual design and architecture of instructional design, focusing on aspects including online course materials and education, augmented and virtual realities architectures, and methodological frameworks for Web based instruction. Designing and implementing effective processes and strategies are the focus of such chapters as *Planning for Technology Integration* by Henryk R. Marcinkiewicz, and *Lessons Learned about Designing Augmented Realities* by Patrick O'Shea, Rebecca Mitchell, Catherine Johnston, and Chris Dede.

Section 3, ***Tools and Technologies***, presents extensive coverage of the various tools and technologies used in the development and implementation of instructional design. This comprehensive section includes such chapters as *iPods as Mobile Multimedia Learning Environments* by Peter E. Doolittle,

which detail software and hardware developments (respectively) and their applications in the field of instructional design. Additional chapters on MOT+Visual, poEML, SEAMAN, and coUML describe some of the newest modifying languages and tools at the disposal of instructional designers. And perhaps of the most vital note to higher educators is the broad discussion over a few chapters on videoconferencing and its quintessential and technical role in pedagogy.

Section 4, ***Utilization and Application***, describes how instructional design has been utilized and offers insight on important lessons for its continued use and evolution. Due to the breadth of this section's subject matter, section 4 contains the widest range of topics, including chapters such as *Application of E-Learning in Teaching, Learning and Research in East African Universities* by Michael Walimbwa and *Internet Citizenship* by Henry H. Emurian and Malissa Marie Carroll. This section is also filled with international case studies and applications of new technologies in higher learning institutions. Also of note in section 4 is the treatment given to developments in course design for foreign language instruction, some of the most recent and relevant publication on the vital subject matter.

Section 5, ***Organizational and Social Implications***, includes chapters discussing the organizational and social impact of instructional design. Overall, these chapters present a detailed investigation of the complex relationship between individuals, organizations and instructional design. The first 8 chapters of section 5 are about the challenges of culture on the ever expanding and diversifying global higher education system. *Behaviorism and Developments in Instructional Design and Technology* by Irene Chen, and *Addressing Emotions within E-Learning Systems* by Valentino Zurloni, Fabrizia Mantovani, Marcello Mortillaro, Antonietta Vescovo, and Luigi Anolli are examples of some of the psychological or behavioral impacts on instructional learning, developing the influence emotion and mental response have on learning styles and pedagogy. And aside from cultural and psychological adaptations of instructional design, there are also spots of interest in *Plagiarism and the Community College* by Teri Thomson Maddox.

Section 6, ***Managerial Impact***, presents focused coverage of instructional design as it relates to improvements and considerations in the workplace. In all, the chapters in this section offer specific perspectives on how managerial perspectives and developments in instructional design inform each other to create more meaningful user experiences. Typically, though the fields of industry and education are not always considered co-dependent, section 6 provides looks into how instructional design and the business workplace help each other. Examples include *Structuring a Local Virtual Work Ecology for a Collaborative, Multi-Institutional Higher Educational Project* by Shalin Hai-Jew; and *Improving Teachers' Self-Confidence in Learning Technology Skills and Math Education through Professional Development* by Taralynn Hartsell, Sherry S. Herron, Houbin Fang, and Avinash Rathod. Section 6 is especially helpful as an addition to the organizational and behavioral studies of section 5, with diverse and novel developments in the managerial and human resources areas of instructional design.

Section 7, ***Critical Issues***, addresses some of the latest academic theory related to instructional design. Importantly, this refers to critical thinking or critical theory surrounding the topic, rather than vital affairs or new trends that may be found in section 8. Instead, the section discusses some of the latest developments in cognitive load, social constructivist and pedagogy theories, as well as new approaches in faculty development, learning with visualizations, and implications of anonymity online. Within the chapters, the reader is presented with an in-depth analysis of the most current and relevant issues within this growing field of study. Chapters such as *Commodity, Firmness, and Delight* by Brad Hokanson, Charles Miller, and Simon Hooper show stylistic and business-savvy industry improvements, while *Ethics in Interactions in Distance Education* directs some of the latest scholarly publication on morality and its online legislation and execution. This section also asks unique questions about the role of business intelligence in developing countries and in linguistic confusion across cultures.

Section 8, *Emerging Trends*, highlights areas for future research within the field of instructional design, while exploring new avenues for the advancement of the discipline. Beginning this section is *Contemporary Issues in Teaching and Learning with Technology* by Jerry P. Galloway, detailing some of the most recent issues plaguing the IT side of online higher education. Closing out the book are two fascinating chapters of recent developments. First, in Patrick Parrish's *Aesthetic Decisions of Instructors and Instructional Designers* comes a study of the effects of visual and graphic depiction on pedagogy and effectiveness. Second and finally, *The Pervasiveness of Design Drawing in ID* by S. Todd Stubbs and Andrew S. Gibbons closes out the book, with a last look at an instructional design topic that has recently found trending importance. These and several other emerging trends and suggestions for future research can be found within the final section of this exhaustive multi-volume set.

Although the primary organization of the contents in this multi-volume work is based on its eight sections, offering a progression of coverage of the important concepts, methodologies, technologies, applications, social issues, and emerging trends, the reader can also identify specific contents by utilizing the extensive indexing system listed at the end of each volume. Furthermore to ensure that the scholar, researcher and educator have access to the entire contents of this multi volume set as well as additional coverage that could not be included in the print version of this publication, the publisher will provide unlimited multi-user electronic access to the online aggregated database of this collection for the life of the edition, free of charge when a library purchases a print copy. This aggregated database provides far more contents than what can be included in the print version in addition to continual updates. This unlimited access, coupled with the continuous updates to the database ensures that the most current research is accessible to knowledge seekers.

As a comprehensive collection of research on the latest findings related to using technology to providing various services, *Instructional Design: Concepts, Methodologies, Tools and Applications*, provides researchers, administrators and all audiences with a complete understanding of the development of applications and concepts in instructional design. Given the vast number of issues concerning usage, failure, success, policies, strategies, and applications of instructional design in organizations, *Instructional Design: Concepts, Methodologies, Tools and Applications* addresses the demand for a resource that encompasses the most pertinent research in instructional design development, deployment, and impact.

Section I

Fundamental Concepts and Theories

This section serves as the groundwork for this comprehensive reference book by addressing central theories essential to the understanding of instructional design. Chapters found within these pages provide a tremendous framework in which to position instructional design within the field of information science and technology. Insight regarding the critical integration of global measures into instructional design is addressed, while crucial stumbling blocks of this field are explored. The chapters comprising this introductory section, the reader can learn and choose from a compendium of expert research on the elemental theories underscoring the instructional design discipline.

Chapter 1.1

Taxonomies for Technology

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INTRODUCTION

For over 3000 years from Homer, Moses and Socrates onwards, the teacher in direct, personal contact with the learner, has been the primary means of communicating knowledge...until the fourteenth century, when the invention of the printing press allowed for the first time the large-scale dissemination of knowledge through books. (Bates, 1995)

Today there is a range of technologies available to those who design learning events, from the old and simple to the new and complex. Key attempts have been made to develop theoretical frameworks of learning technologies and have been reported in the literature of higher education, human resource development, and instructional

design. These three fields are not discrete and some overlap occurs. For example, commentators in the field of instructional design state that their designs are provided for learning in many contexts including schools, higher education, organizations, and government (Gagné, Briggs, & Wager, 1992; Reigeluth, 1983). In many cases the theoretical frameworks are intended to guide the selection of learning technologies but often the conceptualizations have not kept pace with technological change.

There are many definitions of taxonomy and most of them refer to systems for the classification and organization of things. Carl Linnaeus developed the most well known taxonomy during the expansion of natural history knowledge in the 18th century. It is the scientific system for the classification of living things and has the basic structure of organism, domain, kingdom, phylum, class, order, family, genus, and species.

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It has been argued (Wikipedia, 2005) that the human mind uses organizational structures to naturally and systematically order information received and hence makes sense of the world. A taxonomy is clearly an organizational structure and it follows that as the Linnaean taxonomy assists those investigating the life sciences; a taxonomy of learning technologies can help users and investigators of learning technologies. Further it is suggested that taxonomies of learning technologies are appropriate tools to assist in the design of learning events that include technologies.

BACKGROUND

The Linnaean taxonomy has a deep hierarchical structure which reflects the number and diversity of living things. It is reasonable to expect that a taxonomy for learning technologies will be smaller due the smaller number of learning technologies. Just as new species are added to the Linnaean taxonomy as they are discovered, a taxonomy of learning technologies must be adaptable to cater for learning technologies of the future. A taxonomy of learning technologies is therefore a framework that classifies or organizes learning technologies.

There have been a number attempts to classify or organize learning technologies and while their classification frameworks are logically sound they have not always been developed to assist in the design of learning events that use technology in the most effective and efficient manner. Also, there is a considerable range in the depth of approach or rigor. However, all of the approaches either divide technologies into categories, either by intention or as a result of categorization by other criteria.

Leshin, Pollock, and Reigeluth (1992) present a classification scheme for “media” that is based on attributes in which learning technologies are grouped into five “systems.”

- Human-based system (teacher instructor, tutor, role-plays, group activities, field trips, etc.)
 - Print-based system (books, manuals, workbooks, job aids, handouts, ect.)
 - Visual-based system (books, job aids, charts, graphs, maps, figures, transparencies, slides, etc.)
 - Audiovisual-based system (video, film, slide-tape programs, live television, etc.)
 - Computer-based system (computer-based instruction, computer-based interactive video, hypertext, etc.)

They state that the “systems” share the characteristic of carrying “a message (information) to a receiver (learner)” and that some “systems” can “process messages from the receiver” (Leshin et al., 1992, p. 256). Writing in the field of instructional design, Leshin, Pollock, and Reigeluth use their classification as a starting point from which technology-based learning events can be designed: “Now through the process of message design you will tailor your instruction to a particular medium or set of media.” (Leshin et al., 1992)

The approach taken to the classification of learning technologies by Leshin, Pollock, and Reigeluth provides little or no insight into the application of the technology, and is not much more than a labeling system. As they were writing prior to the development of the World Wide Web, the classification system did not include learning management systems or online technologies. They could easily be added to the last category of computer-based systems, but this adds little to the understanding of them or to their application to learning in an appropriate way.

Also writing in the literature of instructional design, Romiszowski (1988) classifies “media” by the sensory channels they support and provides examples such as telephone for the auditory channel, video for the “audio/visual” channel, chalkboards for the visual channel, and devices

or models for the “tactile or kinesthetic” channel. Romiszowski’s approach is slightly more informative than that of Leshin, Pollock, and Reigeluth as he makes the conceptual connection between technologies and “sensory channels.” However his system of classification provides little insight into the characteristics of the technologies which lead to the matching of them to learning activities in an appropriate manner.

Others in the field of instructional design take an even less rigorous approach to the categorization or classification of learning technologies. Reiser and Gagné (1983) argue that a “number of kinds of categories can be devised for the classification of media” and that “frequently employed categories include audio, print, still visual and motion visual, and real objects.” They elaborate that the reasons for categorizing “media” are generally associated with their selection and that their application can be optimized through matching their characteristics to the task:

A particular type of medium can best present a task having a similar classification. For example the learning of a task that requires differentiation of visual features can best be done with a visual medium (Reiser & Gagné, 1983, p. 13).

While Reiser and Gagné’s categorization of “media” is appropriate for the selection of technologies as adjuncts to classroom teaching from the technologies available in the early 1980s, it does not have much to offer the selection of learning technologies as central elements of learning events and does not easily expand to address technologies developed after their conceptualization was published.

Some other commentators have taken a more interpretive approach to the categorization of learning technologies. Contrary to the descriptive classification approaches, Laurillard (2002) categorizes learning technologies through the use of “pedagogical categories” and argues that “there

are many attempts in the literature to categorise and classify the forms of media, none of which is very illuminating for our purpose here” (pp. 77-78).

Laurillard continues with the argument that “educational media” should be classified in terms of the categories and extent of learning processes they support and provides the four categories: “Discursive, Adaptive, Interactive and Reflective.” Laurillard’s categories provide limited insight to the nature and characteristics of learning technologies when used outside of the “teaching strategy.”

In a similar fashion to Leshin et al., Romiszowski, and Reiser and Gagné, Bates classifies learning technologies in two ways. First, according to the “medium they carry” and he states:

“In education the five most important media are:

- Direct human contact (face-to-face)
- Text (including still graphics)
- Audio
- Television
- Computing” (Bates, 1995, p. 32)

Second, Bates distinguishes between technologies that are “primarily one-way and those that are primarily two-way, in that they allow for interpersonal communication” (Bates 1995).

Bates, writing about open learning and distance education in higher education, where in the past communications between learners and between learners and facilitators have been difficult due to the absence or lack of face-to-face opportunities, describes one and two-way technologies for four of the “five most important media.”

Other approaches to the classification of learning technologies are designed for large distance education institutions which have large instructional design resources.

One approach by an organization with instructional design resources (Sun Associates, 2001) is to divide technologies into the categories:

- Tutorial technologies
- Application uses of technologies
- Exploratory technologies
- Communications technologies

This approach is helpful but it does not provide an insight to the nature of the technology, rather, it is suggesting how the technologies should be used. For example, under communications technologies no differentiation is made between videoconference, which is two-way, and Web searching, which is one-way.

Another approach (Bruce & Levin, 1997) divides the technologies into the categories of:

- Media for inquiry
- Media for communication
- Media for construction
- Media for expression

Bruce and Levin's taxonomy further subcategorizes technologies and while theoretically helpful, could be confusing, as the basic differentiation between one-way and two-way is not apparent. They include document preparation as a subcategory of media for communication. It can be argued that all education is (or should be!) communicative and this category does not help to tease apart the appropriate uses of the different technologies.

By far the most exhaustive approach to the development of a taxonomy for learning tech-

nologies is that taken by Tomei (2005). The intention of his work is to provide a "desktop reference for the analysis, design, development, implementation and evaluation of technology based instructional materials" (Tomei, 2005, p. xx).

Tomei expands upon the work of the educational psychologists who developed the commonly known "cognitive, affective and psychomotor domains of teaching" (Tomei, 2005). He argues that a technology domain exists as "the newest domain for teaching [that] addresses technology first and foremost as its own viable content area" (p. 11).

The technology domain is a hierarchic structure containing from the lowest to highest, five levels: literacy, collaboration, decision making, infusion, integration, and tech-ology (Tomei, 2005). The taxonomy is not one of learning technologies *per se*, rather it is a taxonomy of knowledge of, skills with, and attitudes to technology. It serves as an excellent framework within which curricula may be developed to provide students with opportunities not only to become adept users of technology but critical thinkers about technology and its impact.

Tomei's is a rigorous work resulting in a theoretical as well as practical contribution to the field.

In many institutions teachers are often asked to design curricula for students who, by virtue of location or time constraints, will use technologies for a significant proportion of their learning. These teachers need a simple yet robust tool to help them understand the technologies they are being asked to use in their teaching while maintaining their research concentration in their own fields.

In 2006, the author presented a new organizational structure, or taxonomy of learning technologies at the Information Resources Management Association Conference (Caladine, 2006). This taxonomy of learning technologies divides learning technologies into broad categories depending on their communications channels. In the top layer of the taxonomy, learning technologies are categorized as one-way or two-way. More descriptive

Table 1. Taxonomy for the technology domain (Tomei, 2005)

Level	Taxonomy Classification	
1.0	Literacy	Understanding Technology
2.0	Collaboration	Sharing Ideas
3.0	Decision Making	Solving Problems
4.0	Infusion	Learning with Technology
5.0	Integration	Teaching with Technology
6.0	Tech-ology	The Study of Technology

titles have been chosen and the one-way learning technologies are labeled as “representational” as they represent things or materials. The two-way labeled as “collaborative” as they facilitate collaborations.

The taxonomy of learning technologies categorizes technologies as representational or collaborative. Collaborative technologies are then divided into the subcategories of “dialogic” or “productive.” Within each of these categories individual technologies can be further described by their synchronicity or asynchronicity.

CONCLUSION

Many attempts and approaches to the categorization of learning technologies are dated and are no longer relevant to the technologies available to those designing learning events.

The taxonomy for the technology domain (Tomei, 2005) departs from the other attempts as it is a hierarchy of knowledge of, skills with, and attitudes to technology. As such it serves as a relevant and useful guide to the preparation of curricula that develop these attributes in students.

A common characteristic of several of the attempts is the basic division of technologies into one-way and two-way (Bates, 1995; Rowntree,

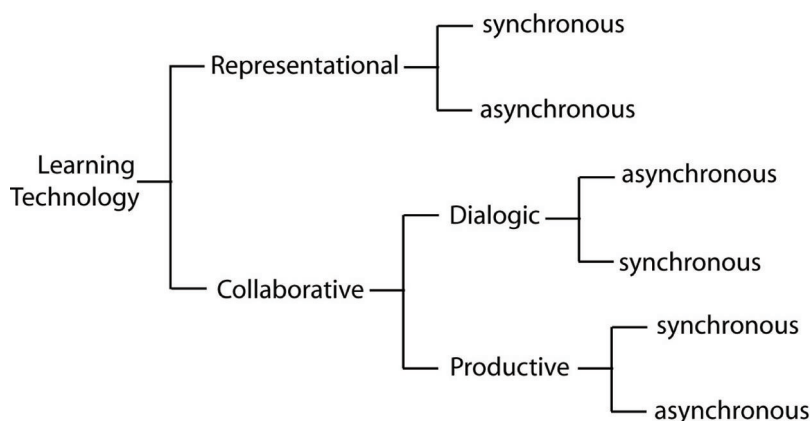
1994). The taxonomy of learning technologies uses this division and adds subcategories to create an organizational structure that is sufficiently robust for general application to technologies used in learning and simple enough to be accessible to busy academics. The taxonomy is designed to provide designers of blended learning courses an introduction to the appropriate uses of learning technologies.

The taxonomy of learning technologies was developed to describe the learning technologies available at the time of writing. It is difficult to predict the near future and impossible to predict the distant future in the field of learning technology. It is hoped that if the taxonomy does not describe future technologies, it will be able to be easily changed to do so.

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Figure 1. The taxonomy of learning technologies



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KEY TERMS AND DEFINITIONS

Asynchronous: Not necessarily occurring at the same time. In asynchronous electronic communications it is reasonable to expect that all communicating parties are not at or near their computer or communications technology. E-mail is an asynchronous technology.

Categorization: Grouping according to the role played.

Classification: Grouping according to similar or like characteristics.

Distance Learning (aka Distance Education): Education in which learners are geographically separated from facilitators.

Education: A structured program of intentional learning from an institution.

Facilitator (aka Facilitator of Learning): The person who has prime responsibility for the facilitation of the learning, rather than terms such as “teacher,” “trainer,” or “developer.”

Flexible Learning: An approach to learning in which the time, place, and pace of learning may be determined by learners. In this chapter this term is used to include the approaches taken by distance learning and open learning.

Higher Education: Intentional learning in universities and colleges.

Human Resource Development: Intentional learning in organizations. Can include training and development.

Instructional Design: The process of is concerned with the planning, design, development, implementation, and evaluation of instructional

activities or events and the purpose of the discipline is to build knowledge about the steps for the development of instruction.

Interaction: Reciprocal between humans and between a human and an object including a computer or other electronic device that allows a two-way flow of information between it and a user responding immediately to the latter's input.

Learner: A generic term to describe the person learning, rather than terms such as "trainee" and "student."

Learning: An umbrella term to include training, development, and education, where training is learning that pertains to the job, development is learning for the growth of the individual that is not related to a specific job, and education is learning to prepare the individual but not related to a specific job.

Learning Activities: The things learners and facilitators do, within learning events, that are intended to bring about the desired learning outcomes.

Learning Event: A session of structured learning such as classes, subjects, courses, and training programs.

Learning Management System (aka Virtual Learning Environment, Course Management

System and Managed Learning Environment):

A Web-based system for the implementation, assessment, and tracking of learners through learning events.

Learning Technologies: Technologies that are used in the process of learning to provide material to learners, to allow learners to interact with it, and/or to host dialogues between learners and between learners and facilitators.

Online Learning: Flexible or distance learning containing a component that is access via the World Wide Web.

Representational Technology: A one-way technology that supports interaction with the material.

Synchronous: Occurring at the same time. In synchronous electronic communications, it is reasonable to expect that all communicating parties are at or near their computer or communications technology. Telephone is a synchronous technology.

Taxonomy: A hierarchical structure within which related items are organized, classified, or categorized, thus illustrating the relationships between them.

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Chapter 1.2

Preparing Teachers to Teach Online

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INTRODUCTION

The vast majority of today's teachers were never taught using computers. They have no firsthand experience using computers for teaching and learning and they may even believe computers are a threat to their jobs. Helping these teachers to become effective online teachers requires a systematic multi-layered approach to professional development. First, teachers have to be convinced of their institution's commitment to online instruction. Then, they need support and guidance as they move through various levels of understanding and concern about what online learning is and its role and value in education. Finally, teachers need to develop competencies that will enable them to be successful online teachers. This chapter presents a brief background

on the use of technology in education, research on approaches to professional development, and specific information on the competencies required to be an effective online teacher.

BACKGROUND: TECHNOLOGY AND TEACHING

Even in the world's most advanced schools, computers have only been available for a few decades. During that time, huge advances have been made in the technologies available for use in schools, their educational applications, and our understanding of how to use them to promote learning.

In the late 1970s and early 1980s, as computers were just beginning to appear in classrooms, professional development focused on operating the computer and running software packages. This included basic operation and maintenance,

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programming, using productivity tools (e.g., word processors, databases, and spreadsheets) and eventually the use of grade-level appropriate curriculum-specific instructional programs.

By the late 1980s professional development had changed its focus. No longer was the goal to simply make teachers competent users. Rather, it was to help them develop strategies to increase the effective student use of technology for learning. Teachers were exposed to concepts such as the use of collaborative learning in technology-based learning environments. They also began requiring students to use technology for research, data collection, and presentation of findings. Teachers' roles shifted from using technology to teach, to using technology to facilitate learning.

The introduction of the Internet and online resources in the late 1990s presented another change in the use of technology in education. Teachers and students began to browse this virtual library for information and resources heretofore unavailable to them. Computers became a tool for searching, retrieving, manipulating, and sharing information. Teachers began to see the online environment as an information repository that contributed to student learning and through which students could contribute to the learning of others. Teaching strategies began to make use of this rich resource by including online research and reporting activities.

By the early 2000s, use of the Internet for communication had evolved beyond mere text messages to include a full range of media — images, audio, and video. Online distance education began to gain popularity. All levels of education began to see online learning as a vehicle for expanding the reach of institutions and by offering educational services to potential students they could not previously reach. The concept of online education presented yet another opportunity to change the role of teachers. The personal relationship between teachers and students, which was so often a critical component of classroom instruction, took on

an entirely different character. Online distance education courses created instructional environments where teachers and students interacted in a digital world and where they might never meet, speak, or even see each other in person.

Overview

Online distance education (also commonly referred to as distance education, online learning, online teaching, and distributed learning), as the name implies, delivers instruction using a computer network, without requiring face-to-face meetings of students and faculty (Arabasz & Baker, 2003). These online courses, taught in virtual classrooms, are often facilitated by use of the Internet (Spector & de la Tega, 2001), and may be synchronous, asynchronous, or a combination thereof.

Online distance education offers exciting opportunities for learners, teachers, and educational institutions. Internet technology allows distance education to make efficient, content-rich, interactive learning opportunities available to learners at locations and in ways previously not possible. For an increasing number of institutions, this capability is broadening and extending their methods of delivering education. Consequently, online distance education has been the focus of numerous research studies, position papers, standards documents, and guidelines. These documents (e.g., Sales, 2005; Smith, 2005; The Institute for Higher Education, April, 2000; The Higher Education Program, and Policy Council of the American Federation of Teachers, May, 2000; Twigg, 2003a, 2003b), address the relative instructional effectiveness of online learning, educational quality, student needs, institutional support, instructional strategies, costs, required teacher competency, and more.

One report, *Quality On the Line* (The Institute for Higher Education, 2000), studied six institutions actively involved in online education and constructed a list of 24 “benchmarks that

are essential for quality Internet-based distance education” (p.25). These benchmarks represented seven categories:

1. Institutional Support
2. Course Development
3. Teaching/Learning
4. Course Structure
5. Student Support
6. Faculty Support
7. Evaluation and Assessment

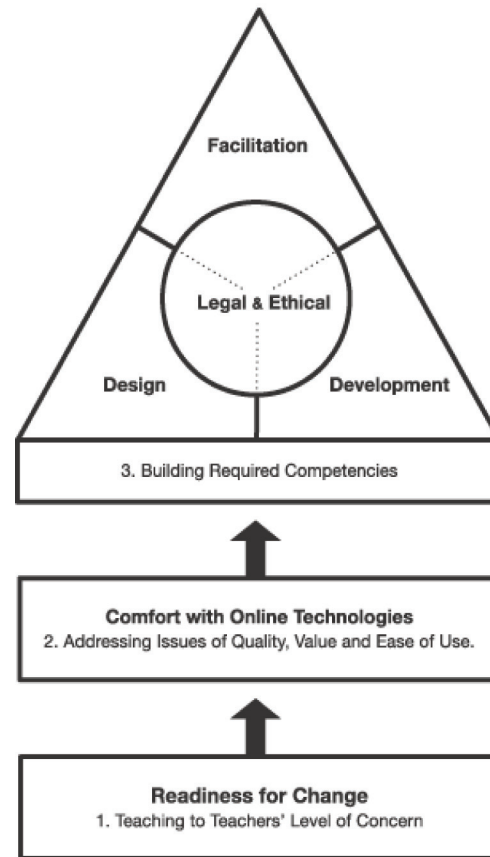
Across all levels of instruction, responsibility for achieving these benchmarks is shared by institutions, teachers and their program areas, and students. However, teachers are primarily involved in the Course Development, Teaching/Learning, Course Structure, and Faculty Support benchmarks.

MAIN FOCUS: A MODEL FOR PREPARING TEACHERS TO TEACH ONLINE

Preparing teachers to participate effectively in online instruction (e.g., Course Development, Teaching/Learning, Course Structure, and Faculty Support) requires carefully structuring professional development. The model below (Figure 1) illustrates the critical components such preparation should address.

Functioning both as a model and a hierarchy, Figure 1 suggests online teacher training begin by assessing and addressing teachers’ readiness to change as indicated through their expressions of concern about the impact of online teaching and learning. It then moves into increasing their comfort level with online technologies as they relate to quality of instruction, correlation of online instruction with the values of the institution, and the ease with which they can teach using online instruction. Only after these issues have

Figure 1. Preparing teachers to teach online



been addressed should teacher preparation focus on developing their competencies to teach online.

The remainder of this chapter is devoted to explaining and supporting the elements of this model and the progression it suggests.

Readiness for Change: A Concerns-Based Approach

For many teachers the transition from teaching in a classroom, where they have direct and personal contact with all of their students, to online teaching, where interactions are often restricted to a virtual environment, is a significant change. The process of change often involves exposing teachers to and integrating them in a number of technology-based teaching and learning activities. The goal is to

increase their knowledge, skill, and confidence in the use of educational technology over time.

The level of teacher readiness for online distance education training should be assessed prior to integrating teachers into any formal training experiences. Loucks-Horsley (1996), while studying teacher acceptance of change in science curricula, proposed that teacher readiness for change can be determined by the types of questions or concerns they express about the change or innovation being considered. This concerns-based approach identifies a seven-level hierarchy of teacher readiness (see Table 1).

Teacher concerns move from the lowest level, Awareness, upward. At the lowest stages, stages 0 through 2, the teacher is moving through levels of considering the innovation as a teaching tool. During stages 3 and 4 the teacher's energy is focused on using and refining use of the tool to optimize teaching and learning experiences. The highest two stages, 5 and 6, show teachers moving into the creative realm that extends the innovation further into unanticipated or developed areas. Naturally, different teachers will move through the hierarchy at different rates and many may never reach the upper levels.

Training should be geared to the level of readiness being expressed by a teacher. In a recent project in Oman, Sales (2007) reports seeing teachers express concerns from the lowest levels to the highest. Some teachers, although asked to participate in a pilot of online teacher training,

simply chose to ignore the opportunity (Stage 0). Others expressed their concerns by asking questions about the project's purpose and the amount of time they would need to commit to it (Stages 1 and 2). Even further up the hierarchy, teachers expressed concern about the time it was taking away from other instructional approaches and possible effects on students (Stages 3 and 4). Within Oman's Ministry of Education some of the trainers participating in the project began suggesting modifications and adaptation of the online learning to better reach learners and achieve desired outcomes (Stage 6).

In some situations the full spectrum of concerns may be represented within the population to be trained. In these cases a series of training interventions will likely be required to reach teachers at different levels of concern. Institutions, having limited resources for the integration of an innovation, may need to make decisions about their ability to provide training to teachers at every level.

Characteristics Influencing Adoption of Technologies

There are many political, cultural, economic, ethical, and resource issues that impact teacher ability to prepare for and use online distance education. For example, Sales and Emesiochl (2004) report on a civil service retirement act in the Republic of Palau which forced technology-trained teachers into retirement and flooded schools with untrained

Table 1. Typical expressions of concern about an innovation (from Loucks-Horsley, 1996)

Stages of Concern	Expression of Concern
6. Refocusing	I have some ideas about something that would work even better.
5. Collaboration	How can I relate what I am doing to what others are doing?
4. Consequence	How is my use affecting learners? How can I refine it to have more impact?
3. Management	I seem to be spending all my time getting materials ready.
2. Personal	How will using it affect me?
1. Informational	I would like to know more about it.
0. Awareness	I am not concerned about it.

teachers. Sales (2007) also reports how a number of teachers in the Sultanate of Oman resisted the adoption of online training because they felt it required them to participate in training on their own time, rather than being released from their teaching responsibilities, as they historically have been, to participate in face-to-face training.

Further, an individual's level of readiness as reflected in the concern-based approach (Loucks-Horsley, 1996) to teacher development discussed above, is strongly influenced by his or her personal beliefs as well as the environment in which he or she lives and works. Teachers' perceptions of a specific educational technology and their beliefs about their own ability to use it easily, successfully, and with better results, strongly influence their willingness to consider adoption of that technology.

In their chapter on the adoption of learning technologies, Wilson, Sherry, Dobrovolny, Batty and Ryder (2001), argue in support of the validity of the STORC approach (Rogers, 1995) when applied to technology interventions in education. STORC is an acronym for a set of characteristics considered during adoption of innovations. These characteristics represent attributes or conditions that must be evaluated favorably before an innovation has sufficient appeal to reach a given level of adoption. In addition to the original set of characteristics (simplicity, trialability, observ-

ability, relative advantage, and compatibility), Wilson, et. al. (2001) proposed a condition of support be added, thereby changing the acronym to STORCS (see Table 2).

The categories of characteristics in this approach may be independent of each other, or may have an influence on each other. However, they do not have a hierarchical or ordinal relationship. Rather, the point Wilson and his co-authors make in their presentation of this approach is that the more characteristics present, the greater the likelihood an innovation will be successfully adopted.

Professional development programs must consider teacher responses to each of the question types listed in the STORCS approach. Training interventions should help teachers understand and generate thoughtful and positive answers to these questions. Their affirmation of these questions will significantly influence their approach to, and enthusiasm for, online teaching.

Instructional Design

The EDUCAUSE Center for Applied Research (ECAR) recently sponsored a study to examine the e-learning activities in higher education entitled, *Evolving Campus Support Models for E-Learning Courses*. In a summary of the report's findings, Arabasz and Baker (2003) identified major

Table 2. An adaptation of the extended STORC approach to adoption of an innovation (as presented by Wilson, et. al., 2001)

Category		Characteristic
S	Simplicity	Is the innovation easy to understand, maintain, and use? Can it be easily explained to others?
T	Trialability	Can the innovation be tried out on a limited basis? Can the decision to adopt be revised?
O	Observability	Are the results of the innovation visible to others, so that they can see how it works and observe the consequences?
R	Relative Advantage	Is the innovation seen as better than that which it replaces? Is the innovation more economical, more socially prestigious, more convenient, and/or more satisfying?
C	Compatibility	Is the innovation consistent with the values, past experience, and needs of the potential adopters?
S	Support	Is there enough support to do this? Is there enough time, energy, money, and resources to ensure the project's success? Is there also administrative and political support for the project?

concerns of online teachers related to distance education.

The first concern cited was “lack of knowledge to design courses with technology” (p.4). This concern is supported by Siragusa (2000). He argues that online teachers who do not possess the necessary skills in instructional design are increasingly being encouraged to develop online courses. He states:

Instructional design decisions that lead to the way in which students learn on the Internet are being placed in the hands of lecturers who are only just coming to grips with online learning and the use of the Internet. ... Research and development for online learning has not yet caught up with the pace at which courses are appearing on the Internet. Instructional design principles that were developed for computer-assisted instruction appear to be overlooked by those now developing materials for the Internet. (p.1)

Instructional design is the process of planning for the development and delivery of effective education and training materials. Instructional designers use a variety of models that ensure a careful and systematic process is employed. Effective processes begin with a needs assessment and continue on to examine content/learning requirements, learner needs, the learning environments, delivery systems, tools and resources available for development and delivery, as well as other resources and constraints that will impact the project (e.g. financial resources, time available for the project, talents and experiences of those working on the project, social or political pressures). This information is then used to develop learning outcomes, select instructional strategies and techniques, guide the selection of instructional resources, and development of course content.

When applied in distance education, or other forms of course development, instructional design results in carefully structured and thoroughly

documented plans for the production of the online course materials. These plans provide an opportunity to carefully review content, sequence methods and assessment to ensure the most instructionally sound course is being developed. This documentation also serves as an excellent resource when conducting maintenance evaluations or implementing revisions to the course structure, content, or function.

Concerns are expressed among online teachers and distance education scholars regarding the preparation of teachers to create courses for the online environment. These concerns highlight the need for professional development programs that emphasize the creation of instructional design competencies among those responsible for course production.

Facilitation

Another significant concern of online teachers identified by Arabasz and Baker (2003) was “a lack of confidence in use of technology in teaching” (p.4). This concern is well founded given that online instruction requires teachers to use a variety of tools and techniques which are new to them. One of the recognized keys to the success of online courses is the facilitation of learning by online teachers (Jaques & Salmon, 2006; Salmon, 2000, 2002). This involves online communication with students and the creation online learning environments that require or encourage communications between students.

Stamper and Sales (2001) state that through frequent, timely, and personal communications with online students, teachers create the perception that they are close at hand — a “close apparent” distance. They argue this communication-enhanced relationship helps distance learners feel they are recognized, contributing members of the course. Stamper and Sales go on to suggest that by creating a close, apparent distance, instructors can

increase learner satisfaction with online courses and reduce drop-out rates.

Salmon (2000, 2002) has conducted action research and published on the facilitation of online courses. Her work illustrates to teachers what she believes are critical skills and techniques specific to facilitating online courses. Through effective use of the e-moderating and e-activities behaviors she promotes, Salmon believes online learning opportunities can be optimized.

Facilitation skills are essential competencies to be included in online teacher development. Training should include modeling of techniques that increase communications. Teachers should be encouraged to plan frequent communications and to promptly address specific student needs.

Development

Course development is the actual production of the software version of a course for online delivery and the supporting instructional materials. Where a learning content management system (LCMS) is being used, online course development is likely to involve teachers in populating content presentation templates with text, graphics, photographs, and other instructional resources. Of course, working with the template interface and different media assets that need to be in the appropriate digital formats can be technically demanding. Since most teachers are not software geeks, this often presents a challenge to be addressed through support services or as part of the professional development program.

In the commercial e-learning development world, course production is a team process (Sales, 2002). Subject matter experts work with instructional designers, programmers and Web-developers, graphic artists, animators, database specialists, and media production professionals. Through a collaborative and iterative process, the instructional design is transformed into a functioning online course presentation, complete

with management, record-keeping, and administrative features.

Some efforts to use a team approach have been undertaken in higher education (Wells, Warner & Steele, 1999). Anne Arundel Community College, for example, created an Online Academy to help instructors develop skills needed to prepare and deliver online courses. Even in this effort, however, online teachers are still expected to develop the course “using software he or she is comfortable working with.”

Most institutions expect online teachers to acquire the skills needed to develop and maintain their courses. Arabasz and Baker (2003) report that across all levels of higher education institutions, only 8% of institutional effort directed at online learning is spent on creating e-learning course elements. Instead of investing in course development, institutes are devoting resources to such areas as Web-based development tools, online references and resources, listservs, and help desks.

Each professional development program for online teachers needs to determine its own institutional competency requirements based on the unique combination of delivery system components and support options. At a minimum, teachers need to have a thorough understanding of development options and the vocabulary necessary to communicate with other members of the development team.

FUTURE TRENDS

Legal and Ethical Issues

Numerous legal and ethical issues are associated with online distance education. Copyright law, which has special interpretation when it comes to online courses (Hoffman, 2000), is often seen as the only legal issue of concern. However, Ko and Rossen (2001) in their book on online teaching identify a range of issues including copyright,

acceptable use, plagiarism, and ownership of the newly created course materials. Mpofu (2002) provides a more comprehensive list by including discussions of privacy and licensing/piracy.

Professional development for online teachers must examine all relevant legal and ethical issues. Issues such as copyright and ownership need to be considered from the perspective of how they will influence design decisions. Acceptable use and plagiarism should be covered as they relate to informing students of institutional policies, posting information online for others to access, and evaluating student work. Issues of software licensing and piracy may influence decisions related to development and delivery environments as well as assignments given to students. Finally, the legal and ethical issues associated with data privacy in terms of students' records and personal safety should also be addressed.

CONCLUSION

Professional development to prepare teachers for online distance education must accommodate the unique needs of each individual teacher. Teacher concerns, readiness to adopt new technologies, and an institution's specific policies, systems, and support services all contribute to the need for individualized or custom tailored training experiences.

Institutions and trainers must recognize that development of online teachers requires an ongoing process, not a single event. Professional development programs need to offer a series of graduated experiences that move teachers along a continuum. Taking them from an entry point based on each teacher's unique needs to an exit point based on institutional competency standards.

Professional development programs should engage teachers in activities that move them from their current level of understanding in each of the follow domains.

- **Readiness for Change:** Teacher readiness for change can be determined by the types of questions or concerns they express about the change or innovation being considered.
- **Comfort with Online Technologies:** Teachers' beliefs about their own ability to use it easily, successfully, and with better results strongly influence their willingness to consider adoption of that technology
- **Design:** Analysis, instructional design, creative design, and in some cases interface design. This domain encompasses the skills and processes necessary to take a course from the concept stage to the point where it is ready for production.
- **Development:** Creation of the media assets that support the content (produced during the design phase), production of the software product (through programming or the use of a tool), and quality assurance testing. The development domain begins with the design and ends with a fully functional, error free, course.
- **Facilitation:** Instructor skills and behaviors, and strategies and techniques for course delivery. Facilitation involves taking the completed course and creating a dynamic learning experience for students. This domain involves teachers in presenting content, engaging students, providing feedback, and otherwise creating a positive learning environment online in support of the "automated" portion of the course.
- **Legal and Ethical Issues:** Laws, rules, regulations, policies, procedures, and associated consequences. This domain, as shown in the Competency Model, overlaps the other three domains. Legal and ethical competencies influence teachers' execution of competencies in each of the other domains.

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KEY TERMS AND DEFINITIONS

Apparent Distance: The perceived proximity of faculty and students in a distance education environment. Close apparent distance is the term used to describe a relationship that is perceived as positive, supporting, in regular communication—a relationship in which the student and faculty are well known to each other and where communications flow easily.

Competency: A statement that defines the qualification required to perform an activity or to complete a task. Faculty competencies for online distance education identify the qualifications needed to be successful in this job.

Course Development: The actual production of the software version of a course for online delivery and the supporting instructional materials. Faculty involved in the development of online courses are often required to have technology specific knowledge and skills – digitizing, converting file formats, operation of specific software programs, and programming.

Data Privacy: Current United States laws provide protection to private data, including students' performance data. Online distance education environments need to address privacy issues though design of courses and security features built into record keeping systems.

Fair Use: A term defined in the United States copyright act. It states the exemption for schools to some copyright regulations. (This exemption pre-dates many current educational applications of technology and may be not address some online learning situations.)

Instructional Design: The process of planning for the development and delivery of effective education and training materials. Instructional designers employ a systematic process that considers learner needs, desired learning outcomes, delivery requirements and constraints, motivation, psychology, and related issues.

Online Teaching: Delivers instruction using a computer network, usually the Internet, without requiring face-to-face meetings of students and faculty. Courses may be synchronous, asynchronous, or a combination. (also commonly referred to as online distance education, distance education, online learning, and distributed learning)

Piracy: Refers to the illegal or unlicensed use of software.

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Chapter 1.3

Reflective E-Learning Pedagogy

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ABSTRACT

The number of learning opportunities that are technology mediated (e-learning) is increasing as institutions of higher learning discover the value of technology in reaching larger numbers of students. The challenge for those instructors who implement such technology in higher education is to correctly apply pedagogy that has been successful in student learning to these new delivery methods. In some cases, new pedagogy is being created. For successful facilitation of knowledge to take place, instructors must make students partners in the process, help them learn to reflect about their activities, and focus on course outcomes rather than the technology itself. We will share key e-learning pedagogy from different areas of specialty (mathematics education,

special education, and instructional technology) in higher education.

INTRODUCTION

Dewey (1933, p. 35) says: “While we cannot learn or be taught to think, we do have to learn how to think well, especially how to acquire the general habit of reflecting.”

Institutions of higher education are realizing the value of the tech-mediated approach (E-learning) as a way to engage learners at a distance as well as enhance courses that meet with the instructor in the traditional setting (Edwards, 2005). While technology has made this a viable teaching alternative, the instructor has to make a concentrated effort not to let the technology overwhelm the teaching objectives of the course.

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Instructors must engage the learners as collaborators in the process. New E-learning pedagogy includes discussions of what to do if technology fails and how to address students' concerns about isolation from other learners. This means constructing a new way of thinking and reflecting on their own instruction, while maintaining the traditional emphasis on course objectives.

When examining E-learning through the lens of constructivism it is important to understand the motivation of those involved, both the instructor and the students (Vygotsky, 1987). When students are asked to engage in problem solving that is relevant to their culture, true learning is constructed (Santmire, Giraud & Grosskopf, 1999). Students in teacher education programs must examine their own culture and learn to reflect on their knowledge, skills, and dispositions. The instructor may use this reflection as a way to evaluate growth both in terms of the E-learning environment and the course content. In this chapter, we will discuss 1) roles of the instructor and the student in E-learning, 2) key pedagogical approaches to increasing students' ownership in E-learning, and 3) reflection as a means of evaluating a student's growth in E-learning.

BACKGROUND

Learning from a distance is not new. For well over 100 years, universities have offered alternatives to visiting the main campus for classes. The first of these, in the United States, were offered by Pennsylvania State University in the form of correspondence by mail courses in 1892 (Shearer, 2004). There is always a demand for access to university classes close to home. Many institutions offer distance as well as face to face instruction. In 2000–2001, 90 percent of public 2-year and 89 percent of public 4-year institutions offered distance education courses (National Center for Education Statistics, 2003). A technology-medi-

ated (E-learning) course is one that may incorporate a variety of technology-based educational strategies: synchronous and asynchronous collaborative communication, project/activity-based learning, and web-based interaction and feedback (Edwards, 2005). It may take place in a wholly online environment or in a combination of online and face-to-face interactions. Technology has made E-learning an attractive option, but technology does not insure successful implementation of coursework (McVay, Snyder, & Graetz, 2005).

According to Russell (1999), there are over 200 studies on technology for distance education that report no significant difference in student learning when technology, instead of traditional classroom approaches, are used to deliver course instruction. This research shows that students achieve similar outcomes despite different uses of media. So the value of technology-mediated learning needs to lie in convenience to the students, not in trying to boost their achievement over peers receiving typical instruction.

E-learning is essentially different from traditional education in that it requires changes in pedagogical approaches (Miller & King, 2003; Moore & Kearsley, 1996). One of the most frequently pointed out concerns about E-learning is the sense of isolation and lack of human contact among its users (Baek & Barab, 2005; Baek & Schwen, 2006; Hara & Kling, 2000). When students do not fully interact with the instructor and other classmates, they do not have ample opportunity to learn content. Interaction among the class community members is vital to the success of E-learning (Moore & Kearsley, 1996; Palloff & Pratt, 2001).

A great deal of research supports constructivist and student-centered pedagogical approaches (Anderson, 2004; Baek & Barab, 2005; Baek & Schwen, 2006; Bonk, Kim & Zeng, 2006; Carr-Chellman, Dyer, & Breman, 2000; Miller & King, 2003) as ways of increasing students' ownership and responsibility, which contribute

to the improved quality of learning. One of the methods that has been successful in E-learning courses is a collaborative learning community approach (Islas, 2004; Palloff & Pratt, 2001). Specific pedagogical approaches to implement the community approach include making students partners in the learning process and helping them to engage in collaborative inquiry and to learn to reflect about their activities (Baek & Barab, 2005; Baek & Schwen, 2006; Duffy & Kirkley, 2004; Palloff & Pratt, 2001).

If instructors are expected to provide students with a learning environment that engages students in real world problem solving using their own experiences and working with others, instructors also need to experience a similar opportunity, in which they can actively search for meaning in content and apply personal experiences (Knox, 1986). Having ownership of their learning, instructors will be more likely to reflect critically on their own teaching practices and may then generate new knowledge and attitudes toward teaching and learning. Teacher education programs and practices are becoming focused on the need to help teachers become more reflective about their teaching. Reflection helps us examine questions and explore our underlying assumptions, values and beliefs while it moves us into more uncomfortable zones to inform our practice (Al-Mahmood & McLoughlin, 2004; Brookfield, 1995). Therefore, reflection can not only help students understand underlying principles of practice (Dewey, 1933), but also assist instructors to measure students' growth.

Instructors must examine how their roles will change in the E-learning environment. They can do this by exploring new ways to approach course instruction using technology, and by researching the approaches that increase student learning within this environment. The final step in the process is to evaluate the effectiveness of the course by looking at students' growth. Traditional methods of assessment can be supplemented by

the instructor's and students' reflection about their growth as professionals and in the classroom.

DIVISION OF ROLES IN E-LEARNING

The techniques for working in an E-learning environment are often different from traditional face-to-face course preparation. The focus for the instructor needs to be on the overall course outcomes and objectives rather than technology issues (Bannan & Milheim, 1997; Rieber, 1993; Su, 2005). In a traditional format, the instructor assigns individual and group activities, welcomes some further communication during office hours and receives the completed assignment in person on the assigned date. When the instructor introduces technology into the course and eliminates some or all of the face-to-face interaction, then numerous other opportunities for dialogue and feedback must be present (Su, 2005). This communication can take many forms and the knowledgeable instructor evaluates and changes her methods of communication depending on the type of course, the type of student, and the type of technology that works best for each class.

COMMUNICATING WITH THE STUDENTS

The instructor in the E-learning environment must be committed to engaging students in communicating about the course content (Su, 2005). These interactions can take a variety of forms. The instructor may be seen by the students via video conference. Verbal communication can take place between students at multiple sites and the instructor. The instructor may also hold online office hours in a chat room or require chat room participation at certain times during the week. The instructor may also verbally communicate via phone. All of these are examples of real time synchronous communi-

cation, requiring everyone involved to participate at the same time. Asynchronous communication is more common in E-learning. The instructor will post assignments, questions and announcements. Students will respond whenever they access the computer. The instructor does need to be aware that the asynchronous nature of most online learning can create anxiety among the students, because no instructor is present (Sherry, Cronje, Rauscher, & Obermeyer, 2005). This anxiety can be mitigated by a clear and organized syllabus. The instructor must also respond frequently to communications from students, and above all, the instructor must model the type of information that is expected for satisfactory information exchange (Seaton, Einon, Kear, & Williams, 2004).

When implementing an E-learning course it is important to have a plan before the instructor starts the course, as well as contingency plans in case technology fails. Videoconferencing allows students at numerous locations to have access to the course in real time. It is helpful to have a facilitator present at each location that receives the broadcast. This person can help the instructor plan before the course starts. A facilitator can also help the instructor design the room layout and discuss the best utilization of the available equipment. The facilitator can also plan for breaks in the transmission and troubleshoot if connections fail. If no facilitator is present at the locations receiving the broadcast, then students should have a detailed class summary to follow in the event transmission is lost and they have to resort to alternative activities with their time.

ORGANIZATION AND FACILITATOR ASSISTANCE

Research from a distance learning class illustrates the need for constant communication between participating sites. Two regional campuses that are part of a large midwestern university in the

United States needed a course on working with students with special needs. The administrators at both sites agreed that having the course at the same time and conducted by one instructor would be efficient and cost effective. The study sought to compare the distance learning experiences of two groups of undergraduate education students. The data was collected at the end of the course using student evaluations. The first time this course was taught, a facilitator was present at both campuses. The instructor presented one week at one campus and the next week at the other campus. The alternative campus received the course via video conference. Twice during the ten week quarter the connection failed. The first time it was reconnected fairly quickly, but the second time the whole class time was lost. The instructor could communicate with the class in front of her, but the facilitator at the other campus did not know what to tell the other class. He was concerned with trying to fix the connection, so he did not answer the phone when the instructor called with an alternative assignment. The second time this course was held as a distance learning course, everyone involved was more prepared. The facilitators agreed to answer the phone quickly when a connection failed and the instructor agreed to have an agenda with alternative assignments available for each class period. The students were emailed the agenda prior to class each week. When the connection did briefly fail, everyone was prepared and the students felt that the class time was not wasted. The fact that both sites had a facilitator that worked to fix the technology problems immediately also created an atmosphere of cooperation and the feeling that the students' time was valued.

The results of the student evaluations support having a facilitator who was available at both sites and a more organized approach to foreseeing and solving technology issues (see Table 1). The student evaluations were not as concerned with technology and were not as negative for the second class. The use of a knowledgeable

technology facilitator was an important factor in the second course, which was perceived as more successful by the participating students. If the course is held online the instructor can still use the support of a technology facilitator. This form of technology support can be utilized for preplanning the course and deciding what aspects of available online tools will best meet the instructor's objectives. The instructor may need extra training in the use of discussion boards or chat rooms. They will also need to understand the procedures students need to follow to upload assignments. It is beneficial for the instructor to have the ability to troubleshoot some common technical issues. For example, when students upload to a web-based course, created in a format

like WebCT© or Desire2Learn©, the document will appear to upload, but if any extra characters (*, ', #) appear in the document name, it will not always successfully upload, which results in the instructor not being able to grade the document in a timely manner. The facilitator can help the instructor learn solutions for these common issues and be available as tech support when students run into more complex problems. This results in the students feeling supported throughout the course and allows them to focus more on content than the actual technology (Sherry, Cronje, Rauscher, & Obermeyer, 2005).

Table 1. Comments Related to Technology in the Distance Learning Course ©2007, Leah Herner-Patnode. Used with permission

Quarter	Theme	Comments
Spring 2005	What aspects of the teaching or content of this course do you feel were especially good?	What changes could be made to improve the teaching or content to meet the objectives of this course?
	Notes WebCT were <u>great</u> . (2)	I really didn't like the TV-web thing across campuses because I felt like I was distracted more and struggled with understanding the content when Dr. H was at Marion.
	WebCT was great	The technological issues were quite distracting. I think our class was the right type for good distance learning.
	Being able to reach you through email	Have two separate courses instead of sharing the same class time with another class through video conference.(2)
	Having Midterm online	We do not have the technology to facilitate class over a feed like this.
		Don't do online course. It's very distracting to the one that doesn't have the professor there.(2)
		The distance learning is a huge pain. I also never really understood what all the assignments entailed. The field word was a lot to be expected also.
		Do not do it over the web. There were too many problems trying to get connected to Marion. (4)
		I didn't really like the distance learning. (2)
		No technology. It was horrible and distracting. (2)
		Can't think of anything but it was weird having a distance learning class.
Spring 06	Course very organized. Outstanding encouragement of student participation. (3)	Format of class made it difficult to feel engaged or interested in material.
	Liked open discussion forum and testing format.	Pretty boring, going over on-line notes not necessary.

AWARENESS OF STUDENT NEEDS

The instructor must be aware of the areas of need demonstrated by each group of students. It is beneficial to discuss the technology expectations along with course objectives (Chickering & Erhmann, 1996). One example of using web-based course tools would be to have the syllabus state that all work is required to be posted in the web-based course dropbox using Microsoft Word. The upload is required by the start of class on the day the assignment is due, and students are responsible for checking to make sure their work is successfully loaded. The syllabus also states that students are required to check for updates posted in the announcement section and access their student email. By making these requirements a part of the official syllabus, students will view them as a natural part of the course expectations.

TECHNICAL SUPPORT

The ability to access technical support is important. Students who are new to technology may have an increased need for extra instruction. This can be accomplished by open hours in computer labs operated by course facilitators, or general university tech support, by utilizing peers, or by making appointments for face-to-face assistance with the instructor. Once the student feels confident with the technology, the student can focus on the course content. When students are frustrated about technology they tend to persevere on that issue and it distracts them from the course objectives. Some student evaluation comments from the first time the distance learning class was taught illustrate this point. When students were asked to list changes that could be made to improve the teaching or content to meet the objectives of the course, there were a number of students who could only focus on the technology (see Table 1). Of the forty-four comments from students for this quarter,

twenty-two referred to the technology aspect of the course versus the course content. Compare this with the Spring 06 comments when out forty comments only six related to the technology, and four of the six were positive. When the technology issues were addressed more effectively, both in terms of planning and student support, the final course evaluations showed improvement in the rating of the instructor. The course content did not change from Spring 2005 to Spring 2006, but the final evaluations were an average of 4.2 on a 5 point scale in all categories for Spring 2006 versus a 3.7 for the previous course when the students felt more uneasy about technology. If the instructor, with the help of technical support, wants students to focus on course content, then she has to create a comfort level with technology that helps them see technology as a tool that enhances, rather than hinders the overall course presentation. Once the instructor defines her role and the role of her students it is important to increase the students' ownership of the course content.

PEDAGOGICAL APPROACHES AND LEARNERS' OWNERSHIP

Increasing students' ownership and responsibility will lead to quality work. A vital way in which to increase learners' ownership and responsibility is the collaborative learning community approach (Baek & Barab, 2005; Baek & Schwen, 2006; Islas, 2004; Palloff & Pratt, 2001). Most salient pedagogical approaches include making students partners in the learning process, helping them to engage in collaborative inquiry and to learn to reflect about their activities (Duffy & Kirkley, 2004; Palloff & Pratt, 2001). Let us discuss these approaches in detail, with examples.

Students as Partners

In the process of inviting students as partners, it is important to consider a new power relationship and dynamics between the instructor and the students and to keep a balance between pre-planned teaching activities and emergent learning activities. Even though macro-level activities can be designed by the instructor, their realization in reality is uncertain. The instructor needs to be flexible enough to allow emergent learning agendas, which give students opportunities to negotiate meaning anew. Learning can take forms quite contrary to what the instructor intended (Baek & Barab, 2005). This implies that planned procedures and structural elements should be intertwined with students' emergent activities and needs in the design. The main considerations are providing minimal structures and allowing for opportunities in which students can contribute in defining their own learning activities. When the instructor works with adult learners such as teachers, the instructor needs to link class activities to students' interests by asking and capitalizing on learner-generated issues (Duffy & Kirkley, 2004). The structure and activities need to be flexible enough to create a learning environment that involves facilitating an intellectual curiosity utilizing students' own experiences. For example, main discussion topics and venues can be planned in advance, but this should be kept minimal, so that the culture of the class community can be filled by the day-to-day professional experiences of the students.

Collaborative Inquiry-Based Learning

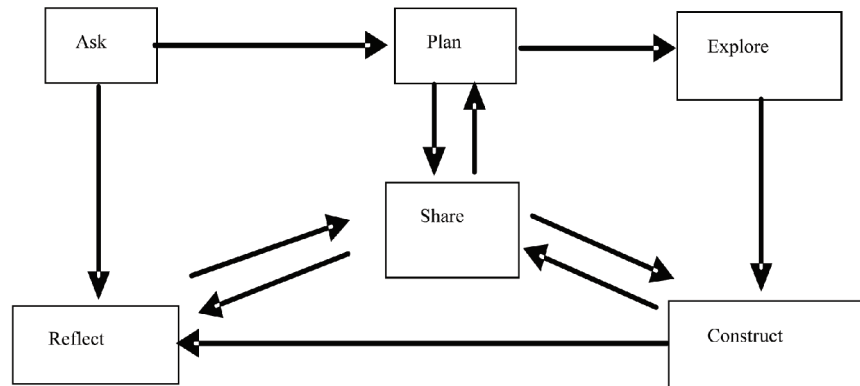
Inquiry-based learning is an instructional approach that emphasizes students' active quest for meaning. It is a way of exploring the world through the process of asking questions, investigating, and making decisions to solve problems. Inquiry-based learning may take many different forms.

First, as a pedagogical term, it includes various instructional models and approaches to facilitate higher-order thinking skills, using inquiry as a main conduit. Second, as a more generic term, it involves critical reflections on the learning processes on the part of learners themselves (Baek & Barab, 2005). Inquiry-based learning is established when learners take the lead in the learning process, thereby enhancing meaningful learning (Brown & Campione, 1994; Cognition & Tech. Group at Vanderbilt 1997; Collins, Brown, & Holum, 1991; Van Zee, Hammer, Bell, Roy, & Peter, 2005). Inquiry activities increase students' engagement and understanding, and also teach the scientific process (Polacek 2005).

Inquiry usually takes the form of processes. Dennen (2005) suggests that different stages of discussion - initiation, facilitation, conclusion, feedback - can be utilized in the process of inquiry. Lim (2004, p. 633) introduces the elements of the inquiry process (Figure 1) which are: Ask, Plan, Explore, Construct, and Reflect. These elements interact with Share activities via discussion and collaboration. The inquiry process can be implemented by individual students or in a collaborative team and is more recursive and circular than linear as it evolves.

- *Ask*: This element presents a real-world, authentic situation, scenario, or case in which students can relate their experiences to topics in instruction. Depending on the level of the students, the level of difficulty and terminology in the scenario will be varied.
- *Plan*: This element helps students to develop investigation strategies to find information in order to answer the generated questions. In a team project, the tasks and roles need to be defined as a part of the Plan.
- *Explore*: The students engage in the process of investigating the problem by collecting relevant information. The process

Figure 1. Display of inquiry-based learning (©2007, Leah Herner-Patnode. Used with permission)



of exploration will include the use of various resources such as GIS, Probeware, forensic, and educational games.

- **Construct:** The students analyze what they have found, and synthesize and build their own knowledge relative to the original question, based on the information obtained during the 'Exploration' Incorporating the concept of learning-by-design, learners will construct their knowledge via projects using Podcast, Wiki and Blogs.
- **Reflect:** The students have opportunities to reflect on their conclusion as well as on the entire inquiry learning process. Students' understanding on the topic/problem will be assessed.

The instructor needs to help students to create their own meaning while engaging in the collaborative learning process. Students need to be actively involved in social enterprise as members of the learning community and to have opportunities to produce objects that show their understanding from the collaborative inquiry (Wenger, 1998). In order to successfully facilitate collaborative inquiry, the instructor needs to provide a supporting structure that effectively supports the learning process, sustains student engagement, and helps

students maintain focus on the performance objectives (Duffy & Kirkley, 2004).

In order to facilitate collaborative team inquiry, a number of team members will be evenly distributed among the weeks. It is important to emphasize that the main purpose of the collaborative inquiry is not to simply reduce the amount of work each individual needs to do, but to create synergy which can be difficult to achieve when working alone. Each week, for example, one of the teams serves as "hosts" of the online community; the team's responsibility is to foster communication in the online community and to facilitate students' learning. In order to foster online dialogues, the team shares the roles of initiator, supporter, and wrapper.

During the collaborative inquiry process, the instructor needs to scaffold the collaborative critical thinking to encourage challenging perspectives, and to provide a supporting environment (Duffy & Kirkley, 2004). In the inquiry process, the instructor needs to encourage students' individual and collective reflection/feedback on their participation and learning. Specific instructions and examples on good/active/responsible participation and non-examples are useful. Providing opportunities to reflect and evaluate their learning will help them increase ownership in their learning. It is useful to create rubrics for students to evaluate their own participation and learning/outcomes

as well as other teams' learning/outcomes. Later, students need to explain and defend the results of their inquiry. If the instructor invites students' voices in the development of the rubrics, it will help students develop ownership in their learning.

Student Participation in the Course Improvement

Along the same vein with the mentioned approaches, it is important to have students' participation in the course improvement. The instructor needs to structure frequent discussions about what is working with the course and what can be improved. A specific forum such as a name of a *Café*, *our learning community*, and *our voice*, can be dedicated to the discussion in which learners freely post their experience about the course. When the majority of community members want to modify a direction of a certain activity to better support learning, it needs to be seriously considered and possibly incorporated into the course design within the extent to which it does not cause confusion. In the next section, we will discuss a way of assessing students' learning in E-learning.

REFLECTION AS A MEANS OF EVALUATING A STUDENT'S GROWTH

"Reflection leads to self knowledge and this is fundamental to the development of our professional practice", says Kuit, Reay & Freeman (2001, p. 139). This chapter views reflection as a means of learning and a tool for assessment. In order to understand why and how reflection demonstrates a student's learning, this section focuses on several different emphases in the study of reflection and ways of assessing reflection.

Emphases in the Study of Reflection

Reflection as Process. "[Reflection] is what a teacher does when he or she looks back at the teaching and learning that has occurred, and re-constructs, reenacts, and/or recaptures the events, the emotions, and the accomplishments. It is that set of processes through which a professional learns from experience" (Shulman, 1987, p. 19). This view focuses on reflection as a reactive process, which is part of learning through teaching. Reflection as a process should be seen as a spiral procedure (Hannary, 1994; Lee, 2000), which produces informative useful knowledge for our future decisions and action (Killion & Todnen, 1991).

Reflection in Practice. When teaching, instructors frequently encounter an unexpected student reaction and attempt to adjust instruction to take into account such a reaction. According to Schön (1983, 1987), reflection can be seen in two time frames: reflection-on-action, which can occur before and after an action and reflection-in-action, which can occur during the action. Both reflection-in and reflection-on-action help reflective practitioners to develop and learn from their experience. This view supports "integration of experience with reflection and of theory with practice" (Osterman, 1990, p. 135).

Reflection in Context. Schön's (1983, 1987) portrayal of reflection has been criticized, because it does not explicitly include any social processes within a learning community. The critics claim that although reflection can be individualized, it can also be enhanced by communication and dialogue with others. Therefore, instructors and students should be encouraged to consider their own practice as well as the social conditions of their practice. This idea of reflection has led to work on the issue of social practice (Solomon, 1987), which includes consideration of ethical, moral, and political principles (Colton & Sparks-

Langer, 1993; Kemmis, 1987; LaBoskey, 1993; Valli, 1992; Zeichner & Liston, 1996).

Reflection in E-learning. When reflecting during the E-learning process, the focus will be on teaching and learning practices in a clearly different way and under new environmental conditions. The main difference between reflection in the E-learning environment and reflection in the general education setting is the communication mode. In the traditional setting, students reflect verbally or in writing (Lee, 2000), whereas students in the E-learning setting reflect through the written communication mode, when they are in discussion boards and chat rooms. It is clearly a new way of talking to each other. These new forms of communication and new environments for learning by using Internet technologies have the potential of collaborative reflection (Bain, 2000; Churchill, 2005).

Reflection to Measure a Student's Growth

Reflection is now seen as a general professional skill. Teacher educators and curriculum developers have been endeavoring to develop systematic criteria to assess one's reflection, as do E-learning instructors. As mentioned earlier, E-learning requires changes in pedagogical approaches (Miller & King, 2003; Moore & Kearsley, 1996) and new methods to assess student learning and performance. This section introduces reflection as an assessment tool to measure student beliefs, knowledge, and disposition. The following areas are ways to measure a student's growth by evaluating the reflection taking place in the E-learning setting.

Content of Reflection. Different issues are considered by different individuals while they have experiences in the same context (Goodman, 1994; Lee, 2005; Sparks-Langer et al., 1991; Taggart, 1996; Van Manen, 1977; Valli, 1992; Zeichner & Liston, 1996). Since each individual screens a

given situation using his/her own filter, there are differences in the content of reflective thinking by individuals. Reviewing content of reflection provides the information about which issues should be addressed and discussed in preservice teacher education and professional development programs.

Attitudes of the Reflector. Dewey (1933) claims that the necessary attitudes for reflection are open-mindedness, responsibility, and wholeheartedness. An individual who is open-minded does not attempt to hold the banner for one, and only one perspective, and does not look to other perspectives with argumentative delight (LaBoskey, 1994; Van Manen, 1991). An attitude of responsibility involves careful consideration of the consequences to which an action leads. Responsible teachers ask themselves why they are doing what they are doing and consider the ways in which it is working, why it is working, and for whom it is working (LaBoskey, 1994). Wholehearted teachers regularly examine their own assumptions and beliefs and the results of their actions and approach all situations with the attitude that they can learn something new. According to Goodman (1991), wholeheartedness enables preservice teachers to work through their fears of making mistakes, being criticized, disrupting traditions, and making changes. Thus it provides a basis for action and growth.

Depth of Reflective Thinking. Lee (2005) proposed three levels of reflective thinking, Recall (R1), Rationalization (R2), and Reflectivity (R3). R1 and R2 are considered reactive and R3 is regarded as proactive. At the R1 level, one describes what they experienced, interprets the situation based on recalling their experiences without looking for alternative explanations, and attempts to imitate ways that they have observed or were taught. At the R2 level, one is looking for relationships between pieces of their experiences, interpreting the situation with rationale, searching for "why it was," and generalizing their

experiences or introducing guiding principles. At the R3 level, one approaches his/her experiences with the intention of changing/improving in the future, analyzes his/her experiences from various perspectives, and is able to see the influence of his/her experiences/actions in other situations.

Attributes of Reflective Practitioners. In E-learning, students sometimes do not have opportunities to demonstrate their growth in practice, due to the lack of interaction with the instructor and other classmates. However, it is still essential to discuss best practices, such as the characteristics of an effective teacher and effective instructional approaches, through a discussion board or reflective statements. The differences between reflective teaching and teaching that is not reflective are discussed by many teacher educators (Gipe et al., 1991; Pollard & Tann, 1994; Taggart, 1996; Zeichner & Liston, 1996). Table 2 compares the differences between technicians and reflective practitioners in approaching a situation. Teachers as technicians and teachers as reflective practitioners approach a situation in different ways. This summary provides ideas for practice that teacher educators must encourage preservice and in-service teachers to carry out (See Table 2).

The reflective practitioners described by researchers are people who make decisions; have an understanding of people; are concerned with the human, as opposed to the technical, aspects of problems; and have a need for affiliation and

a capacity for warmth. They are also spontaneous, curious, adaptable, and open to new events and changes.

FUTURE TRENDS

E-learning is a rapidly growing instructional approach. Almost every institution offers some form of E-learning opportunity to its students. This will continue to grow and evolve as a viable means of instruction. To make sure E-learning is as effective as the best traditional courses, universities have to support instructors in learning about facilitating an E-learning course and the unique pedagogy involved. Continued research on best practices should be disseminated to the higher education community.

The learner-centered collaborative community approach has been considered as a viable way to increase students' ownership in E-learning. It is congruent with the result of a higher-education survey (Bonk, Kim & Zeng 2006) about the future prediction of pedagogical approaches for E-learning. It identified that group problem-solving and collaborative tasks, and authentic cases and scenario learning will be the most widely used instructional approaches in E-learning courses. In order to facilitate the learner-centered environment, the instructor needs to be a co-learner and

Table 2. Differences between technicians and reflective practitioners ©2007, Leah Herner-Patnode. Used with permission

Teacher as Technician	Teacher as Reflective Practitioner
• Locates problems entirely in the students and their actions • Looks for a program or technique to fix the deviant behavior of students • Does not attempt to examine the context of the classroom • Does not seriously question the goals or values embedded in her/his chosen solution • Accepts the problems as given and tries to solve them	• Examines teacher's own motivations and the context in which the problem occurs • Looks for distinct ways to pose the problem and attempts to get a different perspective on the students and the issues involved • Questions teacher's own beliefs and orientations • Is responsive to the unique educational and emotional needs of individual students • Questions personal aims and actions • Constantly reviews instructional goals, methods, and materials

partner in the practice of reflection about teaching and learning.

In the coming years, the technologies that are viable in E-learning will rapidly increase in number. Examples of such technologies will include wireless technologies, peer-to-peer collaboration tools, sharable learning/content objects, simulations and games, virtual worlds, and intelligent agents. The instructors need to be proactive in learning relevant technologies and consider appropriate pedagogical approaches that capitalize on emerging technologies for E-learning.

As mentioned earlier, reflective thinking and reflective practice are now considered as general professional skills. In the context of E-learning, teacher educators should endeavor to find ways of facilitating collaborative reflection, which will strengthen a collaborative learning community and collaborative inquiry in an E-learning course. Another area to which greater attention must be paid is in developing criteria to systematically assess reflection skills. By doing so, teacher educators can not only get evidence of students' growth but also collect insightful information that will improve the quality of an E-learning course.

CONCLUSION

In this chapter, we have discussed the roles of the instructor and student in E-learning, key pedagogical approaches to increase students' ownership in E-learning, and facilitating reflection using E-learning activities. The evolution from instructor as giver of knowledge to instructor as facilitator and collaborator is a difficult route for higher education to follow. The move away from traditional course delivery often changes the role of the instructor. The instructor needs to have an organized approach with access to technology support, so that the focus can be on learner outcomes rather than technology issues (Bannan & Milheim, 1997; Rieber, 1993; Su, 2005). Communication is

important in the E-learning setting and can take many forms. A good instructor gauges what works best for content delivery and utilizes the most effective form of communication with the students. An instructor who understands student needs and accommodates those who need help will provide a course that is organized and prepared for technical difficulties, and whose students will gain a good perception of the overall content. Research supports constructivist and student-centered pedagogical approaches (Anderson, 2004; Baek & Barab, 2005; Baek & Schwen, 2006; Bonk, Kim & Zeng, 2006; Carr-Chellman, Dyer, & Breman, 2000; Miller & King, 2003) as a means to increase students' ownership and responsibility of the quality of their learning. If the instructor wishes to model the role of reflective practitioner, then the instructor needs to examine E-learning pedagogy carefully while constructing a course that requires critical thinking and reflection skills. It is in this way that we move towards using technology as a tool that effectively meets course objectives.

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KEY TERMS AND DEFINITIONS

Asynchronous Communication: Communication between two or more parties is not synchronized or happening in real time. The person communicating can submit her questions

and statements at any time and other people in the class can see the communication when they choose to read it.

Collaborative Inquiry: It is the active quest for meaning. It involves a process of asking questions, investigating, and making decisions to solve them as a way of exploring the world. This may take many different forms. As a pedagogical term, it includes various instructional models and approaches to facilitate higher-order thinking skills, using collaborative inquiry as a main conduit. As a more generic term, it involves critical reflections by learners themselves on their learning.

Distance Learning: Coursework does not take place in the traditional manner with the instructor working face-to-face with the students. Students communicate with the instructor via technology.

Learner-Centered Approach: A pedagogical approach that respects learners' diverse needs and places learners' voices in the center of the course design. It emphasizes learners' ownership through

learners' active search for meaning in content and application of personal experiences.

Learning Community: A curricular structure consists of a group of learners. It encourages learners to actively participate and to contribute to the process of learning. The instructor typically serves as a co-learner and partners in reflective practice about teaching and learning.

Reflection: Dewey (1933, p.7) identified reflection as one of the modes of thought: "active, persistent, and careful consideration of any belief or supposed form of knowledge in light of the grounds that support it and the future conclusions to which it tends"

Technology Mediated Course: A course that may incorporate a variety of technology-based educational strategies: synchronous and asynchronous collaborative communication, project/activity-based learning, and web-based interaction and feedback.

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Chapter 1.4

Higher Education's New Frontier for the E–University and Virtual Campus

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INTRODUCTION

Technologies entered in education since their first appearance and were used both for improving the efficacy and efficiency of traditional teaching and for creating new teaching-learning opportunities (Galliani et al., 1999). The definition “educational technologies” was coined in the 1950s to describe the equipments to be used in teaching-learning controlled environments. The introduction of the computer in teaching led to the definition of “new educational technologies” to mark the overcoming of traditional systems like audio-visual media (i.e., cinema, radio and television) with the new digital medium.

In the 1970s the Association for Educational Communications and Technology (AECT) formulated the definition of instructional technology as

“... the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning. ... We can think about it as a discipline devoted to techniques or ways to make learning more efficient based on theory but theory in its broadest sense, not just scientific theory”.

The Internet in the 1990s introduced further elements of innovation in the use of technologies for education with an exponential growth of instruments and resources leading to the transition from face to face (f2f) teaching to online teaching-learning experiences.

The Internet more than other technological experiences entered in the educational systems all over the world and is today marking a revolution in continuous education and lifelong learning.

Universities, like many other institutions, have been fully invested from the innovation in teaching-learning processes and often participated

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in the transformation of distance education in on line education. Among the best examples on this regard are the Open University and the Phoenix University online, where people can earn they degrees fully online.

After delay, Traditional universities are concerned today with the use of technologies for the improvement of the efficiency of their courses, the monitoring of students' careers and the access to continuous education opportunities.

In what follows a survey of the Italian situation as an example of the more general European context will be analyzed and the research funded from European Commission will be reported.

ITALIAN UNIVERSITIES AND E-LEARNING

European universities have met the challenge of modernisation by introducing e-learning activities in their organization. The governments also encouraged the establishment of e-learning in higher education by supporting the digitization of the infrastructures of their institutions.

The ELUE project (E-Learning and University Education) belongs to the initiatives approved and funded from the European Commission for the promotion of e-learning and aims at the diffusion of e-learning in the university in Finland, France and Italy. The study reports the results of a joint survey carried out on the universities of the respective countries by the Conference of Italian University Rectors (CRUI), by the *Conference des Presidents d'Université Française* (CPU) and by the Finnish Virtual University (FVU).

The project belongs to the set of initiatives designed to foster the creation of an European Area of Higher Education (as referred to from the European Community action in the Bologna Process) and its main ideas and aims can be summarized as follows:

- The systematic analysis of e-learning experiences and their sharing could help in the achievement of a progressive convergence of the university systems in the individual countries towards the establishment of a unique European model,
- The collection and the dissemination of statistical information on the state and role of e-learning in the universities of the countries involved in the project are the main information to be shared. The project also aimed at the individuation of elements useful in identifying, understanding and implementing an observatory on e-learning evolution in the universities.

The results of the investigation were published in 2006 and are available online on the Website of the CRUI (2006).

In what follows some data on the participation in the survey of the Italian universities is reported and the information considered relevant for what follows is discussed.

In Table 1 the percentage in the distribution of Italian universities in the survey is shown.

When limiting to the universities participating in the survey (59 on 77) it emerged that only 64% among them (i.e., 49% of total number of universities) stated that they had an e-learning policy. Figure 1 depicts the percentage of universities reporting the presence of an e-learning policy.

It has to be noted that assuming 51% of the universities without an e-learning policy is real-

Table 1. Participation of the Italian university system in the survey

	Universities	%
Universities which filled in the questionnaire	59	76.6
Universities which didn't fill in the questionnaire	18	23.4
Total	77	100.0

Figure 1. Percentage of the universities reporting the presence of an e-learning policy



istic because the lack of an answer to the survey is widely synonym of a lack of policy on e-learning.

Furthermore the presence of ICT centres has been investigated and 84% of the universities answering to the survey declared the existence of at least one structure of this kind (i.e. 64,37% of the Italian universities). In Figure 2 is reported the graphic of the distribution. This datum has to be completed with the number of ICT centers in the Italian universities as reported in Table 2.

The only remark on the data in Table 2 is the lack of completeness of the same data, because

Figure 2. Percentage of the universities reporting the presence of an ICT center

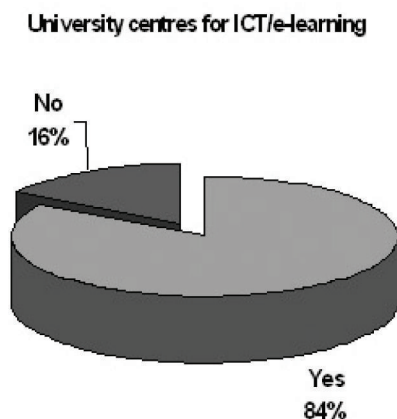


Table 2. Distribution of e-learning centres in Italian universities

Number of e-learning centers	Absolute value	%
One	26	33.77
Two	14	18.18
More than three	19	24.68

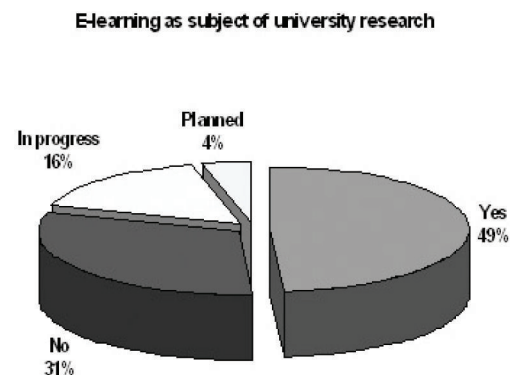
it cannot be automatically deduced that universities which did not answer to the survey did not have one or more e-learning centre (they could have them in the faculties or in other structures).

At last when asked to indicate if research activity was made on e-learning and ICT use in the university only 49% among them declared they had this activity in their agenda (i.e., 37,55% of the universities).

Figure 3 reports how universities make or plan to make research on e-learning and ICT use in education in the Italian universities which answered to the survey.

It is clear from the data reported until now how complex is the context of the e-learning presence in Italian traditional universities where e-learning is present in single structures and is object of study and research but is not an integral part of the university management strategies in teaching.

Figure 3. Percentage of the university research on e-learning



It is beyond the scope of this chapter a detailed discussion of the results of the ELUE project but to have a more complete panorama of Italian situation some further information is needed.

In Italy a special law, the so called Moratti-Stanca Law (from the names of two Minister of the former government who proposed it), recently introduced (2003) Telematics Universities and stated:

- a. The rules and duties those universities are subjected to,
- b. The creation of a Committee all Telematics Universities are submitted to for the approval and the accreditation,
- c. Whatever distance education strategy the University uses for its courses it has to guarantee and verify the presence of the students at the ending examinations (both in single courses and final theses).

Until now eight Italian institutions have been accredited as telematics universities and the National Council for University (CUN, 2005) recently published a document stating what follows:

- The Law suggests the introduction of e-learning strategies at different levels in traditional universities together with the creation of new structures (telematics universities), but except a few requests only accreditation for new telematics universities have been asked for,
- Telematics universities do not make research adequately neither in e-learning and distance learning strategies and application nor in the scientific fields of the courses they propose,
- There is great anxiety for the use of distance learning and e-learning in medical professions (both in initial and in-service training),
- The introduction of e-learning in traditional courses is affected from the problem of the

e-tutor presence/absence, which has not been adequately solved.

E-LEARNING IN EUROPEAN UNIVERSITIES AND THE EUROPEAN COMMISSION INITIATIVES

The previous paragraph shows how complex the Italian situation is as regards e-learning and its use in the universities. In other European countries the situation is similar to the Italian one also if the numbers are different from country to country. To give impulse to the e-learning policies in the universities of the corresponding countries the European Commission promoted many workshops and conferences and supported with grants many e-learning projects. Actually the main aspects the European Commission is working on are concerned with:

- The cooperation among high education institutions on the planning of joined curricula involving different universities, including the agreements for evaluation, validation and recognition of the acquired competences (on a national basis),
- Large scale experiences on virtual mobility together with the physical mobility,
- The development of innovative study curricula based both on traditional learning methods and on line methods.

To the whole set of the above aspects in the context of the e-learning program the European Commission gave the name of *European Virtual Campuses* (notwithstanding the absence of a well settled definition of virtual campus).

In what follows the reports from the European Commission on virtual campuses will be analyzed in a great detail due to the relevance they have on the e-learning development plan.

In the consultation workshop held in Brussels on 23rd November 2004 (EC, 2005a) three definitions emphasising different aspects of a virtual campus were proposed:

- *Collaborative perspective*, denoting ICT-based collaboration of different partners supporting both learning and research in a distributed setting,
- *Enterprise (economic) perspective*, denoting an ICT-based distributed learning and research enterprise.
- *Networked organization perspective*, denoting an environment which augments and/or integrates learning and research services offered by different partners.

At the workshop held in Brussels on 11th October 2005 (EC, 2005b) to explore the issues associated with Virtual Campuses (VCs), one of the four key themes of the EU's eLearning Programme, the need for a critical review of existing projects in this area was identified. The workshop identified a range of issues that affected the successful implementation and deployment of VCs and their long-term sustainability.

Among the conclusions of the European commission is that if e-learning and VC initiatives are to be sustainable within the EU, then it is vital that stakeholders understand how new models of teaching and learning transform the institution and how they can be used to enhance the flexibility and inclusiveness of the European education system.

The starting point for the revision work has been the set of the projects funded from the Education, Audiovisual & Culture Executive Agency (EACEA). The list of the projects as they were approved and funded in three different years is reported in Table 3.

It has to be noted that in the 2006 call for proposals within the eLearning Programme, the EACEA stated that two priorities had been retained for the call:

Table 3. List of EACEA virtual campuses projects in 2004, 2005 and 2006

2004 virtual campuses projects
REVE – Real Virtual Erasmus
eLene-TT e-Learning Network for Teacher Training
ELLEU E-learning per le Lingue e le Letterature Europee
E.A.S.Y Agency for EaSY Access to Virtual Campus
E-LERU Creation of LERU (League of European Research Universities) virtual campus
eTTCampus European Teachers and Trainers Campus
VICTORIOUS Virtual Curricula Through Reliable InterOperating University Systems
MASSIVE Modelling Advice and Support Services to Integrate Virtual Component in Higher Education
VIPA Virtual Campus for Virtual Space Design Provided for European Architects
Virtual COPERNICUS-CAMPUS
2005 virtual campuses projects
eduGI Reuse and Sharing of e-Learning Courses in GI Science Education
eLene-EE Creating Models for Efficient Use of Learning – Introducing Economics of eLearning
E-MOVE An Operational Conception of Virtual Mobility
E-Urbs European Master in Comparative Urban Studies
EVENE Erasmus Virtual Economics & Management Studies Exchange
EVICAB European Virtual Campus for Biomedical Engineering
PLATO ICT Platform for Online learning and Experiences Accreditation in the Mobility Programme
VENUS Virtual and E-Mobility for Networking Universities in Society
2006 virtual campuses projects
VCSE: Virtual Campus for a Sustainable Europe
eLene-TLC eLearning Network for the development of a Teaching and Learning Service Centre
PBP-VC Promoting best practices in virtual campuses

1. Systematic critical review of existing virtual campus projects or experiences, including their valorisation in terms of sharing and transfer of know-how, with an eye to sup-

porting deployment strategies at a European level,

2. Support for the dissemination or replicable solutions to help set up virtual campuses at European level and to establish a community of decision-makers.

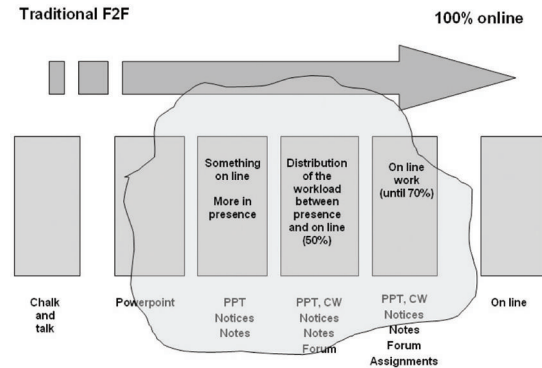
The above list does not exhaust the e-learning initiatives in Europe and, what's more, do not include the many e-learning experiences all over the world. It is beyond the aims of this work the detailed analysis of all the e-learning experiences and of the great deal of virtual campuses projects, but the following examples can help in better understanding the e-learning impact on education:

- Virtual campuses involving universities in regions which had no or less contacts for a long time have been planned and carried out (like the Baltic Sea Virtual Campus where universities from Poland, Estonia, Latvia, Russia, Finland, and so forth cooperate in the development of master programs)
- Virtual campuses based on the use of virtual reality environments are available on the Net (the Nanyang University in Singapore is one of the most interesting examples on this regard),
- International scientific institutions like ESA (European Space Agency) and NASA (USA Space Agency) created virtual campuses for employers' training and for cooperation among scientists all over the world.

CONCLUSION AND FUTURE TRENDS

The experiences reported in the former paragraphs give a snapshot of the changes induced from ICT in High Education and confirm (whenever the need for a demonstration was required) that:

Figure 4. Synthesis of the different e-learning experiences in today universities



- Times and spaces of high education are rapidly changing,
- Deep organizational changes are needed to face the requirements for high quality continuous education,
- Digital literacy is a need for actual and future generations.

Until now it can only be deduced that a lot of experiences, involving at different levels e-learning instruments and strategies, are available and they are well summarized in the image from P.C. Rivoltella (2004) in figure 4.

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KEY TERMS AND DEFINITIONS

Blended Learning: The combination of at least two different approaches to learning. It can be accomplished through the use of virtual and physical resources, i.e., a combination of technology-based materials and face-to-face sessions used together to deliver instruction.

Bologna Process: European reform process aiming at the creation of an High Education European Space within 2010. Actually it includes 45 countries and many international organizations. It pursues the organization of the national High

Education Institutions so that: (a) curricula and degrees are transparent and readable, (b) students can make their studies wherever they want in Europe, (c) European High Education can attract extra-European students and (d) an high quality knowledge base for the social and economic development of Europe is made available.

Brick and Click University: A definition of university which is derived from a business model (bricks-and-clicks). In that model both offline (*bricks*) and online (*clicks*) activities and presences are integrated.

Instructional Technology: A growing field of study based on the use of technology as a means to solve educational challenges, both in the classroom and in distance learning environments. Resistance from faculty and administrators to this technology is usually due to the fear in the reduction of human presence in education it is hypothesized to induce.

Lisbon Conference: Held in January 2000 (in Lisbon) and underlined the aim of making the European Union the most competitive and dynamic society of the world, based on innovation and knowledge.

Virtual Learning Environment (VLE): A software system designed to help teachers in the management of educational courses. The system can often track and monitor the students' operations and progress. It is often used to supplement face-to-face classroom activities.

Virtual University: Sometimes called *telematics university* is an organization that provides higher education on the Internet. Among these organizations there are truly "virtual" institutions, existing only as aggregations of universities, institutes or departments providing courses over the Internet and organizations with a legal framework, yet named virtual because they appear only on the Internet.

Chapter 1.5

Learning Activities Model

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INTRODUCTION

The design of learning is probably more accurately described as the design of learning activities as it is the activities that are designable compared to learning which is the desired outcome of the activities. While the term “instruction” may be out of favor with some commentators, as it implies a teacher-directed approach, “instructional design” has been used for some years to describe the design of the things learners and teachers or trainers do to facilitate learning.

Instruction is a set of events that affect learners in such a way that learning is facilitated. Normally we think of events as external to the learner – events embodied in the display of printed pages or the talk of a teacher. However, we also must

recognize that the events that make up instruction may be partly internal when they constitute the learner activity called self-instruction. (Gagné, Briggs, & Wager, 1992, p. 3)

Courses of study, subjects, or training programs are generally too large to be matched to a particular technology or technological element of a learning management system. Distance education courses are generally characterized by a “package” of several technologies (Bates, 1995) or a “combination of media” (Rowntree, 1994), indicating clearly that more than one technology is generally used. In online learning or e-learning where a learning management system (LMS) is used for a course, subject, or program, the question remains of how to undertake the matching of each technological element of the LMS to subsections of the course, subject, or program.

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The learning activities model (LAM) is based on an investigation of approaches to the categorization and classification of learning activities and reconceptualizes them in such a way as to facilitate the matching of them to learning technologies.

With a small number of notable exceptions (Gagné et al., 1992; Laurillard, 2002) there is little reference in the literature to explicit methods of classification and categorization of learning activities for the purpose of matching them to learning technologies. However, several commentators provide tacit classification as a by-product of discussions for other purposes.

BACKGROUND

The approaches to the theorization of learning activities can be grouped into four categories:

- Some commentators classify learning activities for purposes other than the selection of learning technologies.
- Others do not overtly categorize or classify, yet provide tacit conceptualizations while achieving other ends.
- Yet others simply list methods or examples of learning activities in the absence of a more detailed conceptual framework.
- A fourth approach is to provide categories of learning activities that may ultimately assist in the selection of learning technologies in a way that is appropriate for the learners, the material, the context, and the budget.

By investigating other aspects of distance education, Bates (1995), Taylor (2002), and Rowntree (1994) imply a classification of learning activities. Bates' descriptions of learning technologies as one-way or two-way implies that there are one-way and two-way learning activities and it follows

that learning activities that utilize technologies in these ways can be classified as:

- Interactions with the material using the one-way technologies, and
- Interactions between people using the two-way technologies.

Taylor (2001) provides corroboration of this tacit conceptualization in the description of the generations of distance education, where technologies are categorized as providing "highly refined materials" and/or having "advanced interactive delivery." Further, Rowntree (1994) implies a similar tacit categorization of learning activities by categorizing "media" as those for human interaction and those for interaction with materials. It is not surprising that learning activities can be categorized as interactions with materials and interactions between people as this is reflected in many learning experiences.

THE LEARNING ACTIVITIES MODEL

The learning activities model is a theoretical framework that can be used as an analytical tool and to assist designers of learning events. It is premised on the argument that categories of activities that are subdivisions of the learning process can be matched to techniques, technologies, and methods as part of the design process.

Provision of Material

Traditionally, the predominant approach to undergraduate university teaching consisted of a presentational style. Most lectures were primarily concerned with the provision of material, as learning seemed to be equated with the acquisition of knowledge as opposed to the development or construction of it by students. A similar approach occurred in human resource development and

many programs have been conducted in venues where a trainer presents material to a group of trainees. The material was provided by the words the professor or trainer spoke and the words written on the board, overhead projector, screen, or handout. The material provided in traditional presentations like this resulted in notes and memories that learners took away from the training room or lecture theatre.

The first category of the learning activities model (LAM) consists of activities concerned with the provision of material and is referred to as “provision of materials.” Materials may be provided in the classroom, training room, or lecture theatre where they are part of the learning process. Alternatively, in distance education, flexible learning, e-learning, or online learning materials may be provided away from designated learning venues. Materials can be provided in a number of ways, including:

- The voice of the presenter or facilitator in a training program, lecture, tutorial, seminar, laboratory, study group, or residential school
- Visual aids to the above
- Printed materials, for example, prescribed texts, references, and manuals
- Other printed materials such as training notes study guides, lecture notes, and handouts
- Other media, for example, radio and television programs, audio and video, Internet resources, Web pages, multimedia, streams, podcasts, and Web casts.

Interactions

The provision of material alone is generally not considered sufficient to produce the desired outcomes of a learning event. For learning from materials to occur learners have to interact with it and, clearly, in many learning events other types

of interactions occur. These other interactions can be identified through a brief analysis of the history of distance learning and flexible learning as practiced in higher education and human resource development.

Correspondence courses represent one of the earliest forms of distance learning. In correspondence courses, learners interact with printed materials that are sent to them through the mail. Sometimes there are opportunities for limited interaction with the facilitator in the form of comments and corrections on assignments and assessments. Usually there are few, if any, opportunities for interaction between learners. When technology was added to correspondence courses, and the term “distance learning” (or “distance education”) was applied to it, there was greater opportunity for interaction between learners. However, in many cases this was limited due to the high cost of conferencing technology or other communication technology.

Distance learning presents a clear comparison to face-to-face learning where there usually are many opportunities for learners to interact with facilitators and with other learners. Three discrete categories of interaction can be identified. They are:

- Interaction with materials,
- Interaction with the facilitator, and
- Interaction between learners.

The term “interaction” has been used in preference to “interactive” or interactivity. Apart from the grammatical constraints, this is done to avoid confusion that can occur with the term “interactive.” “Interaction” in several dictionaries is defined as action on each party or reciprocal action. There are usually two definitions of “interactive,” one that describes things that interact and another that describes computers that react immediately to the input or commands of the operator. So that there is no confusion between

what is meant here by interactive and the computer definition of interactive, the use of interaction is retained, and defined as reciprocal action. This is broader than, but includes, the interactivity of computer programs. For example, a conversation in which each party tries to change the attitude of the other can be described as an interaction. Interaction is essentially a two-way process allowing information to flow back and forth between learners, facilitators, and other people or things. For example, when a learner (or for that matter any viewer) watches a broadcast of a television program, material is provided to them. If they make a video recording of the program and replay it, pause, rewind, and replay parts of it, the process gains an aspect of the two-way, and to a limited degree they interact with it.

The three categories of interaction are clearly identifiable in learning although not all categories are present in all learning events. The first category of interaction, and the second category in the learning activities model (LAM), is interaction with materials.

Interaction with Materials

As well as the different categories of interaction that can be identified in learning events there are different levels of interaction that can be present within each category. Obviously there are many levels and styles of interaction and although the interaction of the learner or viewer in the example of the videotape (above) is rather basic, it serves to help achieve the desired learning outcomes through the removal of the ephemeral nature of the broadcast once the program is encapsulated in a video recording. "Interaction with materials" is the second category in the learning activities model (LAM) and some examples of activities in this category include:

- Looking up a definition in a reference book,

- Pausing and replaying sections of a video or audio recording,
- Searching the Internet or World Wide Web, and
- Interacting with computer aided learning packages (e.g. multimedia).

In face-to-face learning, the boundary between the provision of material and interaction with it can be difficult to distinguish. In a presentation, material is provided by the voice of the presenter and by any visual aids used. By definition interaction with the material only happens when a learner does something with it. In flexible learning, the boundary between provided material and interaction with it is usually clearer than in traditional face-to-face learning. Often the material is recorded and provided by a technology and in such cases the boundary is defined by the boundary of the technology.

Interaction with the Facilitator

Interaction with the teacher or trainer plays an important role in many learning events and for simplicity's sake this person is referred to as the "facilitator." The role of the facilitator in traditional face-to-face learning will be different to their role in flexible learning. In flexible learning the role can include some or all of the following:

- Design of materials,
- Consultation with learners,
- Assessment of learners' work,
- Answering learners' questions, and
- Provision of materials.

In some contexts, for example, in-house training in a small company, these activities might be undertaken by one person. In traditional face-to-face learning at a university it could be a team consisting of the presenter, a coordinator, and one or more tutors. In flexible learning, learning

Learning Activities Model

events can be the result of single or team efforts. The teams can consist of academics who provide the content material, tutorial staff who answer learners' questions and assess their work, as well as instructional designers, administration, and other infrastructural staff.

In a face-to-face learning environment, learners interact with facilitators by ways like interjecting in a presentation or asking questions during a consultation with the facilitator in the facilitator's office or elsewhere. An example of interaction with the facilitator in higher education can be a discussion taking place between a teacher and student in a tutorial or seminar. An example of interaction with the facilitator in training could be the discussion between a participant and the trainer in an in-service workshop. Tutorials, consultations, and workshops traditionally have been face-to-face meetings; however, interaction with the facilitator can happen in flexible learning through the use of technologies like electronic mail, audio conferencing, videoconferencing and online discussion. While face-to-face interaction is obviously synchronous, the technologies used for interaction may be either synchronous or asynchronous. Some examples of the techniques and technologies that can be used in interactions with the facilitator are:

- Questions and answers in lectures (synchronous)
- Questions and answers in workshops (synchronous)
- Tutorial discussion (synchronous)
- Phone calls (synchronous)
- E-mail (asynchronous)
- Letters (asynchronous)
- Facilitator/learner consultation (face-to-face) (synchronous)
- Audio or videoconference discussions (synchronous)
- Feedback on assessments (asynchronous)

- Chance meeting and social events (synchronous)

Generally, interaction is a valued quality of learning. The author was a member of the Education Committee of the National Tertiary Education Union (NTEU), the peak academic industrial union in Australia, which developed a policy statement that echoes this sentiment:

NTEU recognises the increase of flexible teaching and learning in tertiary education and while the benefits of flexible teaching and learning are also recognised it must be remembered that education is an interactive process, at the heart of which lies the relationship between student and teacher. (National Tertiary Education Union, 1997, p. 12)

In many Australian universities, it is part of teachers' duty statements to be available for a number of hours per week for student consultation. Also many teachers cultivate an attitude of questioning in their students, hence engendering a learning style that is highly interactive. In human resource development interaction is also valued and considered vital to learning:

All collaborative learning theory contends that human interaction is a vital ingredient of human learning. (Kruse & Keil, 2000, p. 22)

Interacting with the teacher or trainer is the third category of the learning activities model (LAM) and is referred to as "interaction with facilitator."

Interaction Between Learners

Interaction between learners can be formal or informal. The most formal would be in events such as student presentations in tutorials or participant interaction in workshops. Other examples of formal interaction between learners occur where they work as a group or team on a project

for assessment. Less formal interaction between learners can occur at any time or place where they talk about their learning.

The third type of interaction and the fourth category of the learning activities model (LAM) is interaction between students, trainees, or participants and is referred to as “interaction between learners.”

These last two categories (that is interaction with the facilitator and interaction between learners) are both dialogic. Dialog can have different attributes depending on the technology it is mediated by. For example, e-mail is generally limited to text while a videoconference can include body language and vocal attributes. Dialog here is defined as a conversation and is not limited to a duolog.

The Fifth Category of Learning Activities

The first four categories of the learning activities model describe the learning process as consisting of provided materials, interactions with materials, interactions with the facilitator, and interactions between learners. This is not a complete description of all learning activities, rather it is a description of the activities that can be planned and undertaken in order to facilitate learning. There are a number of things that learners do in order to learn or as part of the learning process that the designer of the learning event can facilitate but generally cannot control. These activities do not fit into the first four categories of the learning activities model and include activities such as:

- Learners’ informal reflection on what they have heard or read,
- Formal or structured reflective practice,
- Critical thinking,
- Refining ideas, opinions, and attitudes,
- Comparing new to existing knowledge and experiences, and

- “The penny dropping” or sudden realizations that are apparently not stimulated.

As these activities are outside of the categories mentioned so far, and so that the model can represent all learning activities; a category for these activities is added to the learning activities model. This is the fifth category and is referred to as “intra-action,” a term coined by the author to describe action within. The opportunities for intra-action can be maximized through thorough and appropriate design of the learning activities, and environment. However, as learners bring their own psychological baggage to their learning and as it is ultimately dependent on them, the activities in the intra-action category cannot be prescribed or guaranteed.

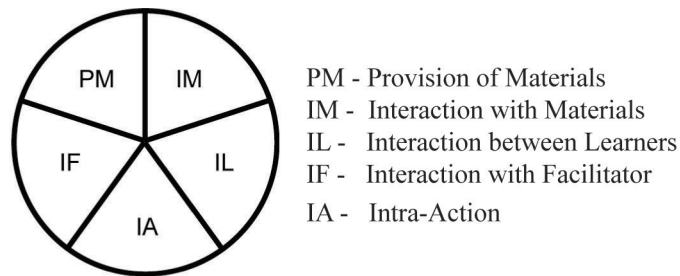
The Learning Activities Model

The five categories described are brought together to form the learning activities model (LAM). This model is a theoretical framework of learning activities has theoretical and practical applications and is represented graphically in Figure 1.

In Figure 1 the space enclosed by the circle represents the total of all activities that happen during the process of learning and can be applied to complete programs of structured learning in a range of granularity. At a coarse granular level the model can be used to analyze and describe the approach taken to learning by an institution or organization and the listing of activities for each category of the model would reflect the approach. At a finer level of granularity the model can be applied to courses or programs or to subjects. At the finest level of granularity the model can be applied to short discrete learning events such as using a set of instructions to perform a task. The five categories of the model, provision of materials, interaction with materials, interaction with the facilitator, interaction between learners,

Learning Activities Model

Figure 1. The learning activities model



and intra-action are indicated by the segments or “piece of pie” shapes.

It is not suggested that all categories of the model need to be present for learning to occur or that there is a relationship that always correlates the presence of more elements with increases in the effectiveness and efficiency of learning. Some successful learning events may use all five categories, and others may use only one or two. There are many factors to be considered in the design of the number of categories of the model to include in learning events. For example, while interaction between learners is generally considered desirable in learning events it may be reduced or not occur where the number of learners is small; the duration of the learning event is short and flexibility of time is desired. In such cases it would be conceivable for no interaction between learners to occur during the process of learning.

The model provides a framework within which the activities of learning events can be mapped and can be used as a tool for the design of learning events. The following examples are provided to illustrate the model in general terms and to demonstrate the applicability of the model to commonplace learning environments.

THE MODEL EXEMPLIFIED

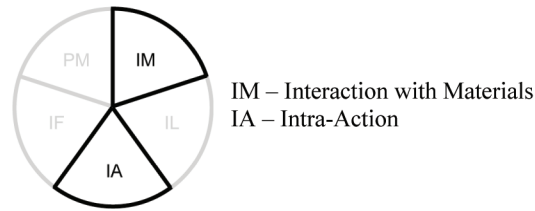
This group of examples concerns a simple, everyday learning event: preparing and cooking food from a recipe for the first time. The desired

learning outcome can be easily, although subjectively, measured as the successful production of the food. The first example is the simplest, containing only two categories of learning activities. In subsequent examples further categories of the model are added expanding and developing the activities of learning. In the simplest case of the example, the learner is the person preparing the food and they interact with the learning materials. The learning materials are the recipe and other relevant information, for example, a conversion chart for weights and measures. We all know that food can be prepared this way and that the results can be anywhere in the spectrum of taste. So it would be reasonable to suggest that effective learning can happen this way.

Example 1

The materials are already on hand and not provided as part of the learning event. The facilitator (assuming the facilitator is the person who prepared the recipe and instructions) is not present and the learner works alone. The activities include interaction with the materials (the materials being the recipe book, not the ingredients) and an intra-action (where the intra-action is the comparing and critical evaluation of the process with recipes prepared earlier and other experiences). This is represented graphically in Figure 2.

Figure 2. Example (1) Interaction with materials and intra-action



Example 2

In the second example the learner prepares the food in much the same way but this time the materials include a videotape of a television program, and through the recorded program activities in the category of provision of material are introduced. As well as interacting with the recipe some limited interaction with the videotape (i.e., replaying, pausing, etc.) is possible as well. The graphical representation (Figure 3) is the same as in the earlier example with the addition of the provision of material category.

Example 3

In the third example the learner prepares the food in much the same way interacting with the materials including the television program. However, the learner is not alone. The learner works and interacts with another learner, discussing aspects of the food preparation, sharing information, experiences, knowledge, and reactions. Hence the category of onteraction between learners is added and the graphical representation is presented in Figure 4.

Example 4

In the fourth example, the learner is a member of a face-to-face cooking class. The learner still

Figure 3. Example (2) Provision of materials, interaction with materials and intra-action

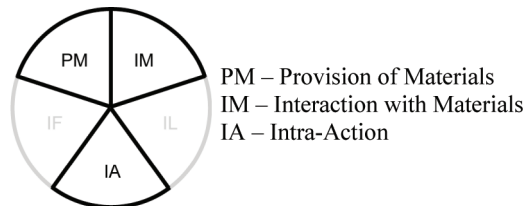


Figure 4. Example (3) Provision of material, interaction with material, interaction between learners and intra-action

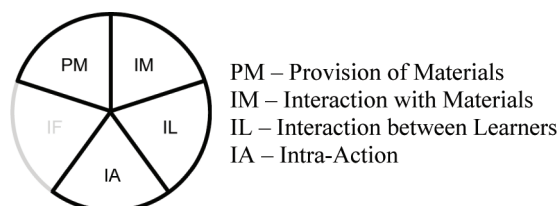
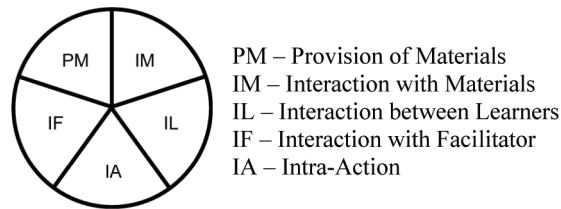


Figure 5. Example (4) All categories



interacts with the materials and the other learners, and material is provided by the words spoken by the facilitator. The category of interaction with the facilitator is introduced as opportunities exist for learners to question and interact with the facilitator. In this example, all five categories of learning activities are present.

The examples of the cooking class show how the model can be used to analyze existing learning events in a general everyday learning environment. The category intra-action has been included in each example and as mentioned earlier this category is one that the learner controls rather than the facilitator or designer and is included here as an indication that it is possible for activities in this category to take place in these examples.

CONCLUSION

The learning activities model (LAM) has been developed for two purposes. First, it provides a theoretical framework for analysis of learning activities, and second, it assists facilitators and designers of learning events in the design process by subdividing learning events or programs into categories of activities. It can be used in a formative way to analyze a proposed learning event or program or in a summative way to assist in the revision of an existing learning event or program. The learning activities model (LAM) can also be used to compare different methods and modes of achieving learning goals.

There are some things that the learning activities model (LAM) cannot, and is not intended to, do. It will not prescribe the best mixture of activities to use for a particular learning event or content area. It is not sensitive to the cultural and demographic make-up of learners. The facilitator is usually the expert on the content and the facilitator or designer should have created a profile of the learners and hence they are best placed to match the activities of the model with the content and the learners.

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KEY TERMS AND DEFINITIONS

Categorization: Grouping according to according to the role played.

Classification: Grouping according to similar or like characteristics.

Distance Learning (aka Distance Education): Education in which learners are separated from facilitators.

Education: A structured program of intentional learning from an institution.

Facilitator (aka Facilitator of Learning): The person who has prime responsibility for the facilitation of the learning; rather than terms such as “teacher,” “trainer,” or “developer.”

Flexible Learning: An approach to learning in which the time, place, and pace of learning may be determined by learners. In this chapter this term is used to include the approaches taken by distance learning and open learning.

Higher Education: Intentional learning in universities and colleges.

Human Resource Development: Intentional learning in organizations. Can include training and development.

Instructional Design: The process of is concerned with the planning, design, development, implementation, and evaluation of instructional activities or events and the purpose of the discipline is to build knowledge about the steps for the development of instruction.

Interaction: Reciprocal between humans and between a human and an object including a computer or other electronic device that allows a two-way flow of information between it and a user responding immediately to the latter’s input.

Learner: A generic term to describe the person learning, rather than terms such as “trainee” and “student.”

Learning: An umbrella term to include training, development, and education, where training is learning that pertains to the job, development is learning for the growth of the individual that is not related to a specific job, and education is learning to prepare the individual but not related to a specific job.

Learning Activities: The things learners and facilitators do, within learning events, that are intended to bring about the desired learning outcomes.

Learning Event: A session of structured learning such as classes, subjects, courses, and training programs.

Learning Management System (aka Virtual Learning Environment, Course Management System and Managed Learning Environment): A Web-based system for the implementation, assessment, and tracking of learners through learning events.

Learning Technologies: Technologies that are used in the process of learning to provide material to learners, to allow learners to interact with it, and/or to host collaborations between learners and between learners and facilitators.

Online Learning: Flexible or distance learning containing a component that is accessed via the World Wide Web.

Representational Technology: A one-way technology that supports interaction with the material.

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Chapter 1.6

What Factors Make a Multimedia Learning Environment Engaging: A Case Study

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ABSTRACT

The purpose of this study is to investigate students' engagement with a multimedia enhanced problem-based learning (PBL) environment, Alien Rescue, and to find out in what ways students consider Alien Rescue motivating. Alien Rescue is a PBL environment for students to learn science. Fifty-seven sixth-grade students were interviewed. Analysis of the interviews using the constant comparative method showed that students were intrinsically motivated and that there were

11 key elements of the PBL environment that helped evoke students' motivation: authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations. These elements can be grouped into 5 perspectives of the sources of intrinsic motivation for students using Alien Rescue: problem solving, playing, socializing, information processing, and voluntary acting, with problem solving and playing contributing the highest level of intrinsic motivation. The findings are discussed with respect to designing multimedia learning environments.

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INTRODUCTION

In order for technology to positively impact classroom learning, students must be motivated to use the technology in addition to learning the content presented with that technology. Literature on motivation and classroom learning has shown that motivation plays an important role in influencing learning and achievement (Ames, 1990). If motivated, students tend to approach challenging tasks more eagerly, persist in difficult situations, and take pleasure in their achievement (Stipek, 1993). Studies have indicated strong positive correlations between intrinsic motivation and academic achievement (Cordova & Lepper, 1996; Gottfried, 1985; Hidi & Harackiewicz, 2000; Lepper, Iyengar, & Corpus, 2005). This suggests that motivational problems or lack of effort is often a primary explanation for unsatisfactory academic performance (Hidi & Harackiewicz, 2000).

Students' lack of interest in mathematics and science has been cited as one of the primary reasons contributing to U.S. students lagging far behind other high-performing countries in math and science, especially at the middle-school level (National Science Board, 1999). According to Osborne, Simon, and Collins (2003), research has indicated a decline in attitudes toward science from age 11 onward. Other researchers have also found that as children become older, their intrinsic motivation to learn science tends to decline (Eccles & Wigfield, 2002; Gottfried, 1985; Lepper, Iyengar, & Corpus, 2005). Therefore, in order to help students succeed in learning math and science, instructional technologists must create technology enhanced learning environments that can motivate students and facilitate learning.

In an effort to meet this goal, we have designed and developed a multimedia enhanced problem-based learning (PBL) environment for six-grade science, *Alien Rescue* (Liu, Williams, & Pedersen, 2002). This program has been used by thousands of middle school students in multiple states. Our

previous research examining the impact of this multimedia PBL environment has primarily focused on its cognitive effects such as its use on acquiring science knowledge and problem-solving skills (Liu, 2004; Liu & Bera, 2005; Li & Liu, 2008), cognitive tools and cognitive processes (Liu, Bera, Corliss, Svinicki, & Beth, 2004), and its effect on reducing cognitive load (Li & Liu, 2007). Studies on *Alien Rescue* have shown it to be an effective learning environment for science knowledge and problem-solving (Liu, 2004, 2005; Liu & Bera, 2005).

As we continued to work with students and teachers in different classrooms, it became apparent that students often considered their experience with *Alien Rescue* "fun" and enjoyed using it. The following quote from a teacher captured the essence of this observation:

Kids are talking about science outside of the classroom. They talk about *Alien Rescue* in the halls and they talk about *Alien Rescue* after school. All of the sixth graders are doing this, and so some of them have friends in different class periods that are working with *Alien Rescue*. They will say, "what did you find out today or have you found where this alien can go?" I think that the most exciting thing is that they are talking science outside of the classroom; I think that is the most impressive thing.

This sentiment led us to ask questions regarding the affective effects of *Alien Rescue*. Why did students like using *Alien Rescue*? What did they find interesting? How did it compare to other school activities they usually do in the classroom? The purpose of this study is to investigate sixth-graders' affective experiences, specifically motivation, as they were using *Alien Rescue* and to find out in what ways *Alien Rescue* was motivating to these students. Our guiding research question was:

How does a multimedia enhanced problem-based learning (PBL) environment, Alien Rescue, motivate students to learn science?

BACKGROUND

Using Multimedia to Enhance the Delivery of Problem-Based Learning

Problem-based learning emphasizes solving complex problems in rich contexts and aims at developing higher order thinking skills (Savery & Duffy, 1995). According to Savery and Duffy, PBL environments have three primary underlying constructivist propositions: (1) understanding is in our interactions with the environment, (2) cognitive conflict is the stimulus for learning and determines the organization and nature of what is learned, and (3) knowledge evolves through social negotiation and by the evaluation of the viability of one's understanding (Savery & Duffy, 1995). In PBL environments, the focus of learning is not only the knowledge outcome, but also the process by which students become self-reliant and independent.

The benefits of PBL, such as the activation of prior learning, self-directed learning, and motivation, have been documented in medical education and with college and gifted students (Albanese, & Mitchell, 1993; Gallagher, Stepien, & Rosenthal, 1992; Hmelo & Ferrari, 1997; Norman & Schmidt, 1992; Stepien, Gallagher, & Workman, 1993). However, literature has also indicated that implementing complex and ill-structured learning environments such as PBL in K-12 classrooms has been challenging (Airasian & Walsh, 1997).

Multimedia-enhanced PBL environments provide a new and different means that can assist students to develop problem-solving skills, to reflect on their own learning, and to develop a deep understanding of the content domain (Cognition and Technology Group at Vanderbilt, 1997), and if designed well, can also be more motivating to students than text-based delivery methods. Multimedia technology can enhance the PBL delivery through its video, audio, graphics, and animation capabilities as well as its interactive affordances

to allow students to access information according to their own learning needs and present multiple related problems in one cohesive environment (Hoffman & Richie, 1997).

Motivation as an Important Factor for Learning

For preschool children, learning is fun. There are no motivational problems for learning in these years (Cordova & Lepper, 1996). Their motivation is manifested by their choice of behavior, latency of behavior, intensity of behavior, and persistence of behavior, and is accompanied with cognitive (e.g. goal setting) and emotional reactions (Graham & Weiner, 1996). Motivation is often considered to be a necessary antecedent for learning (Gottfried, 1985; Lepper, Iyengar, & Corpus, 2005) and is a function of expectancy of attaining a goal that is valued (Klinger, 1977; Pintrich & Schunk, 2002; Weiner, 1991). When students are intrinsically motivated to learn something, they may spend more time and effort learning, feel better about what they learn, and use it more in the future (Malone, 1981; Okan, 2003). An activity is said to be intrinsically motivating if people engage in it 'for its own sake' and if they do not engage in it for extrinsic reasons or motivators (Malone, 1981). Extrinsic motivators, such as external rewards and punishments, can destroy the continuing motivation of students to learn more about subjects outside of class (Greeno, Collins, & Resnick, 1996; Maehr, 1976).

Unfortunately, in later years, instruction in school, rather than being fun, is often boring and dull to students, and students' motivational problems to learn quickly appear: "In a variety of settings and using a variety of measures, investigators have found children's reported intrinsic motivation in school to decrease steadily from at least third grade through high school" (Cordova & Lepper, 1996, p. 715). The problem of motivating students is particularly acute when the subject mat-

ter is science (Tuan, Chin, & Shieh, 2005), from the point of entry to secondary school (Osborne et al., 2003) — when their intrinsic motivation to learn science, interest in science, and attitudes toward science decline (Eccles & Wigfield, 2002; Gottfried, 1985; Lepper, Iyengar, & Corpus, 2005; Stake & Mares, 2001). Thus, promoting intrinsic motivation is critical to help students learn science.

Sources of Intrinsic Motivation for Learning Environments

There are many different perspectives of the sources of intrinsic motivation since it may vary over time, circumstances, and how people view what they are doing (Pintrich & Schunk, 2002). Lepper and Malone (1987) summarized past views of the sources of intrinsic motivation and their characteristics (p. 258):

- Humans as problem solvers: challenge, competence, efficacy or mastery
- Humans as information processors: curiosity, incongruity, or discrepancy
- Humans as players: fantasy involvement using graphics, story, and sound
- Humans as voluntary actors: control and self-determination

These four perspectives on the sources of intrinsic motivation are commonly expressed as challenge, curiosity, fantasy, and control, respectfully (Pintrich & Schunk, 2002). Though listed as separate categories, these perspectives overlap each other. For example, people become curious (i.e. humans as information processors) because of an incongruity in information. This often leads people to want to solve the problem or challenge (i.e. humans as problem solvers) presented by the discrepancy. Each perspective separately cannot sufficiently explain the phenomenon of intrinsic motivation. However, in total, they provide a comprehensive understanding of how learners

can be motivated by a learning environment and its implementation in the classroom, which may reduce the need for the teacher as the source of motivation.

Purpose of the Study and Methodology

To address our research question, we used interviews as our primary data source and the constant comparative method as our analysis technique. We also include descriptive statistics to illustrate specific aspects of the multimedia PBL environment that affect motivation and learning.

A Multimedia PBL Environment: *Alien Rescue*

Alien Rescue is a multimedia enhanced PBL environment for 6th grade science and is designed in accordance with the National Science Education Standards and the Texas Essential Knowledge and Skills (TEKS) guidelines (Liu, Williams, & Pedersen, 2002). The learning objectives include increasing knowledge of our solar system and improving problem-solving skills. It typically takes fifteen 45-minute class periods to complete. *Alien Rescue* presents a complex problem for scientific investigation and decision-making by students. The story of *Alien Rescue* has a science fiction premise that allows students to take on the role of a scientist in charge of finding habitats (e.g., the planets and moons) in our solar system for six endangered aliens by using a rich set of technology enriched cognitive tools. *Alien Rescue*'s cognitive tools include information databases with various media, simulation tools, expert modeling, and charts and a notebook tool.

Participants and Research Setting

One hundred and ten sixth graders from a middle school in a mid-sized southwestern city used *Alien*

What Factors Make a Multimedia Learning Environment Engaging

Rescue as part of their science curriculum for three weeks. The demographics of these sixth graders were approximately 71% White, 15% Hispanic, 10% Asian/Pacific Islander, and 4% African American. About 50.8% were female students and 49.2% were male students.

We observed students' interaction with *Alien Rescue* for the entire duration, and interviewed roughly 50% of the students (n=57). Both individual and focus group interviews were conducted during and after using the program. Focus groups of two to five students were randomly formed as time and seating arrangement permitted. We made an effort to talk to as many students as the time and situation allowed. Altogether, sixty interviews occurred, including ones performed during and after the completion of the program. The time for each interview ranged from 5 to 20 minutes.

Interviews and Analysis

All interviews were audiotaped and transcribed. The interview questions sought to capture students' cognitive and affective experiences during and after using *Alien Rescue*. As recommended by Suchman (1990), these semi-structured interviews occurred as informal conversations that were open-ended but guided by students' activities. Sample interview questions included the following:

- What are you working on now?
- Have you found a planet for the alien species? Which one? Why do you think it is a good home for species X? How did you reach that conclusion?
- Why did you need to launch probes? What did you find out? Do you understand the data? If you find something you do not know, what do you do?
- Which parts did you like or dislike most about *Alien Rescue*? Why?

Interviews after the completion of the program were also semi-structured and conversational, focusing on students' overall experience and impression of the program. The following were eight core questions used as the interview guides:

- What did you think of *Alien Rescue* (AR)? On a scale of 1 to 5 (highest number meaning the best), how do you like AR?
- Which part did you like the most/least about *Alien Rescue*? Why?
- Did you find the problem challenging? Did you like to solve it? Why?
- What have you learned? Did you think that you learned any science content by using *Alien Rescue*? What scientific topics, concepts, or skills have you learned by using *Alien Rescue*? How did you learn?
- How different is working with *Alien Rescue* from working on other school activities? Did you like researching and how was it different from researching in other classes or subjects?
- Did you choose your own team member? How did you work together?
- Did you talk with your peers about *Alien Rescue* outside of class? If so, what did you talk about?
- Would you want to work on programs like *Alien Rescue* in the future? Why?

Transcribed interviews were analyzed using the constant comparative method (Lincoln & Guba, 1985). Relevant information from the students' utterances or incidents was extracted through a systematic set of methodological procedures that inductively generated and connected raw data to codes, codes to categories, and categories to themes (Creswell, 2005). First, the data was examined for evidence or indicators of motivation and/or affect, since these two psychological concepts are considered to be highly linked (Eccles & Wigfield, 2002). The relevant incidents in the transcripts

were coded to describe what the students said about motivation and emotion, a process referred to as “focused coding” (Charmaz, 2006, p. 57). At the next level, the codes were compared with each other and categories emerged at a higher level of abstraction that subsumed these codes. The analyses continued until an “emergence of regularities” (Lincoln & Guba, 1985, p. 350) was reached. The emerged themes were compared with and against conventional intrinsic motivational theory perspectives with the purpose of framing our categories as well as informing existing knowledge.

RESULTS AND DISCUSSION

Findings

Of the approximately 500 paragraphs of text recording the students’ spoken words in the transcript, there were 145 incidents where students spoke of their motivation and affect. A paragraph consisted of as little as one word to as much as several sentences. Some paragraphs contained more than one incident. Of the 145 incidents, 142 incidents expressed positive motivation and affect. Figure 1 summarized students’ expression of motivation and affect. Beyond these 145 incidents of motivation and affect, there were 288 incidents describing the reasons driving their motivation and

affect, such as “I liked researching on the aliens and stuff like finding stuff out.”

After analyzing 288 incidents of students’ motivational drives, eleven themes emerged that influenced the students’ positive motivation and affect while using *Alien Rescue*. The themes for motivation and affect were: authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations. These themes and categories are shown in Table 1, along with the number of incidents and percentages.

Authenticity

Students found situated authentic learning to be motivating and valuable. There were three sub-categories for authenticity: authentic activity, scientific practices, and scientific roles. When asked how different was working with *Alien Rescue* from other school activities, some students responded that the activity was different because it was authentic in nature: “It [*Alien Rescue*] was just like doing something that a real scientist would do.”

In addition, students were motivated by taking on the role of a scientist and performing what they described as scientific practices. Students were able to role-play as a scientist and work within a space station while using the tools afforded by the environment. When asked questions on what they liked about *Alien Rescue*, students’ answers

Figure 1. Students’ expressions of motivation and affect

Categories	No. of Incidents	Percentage of Total
Concentration	3	2%
Fun	50	35%
Interesting	9	6%
Like	67	46%
Persistence	6	4%
Self-esteem	7	5%
Frustration (negative)	3	2%
Total	145	100%

What Factors Make a Multimedia Learning Environment Engaging

Table 1. Students' sources of motivation while using *Alien Rescue*

Themes	Categories	No. of Incidents
Authenticity (19 incidents, 7% of total)	Authentic Activity	5
	Scientific Practices	8
	Scientific Roles	6
Challenge (28 incidents, 10% of total)	—	28
Choice (34 incidents, 12% of total)	Confiscation	12
	Control	7
	Freedom	15
Cognitive Engagement (54 incidents, 18% of total)	Learning	18
	Problem solving	10
	Researching	21
	Thinking	5
Competence/Confidence (12 incidents, 4% of total)	—	12
Fantasy (39 incidents, 14% of total)	Empathy	10
	Fiction	29
Identity (11 incidents, 4% of total)	Attainment Value	11
Interactivity (25 incidents, 9% of total)	Activeness	4
	Computer-based	7
	Feedback	4
	Playing	2
	Miscellaneous	8
Novelty (15 incidents, 5% of total)	Novelty	13
	Variety	2
Sensory Engagement (21 incidents, 7% of total)	Multimedia	8
	Probes	13
Social Relations (30 incidents, 10% of total)	Debate	6
	Group Work	10
	Peer Interaction	14

included statements such as: “I liked *Alien Rescue* because how else were you going to learn if you want to be a real scientist because it has a lot of the things you have to do and have to learn how to do” and “I like the program it was neat and... I think it was a good experience if you were going to be scientist some day—it just made you ready for that stuff.”

Challenge

In general, students liked the challenge of using *Alien Rescue* and found it motivating: “I thought it was hard, but it was fun at the same time because it was a challenge and I personally like challenges.” For some students, *Alien Rescue* was “more of challenge, so you can’t give up,” which shows a desire to attempt solving the problem. Other re-

sponses to whether *Alien Rescue* was challenging or difficult included “I think it’s fun and it’s kind of hard” and “*Alien Rescue* gave me a good challenge because it made me exercise my brain more than I would normally if it was an easier game.” However, there were a few instances of students expressing frustration that *Alien Rescue* was too challenging or that there was not enough time to complete it. A student said, “I just think that the reason that it [*Alien Rescue*] could probably be better is because it could have been easier.”

Choice

Students’ feeling of control and choice were important with both positive and negative affective valences. When asked what was liked about *Alien Rescue*, a student replied, “They [probes] were fun because you got to create them and tell them what to do.” Students thought it was fun to explore the program, choose what to do, create probes, and launch them to targeted planets and moons. On the flip side, students did not like losing control, such as when using the expert tool for guidance. The expert tool is a set of video clips in which an expert explains how they would address aspects of the problem and share their problem-solving strategies. Students did not like this and were able to explain exactly why:

Student: well the thing I hate about it [*Alien Rescue*] is the expert.

Group: OH! [agreement from the group]

Student (cont.): He would immediately take control of everything. You can’t get rid of him, he would just stand there and start talking and he would just take control for some reason...

Cognitive Engagement

The students interviewed liked the cognitive engagement that *Alien Rescue* afforded. In fact,

this was the most mentioned reason why they thought *Alien Rescue* was fun. The four main sub-categories expressed by students were learning, problem solving, researching, and thinking. For instance, a student articulated, “...I like the program. It was neat and I learned a lot of terms, a lot of scientific names that I didn’t know before...” When asked why they liked researching on *Alien Rescue*, one student summed it up by saying, “I think that it was fun, doing the research on the planets because you got to figure out different things about the planets and you get to send probes and get information that you don’t know and then you have to research all the aliens and figure out what they need and then try to match them up.” A student appreciated that *Alien Rescue* is “like a puzzle that’s kind of hard to solve but kind of easy at the same time, not easy I should say but difficult. Yeah, and it’s fun and good.” Another student said, “It was neat converting things from Kelvin to Celsius and how you could like figure out their temperatures and stuff.”

Competence/Confidence/ Self-Efficacy

Some students felt competent or confident of his or her knowledge of *Alien Rescue* and his or her recommendations of habitats for the aliens. This may also be considered self-efficacy, which according to Eccles and Wigfield (2002), is a person’s self-evaluation of his or her ability and beliefs about the probability of success in tasks. During engagement with *Alien Rescue*, students attained the feeling of competence and self-efficacy. After completing *Alien Rescue*, this feeling manifested itself as confidence regarding the selection of habitats for the aliens. One student expressed his or her confidence as, “I’m very confident because I really researched, I’m pretty sure that it was right.” Another student said, “I’m pretty confident, well, we are because we think that we researched it a lot and we think that we got it right.”

However, not all the students felt confident about their recommendations. For example, a student who was not expressing confidence because of computer problems said “I was sort of confident on some because the computers we had kept messing up and it erased my notes but we did the best we could and I think that’s all that matters.”

Fantasy

Fantasy was the second major reason, after cognitive engagement, for why students liked and were motivated to use *Alien Rescue*. Fantasy was expressed in terms of empathy for the aliens and space exploration. With regards to aliens, students were motivated by the fictional narrative of saving the aliens’ lives and as students said, “you’ve got to do it to help save the aliens” and “if you miss something the alien will die for that” and “[I like *Alien Rescue*] because [of the] aliens, ‘cause it’s also fun to imagine having them and being friends with them.” Others expressed positive affect for *Alien Rescue* because it was fictional, such as “I thought *Alien Rescue* was pretty cool because you got to actually have some fiction fun in it.”

The science fiction aspect of *Alien Rescue* made one student remark, that in “most other experiments, you don’t have this much fun because you have to do it in real life, this is like science fiction or something.”

Identity/Attainment Value

According to Eccles and Wigfield (2002), the attainment value is the individual’s determination about whether the task confirms or disconfirms the core aspects of the person’s beliefs and self-concepts about his or her self. That is, the task confirms or disconfirms an individual’s self-identity, which is informed by the communities that the student wishes to participate in, whether in school or beyond.

For some of the students, *Alien Rescue* affirmed their identity. These students were motivated to learn science in order to fulfill their desire to become a scientist or space explorer, or both. *Alien Rescue*’s science fiction narrative brought special personal meanings to the activities for some students. For instance, a student said, “I want to one day go out of space and find a new planet plus the ones already discovered and study asteroids and comets because I really like space ‘cause its very interesting”. Another student stated, “And considering the fact that I have been wanting to be an astronaut since I was like three or four years old, this was just like the best program for me...” Another student wanted to “know what it would be like standing on the moon or going to other places” and wanted to eventually “go out of space and find a new planet plus the ones already discovered and study asteroids and comets” because of an individual interest in space.

Interactivity

Students were highly engaged with *Alien Rescue* because of its interactive features. Students’ comments on interactivity can be broken down to activeness, computer-based, feedback, playing, and miscellaneous. Of these, activeness and being computer-based were the most important for these students. When asked, “How different is working with *Alien Rescue* from working on other school activities?,” a student summed up his peers’ comments by saying, “It [*Alien Rescue*] was better because instead of being stuck on the desk, you got to play around with the computer and kind of do whatever you wanted.” Another student who liked “hands-on projects a lot more than reading out of a book” reiterated this point. One student summed up how interactivity evoked positive affect and motivation, saying “...it’s funner because you are not just looking through textbooks you get to actually play around and it’s funner than just sitting there in class.”

However, a few students did not think there was adequate feedback from the program. One student commented on the lack of feedback, "... I think it should tell you if you got it right and show how if they like where they live." In other words, *Alien Rescue* did not present the outcomes of the students' recommendations for the habitats of the aliens, and some students desired this feedback.

Novelty

Students liked to have new and different experiences. This was reflected by their preference for the novelty of *Alien Rescue*, especially since it is computer based, and how it varied from regular classroom instruction. For instance, when asked "On a scale of one to five, one being not very much and five being very much, how much do you like *Alien Rescue*?", a student replied, "I would give it a five because I like doing things that are irregular."

Sensory Engagement

Not only did students find cognitive engagement motivating, but also the engagement of their visual and audio senses. Students enjoyed the multimedia presentation in general (e.g. video scenario of the problem at the beginning of the program, graphics), but the aliens (including 3D alien videos) and probe simulations, in particular. For instance, when students were asked, "Did you like researching and how was it different from researching in other classes or subjects?" one student answered, "[I like *Alien Rescue*] because you have fun and you get to look at the aliens, you get to look at the graphs, you get to look at the pictures and then just kind of go from there" and another student answered, "I like this one part about watching probes."

Social Relations

Interaction with fellow classmates and peers was an important feature of *Alien Rescue*. These interactions took the form of debating within groups on where an alien should go, "one of the things that I liked about the research was working in a group because I think it would have been a lot less fun working by ourselves because I think its fun to talk and, it's actually fun to argue because you are actually getting all that information out and its fun all around."

Not only did the debate occur within groups but also between friends from other groups and peers outside of class:

"Well, I talked about it with my friends, because one of my friends was, 'Oh my gosh I'm totally clueless about this one alien. Do you know where they go?' And I said, 'Well I think they go over there' and she said, 'No, that's wrong they need to go here.' And we would have messed up if it weren't for my friends, because my friend stopped me in the hall and she said, 'guess what we finished Alien Rescue today' and I said, 'That's [habitat] what I chose and she said, 'No, it isn't [right]. Then, I figured it out and so my friend ended up being a little bit wrong and then I had to call Lynn. And then they had a big argument with me because they thought I was wrong and my friends were wrong. I said, 'No I'm right' and then I had to do more research."

Students also found that group interaction afforded them the teamwork needed to solve the problem. As a student pointed out, "when you work in groups, you don't have to do all the research" and the different tasks can be distributed to the appropriate people. As an example, the same student cited the conversion of Celsius to Kelvin problem as being a topic one student may know, but another student may not know. The sense of camaraderie is enhanced by the fact that students

within the same group can help each other since “your partner tells you information that you don’t know.” Unfortunately, not all the members of groups were helpful, as a student stated, “I sort of did work by myself because my partner never helped me.”

GENERAL DISCUSSION

The purpose of this study was to explore the characteristics of a multimedia enhanced problem-based learning environment that intends to provide a rich context for learning science and afford students a motivating experience. The coding and categorizing procedures found eleven key elements that middle-school students considered motivating and/or evoked affect: authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations.

These elements were in congruence with the four sources of intrinsic motivation as discussed in the literature. A new source of intrinsic motivation was revealed through the analysis: humans as socializers - interpersonal relationships, identity, and group membership. Thus, our study was able to expand upon the existing theory on sources of intrinsic motivation with the addition of “humans as socializers” as a fifth source.

Humans as Problem Solvers

Activities are intrinsically motivating when the problems or challenges are personally meaningful. To best promote this motivation, the task should be optimally challenging (Csikszentmihalyi, 1990), and if possible, adaptable to the learner’s ability. As the individual masters challenges in an activity, s/he also attains a feeling of competence, mastery, and self-efficacy for accomplishing that activity. Challenges that are too easy bring on boredom and

challenges that are too difficult evoke feelings of frustration or helplessness.

The results showed that *Alien Rescue* was able to evoke the humans-as-problem-solvers motivation within students. This was the single largest source of intrinsic motivation. This is not surprising since problem-based learning environments often have been found to be intrinsically motivating (Gallagher, Stepien, & Rosenthal, 1992; Hmelo & Ferrari, 1997; Savery & Duffy, 1995), and the core task of a PBL environment is problem solving.

The sources of motivation in *Alien Rescue* that comprised this perspective were: authenticity, challenge, cognitive engagement, and competence. As has been found by other researchers, challenge was a key source of motivation among students (Lepper & Malone, 1987; Malone & Lepper, 1987; Ryan & Deci, 2000). Cognitive engagement was the single most discussed theme by the students in this study. The students were intrinsically motivated in using *Alien Rescue* because it cognitively engaged them to research and learn new concepts and facts, and to think and solve the complex problem presented. Thus, *Alien Rescue* does not only present a challenge but provides an environment in which students valued the learning and thinking processes required to meet the challenge. The rich set of technology-based tools within *Alien Rescue* (Liu & Bera, 2005) supported the learning and thinking processes as well as encouraged interactivity.

In addition, many students knew that they were engaged in authentic activities and understood that solving the problem in *Alien Rescue* required skills that were authentic to the practices and roles of being a scientist. Results suggested that this authenticity was a source of intrinsic motivation, perhaps because it brought more meaning to the problem-solving exercise. Some students found personal meaning because they valued space exploration and science (i.e. identity/attainment value). However, a learning environment cannot

accommodate for all the different, sometimes idiosyncratic, attainment values of students. Instead, the best way to accomplish the inclusion of meaningful activities is to present them in a way that convinces students that the processes employed are authentic in nature.

Finally, some students believed that they found the correct habitats for the endangered species and were confident about their decision. This perceived competence may be viewed as a source of intrinsic motivation and/or the result of intrinsic motivation. *Alien Rescue* scaffolds and reciprocally builds a student's perceived competence as the students proceed to complete the program. This is an important design consideration: students should develop the feeling of self-efficacy as they progress through the learning environment in order to promote intrinsic motivation.

Humans as Players

People play because it is fun. Fantasy involvement using graphics, characters, story, and sound can promote the feeling of play. Fantasy, heightened by using sophisticated multimedia techniques, removes students from everyday (non-play) life, which in turn promotes the feeling that the activity at hand is playing. A playful activity affords the learner to focus on the activity, which drives engagement (Csikszentmihalyi, 1990). However, if the activity is too playful, then the learner may focus on the playing aspects and less on the learning objectives.

Fantasy and interactivity combined, i.e. human as a player, were strong sources of intrinsic motivation for students to use *Alien Rescue*. Fantasy was the second biggest contributor to intrinsic motivation for the students. Fantasy involvement was promoted by using a science fiction narrative that was expressed through multimedia and interactivity. Interactivity is closely aligned with the concept of playing, and in particular, students liked playing on the computer. Results suggested

that the activeness (see Vinter & Perruchet, 2000) and feedback that *Alien Rescue* afforded via computer-based activities evoked positive affect for students. Finally, an indication that the students were experiencing play was that many of them called *Alien Rescue* a computer game and compared it to other games they played.

Humans as Information Processors

We take pleasure in resolving the mystery or disequilibrium and prefer activities that are neither very familiar nor very different (Pintrich & Schunk, 2002). Like challenges, to best promote this motivation is to provide optimal, intermediate levels of surprise and incongruence. Interestingly, curiosity was not explicitly mentioned by students using *Alien Rescue*. Instead, students described being motivated by novelty. That is, they were attracted to novel and different experiences as presented by *Alien Rescue*.

Piaget (1977) theorized that organisms (humans) not only desire experiences that are close to their existing schema, but also radically new experiences that require new cognitive structures or schemata to be accommodated. "Piaget explains how, at times, this process results in a 'reach beyond the grasp' in the search for new knowledge" (Fosnot, 1996, p. 13). Here, it seems that there is some overlap of the metaphor of humans as problem solvers and humans as information processors. Students were not only interested in meaningful challenges but their interest was piqued if the experience was novel to them. This novelty was especially enhanced by the multimedia delivery of *Alien Rescue*. Such use of multimedia effects promotes sensory curiosity (Malone & Lepper, 1987).

Yet, it is interesting that "human as information processors" was not as strong as a source of intrinsic motivation for students using *Alien Rescue* as expected. This could have been because the interpretation and categorization by the researchers

may have unintentionally marginalized this source. For instance, perhaps when students expressed their fondness for designing and using probes to find information about specific planetoids, this was an indication of their need to resolve their curiosity instead of preference for fantasy involvement using graphics. Or maybe it was both.

Humans as Voluntary Actors

The sources of intrinsic motivation from the perspective of ‘humans as voluntary actors’, as stated by Malone and Lepper (1987), are: control and self-determination. People are fond of the feeling that they are in control of their environment. Environments that provide choices and self-direction support the feeling of autonomy, which enhances intrinsic motivation. This motivation is best promoted when the activity provides “a sense of personal control over meaningful outcomes” (Lepper & Malone, 1987, p. 258). Yet, too much control over the outcomes can reduce the meaningfulness of the activity.

The open-ended nature of *Alien Rescue* affords a significant amount of choices. Therefore, it was expected that students would have mentioned choices and control more often than was found. Yet, as an indication of their desire for control, students had a strong negative reaction to the expert-modeling tool, which they felt had confiscated their control.

Humans as Socializers

The theme of social relations was an essential motivating factor of *Alien Rescue* users. Most students found the socializing aspect of working with their peers motivating. Debating and arguing their perspectives about the problem and possible solutions were engaging and fun. Such lively discourse occurred both inside and outside the classroom. Collaboration is an important aspect of PBL environments. Unfortunately, the difficulty in

logistics of performing group assessment in K-12 classrooms often discourages curricula incorporating group work. The results of this study pointed to the need to consider peer collaboration as part of the implementation of learning environments.

Developing and maintaining social relations or socializing is not explicitly stated as a source of motivation in most classical descriptions of intrinsic motivation because it appears to be extrinsic in nature. However, Lepper and Malone implicitly incorporated socializing by including self-determination (Deci and Ryan 1992; Ryan & Deci, 2000) as part of the humans as voluntary actors perspective. Self-determination theory of intrinsic motivation posits that people are innately motivated to seek out optimal stimulation and challenges that meet the needs of autonomy, competence, and relatedness. In self-determination theory, the competence need is the desire to feel capable of acting appropriately in an environment, which overlaps directly with the concept of humans as problem solvers. The autonomy need is the need of humans to feel that they are in control of their environment, as discussed in the metaphor of humans as voluntary actors. Thus, a more accurate portrayal of humans as voluntary actors is that it is about control and autonomy, rather than self-determination.

However, self-determination theory also includes relatedness as a source of intrinsic motivation. Relatedness is the need to feel secure and connected to others in the learning environment. The need for security and connectedness is closely aligned with Maslow’s (1955) theory of hierarchy of human needs of safety and belongingness. In Maslow’s theory, safety needs can be seen in individual’s preference for familiar (e.g. social) surroundings, and belongingness needs involve the need for affectionate relationships and the feeling of being part of a group (Petri, 1981).

In support of the existence of the need to be connected to others and interpersonal relations as a motivator, there have been numerous studies

demonstrating that cooperative learning and group activities, such as those provided in problem-based learning environments, have a positive effect on students' interest, engagement, and motivation (Shernoff, Csikszentmihalyi, Schneider, & Shernoff, 2003). And although not mentioned in the above intrinsic motivation metaphors, Lepper and Malone's (1987, p. 248) taxonomy of intrinsic motivations includes interpersonal motivations, which are promoted by organizing activities with cooperation, competition, and recognition. A fundamental design element of PBL environments is organizing the activity so that learners cooperate to solve a problem, which affords the opportunity to enhance interpersonal relations and motivation.

The innate desire of individuals to establish, strengthen, and maintain interpersonal relations—the sense of belonging to and participating in a social group or community—is aligned with the social constructivist view of motivation (Greeno, Collins, & Resnick, 1996; Wentzel, 1999), which is an underlying theory behind problem-based learning environments. In the classroom, this social group comprises of friends and classmates. The super-motive is the reciprocal process of valuing the social group and the development of one's identity within that social group. Individuals have the innate need to belong to a social group or community where they can develop their self-esteem and attain esteem (via social recognition) from others through participation in that social group or community (Bandura, 1986; Hickey, 2003; Maslow, 1955; Ryan & Deci, 2000). Motivation is the process of negotiation of one's identity and participation in a community in order to attain esteem (Lave & Wenger, 1991).

The Significance of Using Technology in PBL Delivery

Within the context of PBL, the eleven elements that the students found to be motivating about *Alien Rescue* were, to a large extent, delivered and

enhanced with the assistance of technology. Situating the central problem within a science fiction premise, using video newscasts to announce the arrival of the aliens, placing students in the role of a scientist, providing a space station environment for the student to explore, and providing numerous databases of rich information make the learning environment more compelling and engaging for these sixth-graders.

Students' research and problem solving in *Alien Rescue* are assisted with the set of cognitive tools, each with a specific function. These cognitive tools are an important part of enhancing intrinsic motivation. This includes providing tools that students consider are authentic and used in the "adult world" such as the notebook, probe designing, and informational databases about NASA missions, and our solar system. These tools are interactive, supporting fantasy and sensory engagement. They provide necessary cognitive scaffolding during students' problem solving. As students develop more expertise during the process, they feel more confident with their work, which ultimately leads to enhancing students' self-efficacy. The cognitive tools provide students both cognitive scaffolding in assisting them to solve a complex problem, and also motivational scaffolding in making them feel less overwhelmed or helpless. Together with the incorporation of teamwork, students are in control of their own learning, relying less on the teachers, and are encouraged to be self-reliant and independent. The cognitive tools, however, should not be considered to have a one-to-one correspondence to the sources of motivation. Instead, the relationship between the tools and sources of motivations are one-to-many. That is, every tool can afford different sources of intrinsic motivation. For instance, the probe-designing tool supports the fantasy narrative, provides control for the students to test hypotheses and multimedia sensory curiosity while affording the students to continue the process of problem solving. When designing cognitive tools within a learning envi-

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ronment, designers should consider how tools, individually and collectively, support the sources of intrinsic motivation (See Figure 2).

CONCLUSION

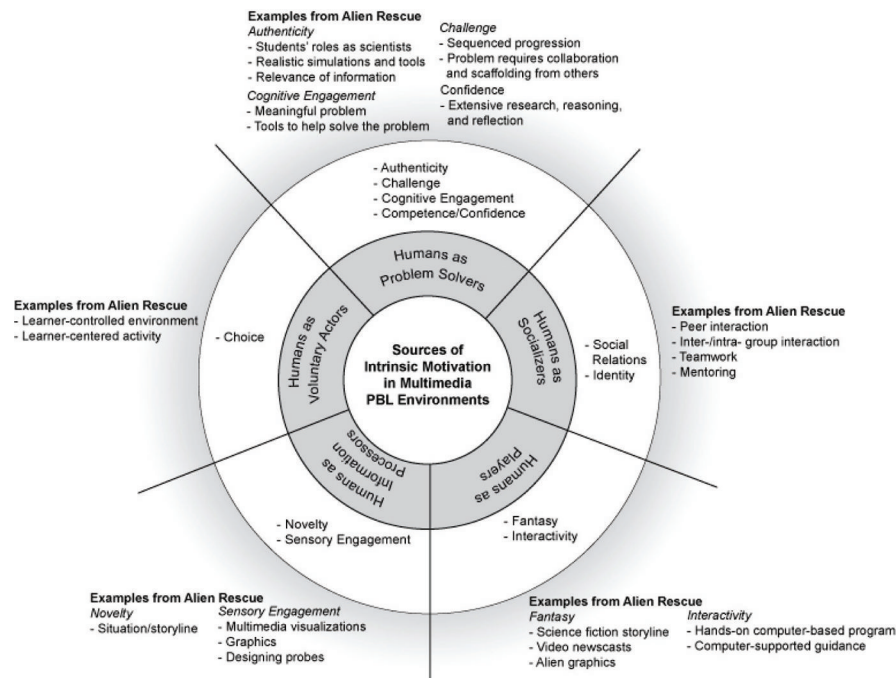
Intrinsic motivation is shown to be highly correlated with the academic success of students, and is thought to be the antecedent to learning. Thus, it would behoove designers of multimedia learning environments to consider incorporating elements that promote the five sources of intrinsic motivation: problem solving, playing, information processing, voluntary acting, and socializing.

The findings of this study showed that students using *Alien Rescue* repeatedly described their experience as fun, interesting, and enjoyable, which are the characteristics of being intrinsically motivated. The two strongest sources of intrinsic motivation for students using *Alien Rescue* are

their participation in problem solving and playing. The students expressed pleasure in engaging cognitive challenges while problem solving and the environment afforded these middle school students the feeling of playing while problem solving. Thus, removing them from everyday life and immersing them in a fantasy appeared to motivate the students to engage in solving a difficult task. The importance of incorporating these sources of intrinsic motivation into designing multimedia learning environments for this age group is obvious.

Other sources of intrinsic motivation such as social relations, curiosity, and choice—though less mentioned in comparison, also merit attention in designing multimedia learning environments. A learning environment that promotes social relations is important because it is not only a source of intrinsic motivation, but peer collaboration is also a way to scaffold student learning through the zone of proximal development (Vygotsky,

Figure 2. Summarizes the motivating characteristics as exhibited in *Alien Rescue* with their corresponding theoretical motivational perspectives



2006). In addition, students are motivated by the novelty of the computer program, as well as with the sensory curiosity afforded by the rich multimedia design. Finally, choice is an essential source of intrinsic motivation and becomes salient to the students who, as shown in this study, had strong negative reactions when it was insufficient or taken away.

Taken together, the eleven elements (authenticity, challenge, cognitive engagement, competence, choice, fantasy, identity, interactivity, novelty, sensory engagement, and social relations) as exhibited in *Alien Rescue* have shown what makes a learning environment engaging to the sixth-graders, and reflect the five sources of intrinsic motivation. Thus, these motivational factors are important for designers to consider in designing learning environments.

FUTURE RESEARCH DIRECTIONS

This study provided some empirical based insights into how a multimedia learning environment can motivate students to learn academic subject matter. One possible future direction of research relates to how to optimize the sources of intrinsic motivation using multimedia. Is it possible to find an optimal level of motivation for a target group of students or is it better to try to develop an adaptable system to accommodate idiosyncratic motivational levels of each student? If the adaptable system approach is taken, how does one measure the student's motivation without interrupting working/playing and confiscating control?

Another possible future research direction is to determine how to enhance the sources of intrinsic motivation of PBL environments, such as *Alien Rescue*. Socializing, evoking curiosity, and choice-making were appreciably less mentioned by students in this study as compared to other sources such as problem solving and playing. How can these secondary sources be enhanced?

Also, will all the sources of intrinsic motivation be enhanced when focusing on improving one or more of the sources' efficacy?

Finally, it is possible to use the five sources of intrinsic motivation as a rubric for evaluating future research on motivational characteristics of multimedia learning environments. Quantitative instruments can be developed to evaluate a wide range of multimedia learning environments to determine which sources were the major contributors for each genre. For instance, how do the results of this study compare to other multimedia enhanced problem-based learning environments? The results from studying each genre of multimedia learning environments can also be compared and contrasted to gain greater understanding of how to motivate students. From this research, we would not only understand how to enhance motivation through multimedia, but we could also be able to add new insights and dimensions to motivational theories as well.

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Chapter 1.7

Quality Learning Objective in Instructional Design

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INTRODUCTION

Due to continuous technological advancements, the Web offers diverse applications for e-learning. However, in practice, many times technological development is considered synonymous with improved education. It is very important to take into account the appropriate use of Web development in order to promote knowledge acquisition with a proper selection, delivery and construction of information.

In order to support knowledge management in e-learning, it is critical to take into account the type of information in development. The evolution of the Web towards semantics supports the idea of giving more significance to contents than

to syntax. In this way, the machines can make complex tasks to deliver users the information to meet their needs.

The challenge of defining the type of information to manage for e-learning is a topic that has led to the emergence of new concepts for resource development. One of these concepts is the learning object, which considers resources as independent units that can be re-used for other contexts and educational situations.

However, there are a lot of LOs definitions; the most widespread one is from IEEE LOM (2002) that states the “digital or non-digital entity that may be used, reused or referenced while the learning receives technical support.” However, this concept is too broad to guarantee an efficient resources management. We believe LOs should represent

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at least a single instructional objective and all of the related materials required to support that goal.

In order to manage LOs without interoperability problems, specifications and standards are in development. However, the ability to interchange learning objects is not synonymous of a good quality result. Research about quality LOs is a topic that has had limited focus and there are only a few published works dealing with their quality design.

In today's world, reusable LOs concepts and standards for their treatment represent an advantage for knowledge management systems to whatever kind of business that supports an online system. Users are able to manage and reuse content according to their needs without interoperability problems. The possibility of importing LOs for e-learning aims to increase their information repository, but the learning object quality is not guaranteed.

As stated before, the purpose of this article is to provide an awareness of the elements that should be considered in quality learning objects' instructional design for e-learning systems.

According to this, in the second section we propose our own LOs definition considering different kind of aggregation levels; in this way it is possible to make clear what we understand for LOs and what kind of LOs we are managing. Another important issue is to make clear what is the meaning of quality; for this reason in this section we present our own definition about it.

In order to achieve quality LOs design it is important to take into account their characteristics. The third section defines LOs' characteristics in order to promote quality LOs instructional design.

To achieve this we analyze cognitive theories to promote learning as well as explain issues relating to the LOs characteristics that help to improve their quality for a suitable management. It is because LOs need to be enabled with other ones to build the largest units (didactic units, courses, etc.) possible to deliver selected LOs for students; it means they are part of the whole. In addition, this

work offers recommendations for quality criteria of resources to consider in composing quality didactic units from LOs. Finally, the fourth section points out our conclusions

LOS AND QUALITY CONCEPT

There are new organization models, which need to be encouraged (Cunha et al., 2006). One of the most important is the virtual organization model (Putnik et al., 2006). As a product of Web development, the LOs concept exists (Moreno & Bailly Baillièrre, 2002; IEEE LOM, 2002; Polsani, 2003; Wiley, 2000). LOs have characteristics of being independent units, which are able to be reused in other educational situations.

In agreement with this there are new ways for working and organizational dimensions (Cortés et al., 2006). Knowledge management for e-learning based on reusable LOs means the possibility of accessing specific content according to the learners' needs. To avoid interoperability problems, there are some organizations that are working to develop standards and specifications to manage resources for e-learning systems.

To manage LOs, it is important to respond with what we understand for LOs. We define a LO as a "unit with a learning objective, together with digital and independent capabilities, accessible through metadata to be reused in different contexts and platforms" (Morales et al., 2006).

LOs must have a learning objective because it enables it to direct the contents and material relating to them. Ideally a LO must contain different types of elements, which help to clarify the main idea. In this way learning could be reinforced.

For reusing LOs in many educational levels and contexts, it must include a principal or a few related ideas; in this way teachers are free to decide in which learning context they must be used. It is possible because LOs are not necessarily related to any time, methodology or instructional design.

Independent LOs characterized by one or few related ideas means the possibility to teach some topic by itself, avoiding reusability problems. Accessible through metadata capabilities deliver the LOs characteristics providing different kinds of information about them.

Our proposal is based on IMS specifications, for this reason we refer to metadata considering IMS LOM (Learning Object Metadata) (IMS LOM, 2003), which is a derivation of IEEE LOM (IEEE LOM, 2002). Finally, LOs reusability means the possibility that a LO could be reused many times independent of software and platforms changes. This issue reflects their interoperability and durability characteristics.

IEEE LOM (2002) defines different kinds of aggregation or granularity levels for Los; this means different type of LOs to manage according to their size. However, we think IEEE LOM (2002) definitions are too wide and do not consider educational sense. According to this we suggest the following definitions:

- **Level 1:** The smallest level of aggregation, for example, a picture, an image, a text, and so forth (IEEE LOM, 2002)
- **Level 2:** A lesson with a specific learning objective and a kind of content, practice and evaluation activities
- **Level 3:** A learning module composed by a group of lessons (LOs Level 2), practice and evaluation activities
- **Level 4:** One or more courses composed by a group of modules (LOs Level 3) with different kinds of contents, practice and evaluation activities

The levels mentioned suggest pedagogical components in order to help students to achieve their learning objectives. However this issue is not enough to ensure quality Los.

In order to propose quality LOs design it is important to define what is the meaning of “qual-

ity Los.” According to the RAE (2006) definition, quality is a property or group of properties inherent in a thing, which aims to judge their value. Taking into account this definition and LOs characteristics, we define quality learning objects design as a property or group of properties inherent in a learning objects, which aim to value them as equal, better or worse than other ones.

Quality is a concept that involves other issues for their evaluation, for example, quality criteria, metrics, instruments, and so forth. To achieve a whole quality LOs design, in the next section we are going to mention LOs characteristics that aim to define quality criteria to evaluate their quality for an instructional design process.

LOs INSTRUCTIONAL DESIGN

Different kinds of learning theories exist to explain how learning occurs. However, to apply some design for contents it is necessary to consider some methods depending on learning situations, it is possible through instructional design. Reigeluth and Moore (1999) explain that instructional design is a theory that offers an explicit guide about how to teach to learn.

Instructional design theories are related with the kind of information to try. About LOs some instructional design theories exist. Merrill (1999) proposes the instructional transaction theory directed to mechanized process “is an attempt to extend the conditions of learning and component display theory so that the rules are sufficiently well specified to be able to drive automated instructional design and development.”

This theory describes knowledge in terms of three types of knowledge objects: entities, activities, and processes. Also it identifies a lot of issues like interrelationships among knowledge objects including: components, properties abstractions, and associations between entities, activities, and processes.

Merrill's theory has been criticized about its excess structure because it doesn't facilitate the content developers' work and to put it into practice.

Based on Merrill's theory (1999), Cisco Systems (2004) suggests a guide for reusable learning objects creation. This guide proposes specific structures for any kind of specific learning object. It also provides a help guide and examples for their classification. To ensure solid structures for multi-courses, Cisco Systems provides five levels of hierarchy: course, module, lesson, topic, sub-topic. Each one of these levels has specific elements to structure them.

Cisco System LOs structure is shared by Moreno and Bailly-Baillière (2003), however they suggest taking into account three kind of contents: data and concept, procedure and process and finally reflection and attitude. According to them, the three kinds of contents involve the other ones (Moreno & Bailly-Baillière, 2003). In this way it is possible to simplify the content developers work covering other related types of contents. We think defining three kinds of contents involving another ones is a good idea because each kind of them defines what learners are able to do, because each one of them represents a specific unit of learning together with a specific difficulty level. For example, data and concept refer to basic information about any subject, so they need to be considered at the beginning of a lesson; process and procedure implies a high level of difficulty because it refers to some sequenced steps, which needs to consider previous to basic information (data and concept).

Finally, we would like to suggest "principles" kind of content instead of "reflection and attitude;" this is because principles learning is related with high cognitive levels as induction, deduction, and so forth. Then, this kind of content needs to be considered at the end of a lesson.

Nowadays, LOs instructional design is a topic that is highly discussed. However, according to those mentioned above there are some issues

that must be considered to ensure a quality LOs instructional design. According to this in order to provide an awareness of the elements that should be considered in the quality learning objects instructional design for e-learning systems we suggest some quality criteria into the following LOs components.

- **Overview:** According to Cisco Systems (2004) and Moreno and Bailly-Baillière (2002), a didactic unit needs a general vision in which may be explained general objectives and introduction about the LOs content. Introduction is an important element for any kind of content because, as well as their informative function about the contents, they establish the purpose of the topics and orient learners to what they are expected to learn. On the other side, it is a motivation element that aims to engage the students, letting them know why it is important for them.

An overview must show the LOs objective too. As we explain in the LOs definition, according to LOs reusability characteristics ideally an objective must be simple with one or few related ideas. We suggest that an objective must be directed to learn one kind of content because in this way all the instructional design would be targeted to achieve this specific objective.

Other important issues that must be included in a LOs overview are its own title and the title of the unit of learning; in this way students can know what part of a whole they are trying; the list of topics that aim to relate the topics; the number of hours to be available to achieve the objective that aim to organize the learning; and, finally, keywords that aim to know what related areas are involved with the LOs content.

- **Contents:** One of the most important issues for instructional design is to define what

kind of content we are trying. According to this some instructional design proposals exist (Merrill, 1999; Clark, 1999; Moreno & Bailly-Baillière, 1999; and so forth) in order to define a suitable information or type of knowledge (facts, procedure, process, concept, principle, etc.) The type of content or unit of learning is very important because it responds the answer about what to teach according to a specific cognitive domain.

In general any kind of content must have some quality characteristics taking into account different issues. From a pedagogical point of view, contents must be in line with logic and psychological meaningful: that is to mean, on one side discipline logic (content sequence, methodology, kind of activities, etc.), and on the other side users suitability (level of difficulty, user interests, etc.). Other issues related with any kind of content are the information veracity, data entirely correct, good redaction and orthography, and so forth.

However, taking into account the LOs characteristics it is important that contents do not mention something about the time, for example, this week or this semester... because it could delay its reusability for other educational situations. The same thing must be taking into account for the audience, so phrases related to the kind of users like “dear engineering students...” must be avoided.

- **Practice activities:** Activities may be directed to promote new knowledge acquisition and prepare users for a final assessment. Clark (2002) promotes **practice** and **assessment** activities. The first one has to support students to acquire new knowledge providing feedback, pointing out the most important information, and to prepare them for a final evaluation. The second one must be a final experience together with an approbation or reproval degree. They

are used to verify if the objectives were achieved or not.

Activities may be included into any kind of content during all teaching and learning processes. They help users to know if they must to take the next lesson or a content feedback.

Activities are recommended for any kind of instructional design, however for LOs there are several issue to take into account that are not usually discussed. In general activities are too related with a context. Activities are recommended to acquire new knowledge according to the students' context (culture, interests, etc.).

However activities related with a specific context can causes problems to reuse LOs for another context. To promote LOs reusability we suggest proposing into instructional design some LOs activities that aim to learn the contents independent of the context. For example, some self-assessment activities can help students to remember and, relating concepts between them, some questions about content reflection can help to learn specific contents, and so forth.

In order to avoid contents reusability problems we suggest making some context activities independent of the LOs structure, in this way the LO would have more probabilities to be reused in another context.

Some authors (Zapata, 2005; Del Moral & Cernea, 2006) promote constructivist learning environments for learning objects. They emphasize that activities must be as diverse as possible to attend to different kind of users: case studies, to resolve problems, collaborator work, reflect about situations, and so forth. However, we think a deep reflection about them is necessary before their application to LOs.

Activities are closely related with the kind of contents; if LOs contents are just talking about a basic concept, fact or data, the kind of activities may be directed to reinforce them, for example, relating basic concepts with true or false options, and

so forth. Probably another activity like case study doesn't need this level of complexity. According to this, in order to respond different complexity levels, contents, and cognitive domains, we suggest taking into account three kinds of activities: initiation, restructuring and application.

- Initiation activities classification may be for all LOs, which are designed to teach basic content for a specific subject. An example of this is a quiz.
- Restructuring activities classification may be directed to promote new knowledge acquisition, such as activities that promote questions, investigation, and so forth.
- Application activities may be directed to promote students' experiences in order to achieve their new concepts acquisition. An example of this activity is a case study.

Due to LOs reusability characteristic some authors like Cisco System (2004) and Bailly-Baillièrè (2002) recommend making some sequential activities at the end of a lesson. This is to avoid consistency problems with new LOs adaptation. In this way it is possible to attend the whole of each one of individual LO content.

Web development is directed to the social web, which promotes collaborative tasks that need to be considered for learning. According to this. García-Peñalvo et al. (2007) suggest relating Web tools with different kind of e-activities in order to promote collaborative work.

- **Summary or conclusions:** For whatever kind of teaching and learning process, it is advisable a summary after contents review. For a suitable summary it is advisable to point out the principal ideas and relation between them, in this way it is possible to reinforce the contents and learner progress. Also it is important to relate the contents with another knowledge areas. This may

be done, for example, by diagrams, schemas, conceptual maps, and so forth.

- **Evaluation activities:** As we mentioned above, assessment is a kind of activity that must be a final experience together with an approbation or reproval degree. Their function is to verify if the objectives were achieved or not. An evaluation must take into account each one of the learning objectives and must be directed to any kind of content and their level of difficulty.

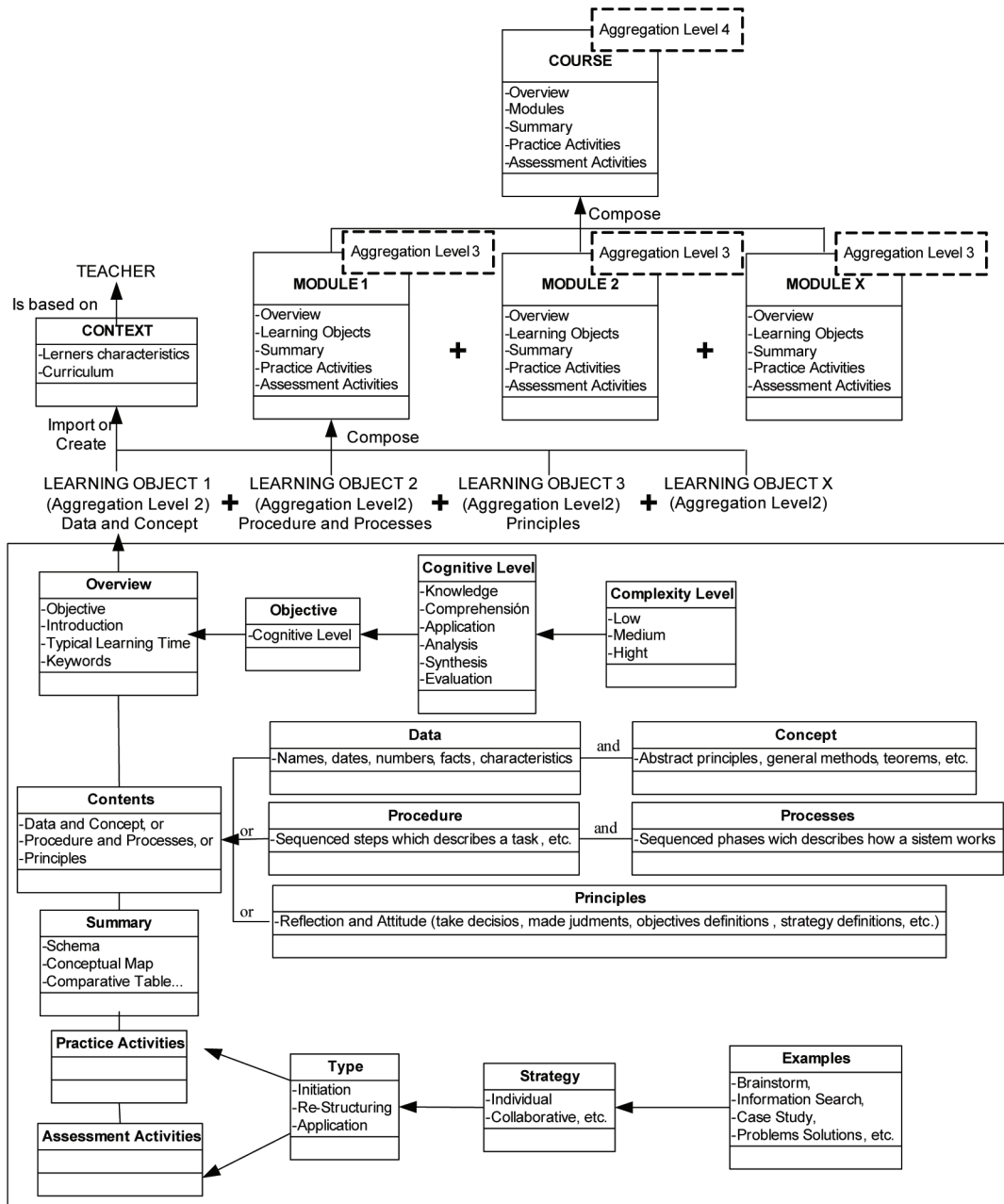
As we said before, LOs need to be enabled with other ones to build the largest units (didactic units, courses, etc.) possible to deliver selected LOs for students (Cisco System, 2004; Moreno & Bailly-Baillièrè, 2002). According to the LOs components mentioned above, Figure 1 shows the relation between LOs instructional design components through an ontological model proposing some classification that could be considered for an application profile in order to improve LOs management.

LOs classification suggested above is a way to facilitate LOs management according to instructional design characteristics. Cognitive level aims to define what student skills to develop and what they are able to do. This information is important from a pedagogical point of view to determine their reusability in another educational context.

On the other side, contents classification aims to decide if they are suitable for other educational objectives and aims to determine the contents sequence, because any kind of content defines the specific type of content that LOs contain. This issue is useful to give students specific LOs content they need.

According to the knowledge model proposed, activities are classified by practice and evaluation, as we explained in the first section. Both have the same classification and strategy, however the last one must be evaluated to promote students to another learning stage.

Figure 1. An ontological model for LOs instructional design



LOs normalization is a way to prepare LOs for their management and evaluation, because in this way it is possible to uniform their characteristics promoting their quality criteria. This issue aims to respond to an important question for knowledge management: what to manage?

CONCLUSION

Nowadays LOs are a subject that is highly discussed, but there is not a consensus about their instructional design. This is due to several things, one of which is a big breach between pedagogi-

cal and computer science areas. On one side, from the computer science area there is a high concern about promoting LO characteristics for automated process: reusability, accessibility and interoperability.

Nowadays some specifications and standards are in development as an attempt to solve these problems. As well some researches are focused in development repositories to attend to any kind of LOs aggregation level.

From a pedagogical point of view, researchers complain of a lack of instructional design plan, which aims to direct the LOs content to achieve a learning objective. However, there are some pedagogical issues that are difficult to achieve for automated process.

Nowadays technical and pedagogical issues for quality learning objects design are not easy to solve because it depends of an agreement between them. In a way to help to give a solution we suggested some issues to take into account from instructional design view. We think it is very important to apply some instructional design, because it aims to give LOs educational sense.

The LOs definition we are proposing aims to define some instructional design components, and quality criteria provided aim to create a valid and quality unit of learning. On this basis, it is easier to apply quality criteria for LOs because they have a uniform structure.

This work does not pretend to solve the LOs quality problem, but proposes some ideas to improve their quality into a pedagogical point of view that must be applied both to instructional design and metadata information.

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KEY TERMS AND DEFINITIONS

E-Learning: The use of Internet technologies for learning activities to promote a wide display of solutions for improving knowledge and performance.

Instructional Design: Instructional design is the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction. It is the entire process of analysis of learning needs and goals and the development of a delivery system to meet those needs. It includes development of instructional materials and activities, and tryout and evaluation of all instruction and learner activities (<http://www.umich.edu>).

Learning Object: A unit with a learning objective, together with digital and independent capabilities, accessible through metadata to be reused in different contexts and platforms.

Learning Objects Repository (LOR): Collections of learning objects that are accessible via Internet. They function like portals with a Web-based user interface, a search service and a catalogue for the resources contained.

Level of Granularity: How much or how little information is included in a learning object. It is related with the LOs size.

Metadata: Coded information about a learning object that aims to describe and manage them in the learning object repository.

Quality Learning Objects: A property or group of properties inherent in a learning objects, which aim to value them as equal, better or worse than other ones.

Reusability: A property of learning objects, which promotes the reuse of them for other educational situations and contexts. It depends on both metadata information and instructional design.

Chapter 1.8

Instructional Design Methodologies

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ABSTRACT

Instructional design (ID) is the systematic process of planning events to facilitate learning. The ID process encompasses a set of interdependent phases including analysis of learners, contexts and goals, design of objectives, strategies and assessment tools, production of instructional materials, and evaluation of learner performance and overall instructional design effort. The system approach, developed in the 1950s and 1960s, is rooted in the military and business world and has dominated educational technology and educational development since the 1970s. Currently, there are more than 100 different ISD models, with almost all based on the generic ADDIE model. Other commonly known models include the Dick and Carey model, the R2D2 model, the ICARE model, and

the ASSURE model. These models share three major components: analysis, strategy development, and evaluation. This chapter identifies the different roles and responsibilities involved when developing a typical title and outlines the main steps in the development.

INTRODUCTION

Instructional design (ID) is the systematic process of planning events to facilitate learning. The ID process encompasses a set of interdependent phases including analysis of learners, contexts and goals, design of objectives, selection of strategies and assessment tools, production of instructional materials, and evaluation of learner performance and overall instructional design effort (Gagne, Briggs, & Wager, 1992).

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Instructional design models may be defined as the visualized representations of an instructional design process, showing the main elements or phases of the process and their relationships. The systems approach involves setting goals and objectives, analyzing resources, devising a plan of action, and continuous evaluation and modification of the program (Saettler, 1990). The system approach, developed in the 1950s and 1960s and rooted in the military and business world, has dominated educational technology and educational development since the 1970s.

Currently, there are more than 100 ISD models, but almost all are based on the generic ADDIE model. The more commonly known models are the Dick and Carey model, the ICARE model, and the ASSURE model. These models all share three major common characteristics: analysis, strategy development, and evaluation. This chapter identifies the different roles and responsibilities involved in developing a typical title and outlines the main steps in the development. This chapter also explores ID in terms of definitions, models, and usage.

INSTRUCTIONAL DESIGN, TECHNOLOGY, AND THEORY BACKGROUND

The following key ID terminologies (1996) are explained in “Definitions of Instructional Design”:

- The discipline of instructional design is a branch of knowledge concerned with research and theory about instructional strategies and the process for developing and implementing those strategies.
- Instructional development is the process of implementing the design plans.
- An instructional system is an arrangement of resources and procedures to promote

learning. Instructional design is the systematic process of developing instructional systems and instructional development is the process of implementing the system or plan.

- Instructional technology is the systematic application of theory and other organized knowledge to the task of instructional design and development.

The growth of instructional design is relatively brief when compared with more mature design fields such as architecture. Only during the last century have scholars conducted in-depth research into learning theories, instructional theories, and systematic approaches to instruction. Many researchers analyze how human learning is relevant for the design of educational material (Gros, Elen, Kerres, Merrienböer, & Spector, 1997; Reigeluth, 1999; Schneider, n.d.; Winn, 1997). ID theory provides guidance on the task of designing learning experiences. It also provides a bridge to learning theories and instructional theories. According to Reigeluth, “Instructional theory describes a variety of methods of instruction (different ways of facilitating human learning and development) and when to use—and not use—each of those methods” (Squire & Reigeluth, 2000).

Most researchers agree that instructional materials are concerned with electronic learning environments. Such an environment is a combined system involving tasks, stakeholders, courseware, etc., which is aimed at supporting learning processes. Learning takes place mostly in interaction between learners, courseware products, other tools, and to a lesser degree tutors (human or artificial) (Schneider, n.d.).

The discipline of instructional design concerns research and theory about instructional strategies. Theory background for teaching and learning are presented in the following section.

INSTRUCTIONAL DESIGN PROJECT MANAGEMENT

Developing an instructional project involves skill sets ranging from project management and interface design to sound preparation and programming. Sometimes, budgets and schedules require multimedia developers to juggle more than one role. Design teams represent various fields of expertise (producers, instructors, editors, etc.). Although multimedia tools make it possible for one person to perform every task, few people have the combination of technical, artistic, and management skills necessary to fill every role well. As a rule, teams with a range of expertise best develop instructional design projects. The more a person understands each team crew's role and responsibilities, the better they will perform in these roles.

- Project manager
- Instructional designers
- Content experts/writers/script writer/writer/editor
- Developers/program authors/lead programmer
- Video specialists/camera operator
- Audio/video specialists/sound engineer/audio technician
- Graphic artists/art director
- Testers

The entire instructional design team together has to establish a consistent design for the title by specifying what the navigation system looks like, where information and media appear on screen, and what fonts, colors, and graphical design elements to use.

Time is critical, especially with a team of more than three members working on the same instructional project. Team members need to share expertise, intent, calendars, and internal standards. Designers need to clarify their goals, objectives, content, and evaluation plans to the producers.

Producers also need to focus on the identified audience and objectives and suggest technology options. The instructional design steps save time by focusing the team and serve as the foundation for project development and a roadmap through the process.

INSTRUCTIONAL DESIGN AND TECHNOLOGY PROJECT MANAGEMENT LIFE CYCLE

Every instructional design project is different, but almost all follow these typical project planning, development, and implementation steps:

1. Determine project scope
2. Letter of understanding
3. Contractual agreement
4. Storyboard
5. Prototype
6. Script development
7. Media development
8. Authoring
9. Alpha testing
10. Beta testing
11. Project delivery

Several of the previously mentioned steps can overlap each other. Most projects involve several cycles of media development, authoring, review, and revision. In fact, your project is likely to evolve as your resources change. For example, the content has to be ready before the developers can integrate it into the final project. But writers need to integrate the content and review it on screen in order to edit the content well.

THE APPLICATIONS OF INSTRUCTIONAL DESIGN MODELS

In addition to its concerns with research and theory about learning and instructional strategies, the

discipline of instructional design is also concerned with the process for developing and implementing those strategies. The learning and instruction theories discussed above forms the basic foundation of most of the work that instructional designers do, much as a basic understanding of engineering undergirds the work of architects (Schneider, n.d.). Instructional design theory is also what designers draw on when they need guidance to overcome problems in the design process.

Models help learners to visualize the problem, and then break it down into discrete, manageable units (Ryder, 2006). In instructional design, models can be defined as the visualized representations of an instructional design process, displaying the main phases and their relationships. Each phase has an outcome that feeds the subsequent phase. ID models are visualized representations of an instructional design process, showing the main elements or phases and their relationships. The instructional design models are the instructional designer's primary "tool," which functions as a guide allowing the designer to produce effective, efficient, and consistent instruction (Hinton, n.d.).

Instructional design models can be used in many settings and to varying degrees. Individual instructors creating their own traditional classroom material can benefit from consciously using an instructional design model. Instructional design projects present the same kind of management issues that other types of projects face. Designers need to consider variables that range from how the project should look onscreen to what the personnel, equipment, budget, schedule, and resources allow the project to accomplish. Good project development depends on having a clear picture of the steps involved in the process. Instructional design teams use instructional design models to speed up the process, assist in internal and external communication, and cover all phases of instructional design.

Close alignment of instructional design steps insure that the elements of instruction are all consciously addressed and all the pieces relate to

and support each other. This also ensures that the design is complete and packaged to be transmitted to the clientele prior to instruction. In this way, no phase of instructional design will be forgotten or shortchanged. Instructional design models can help both individuals and design teams work through the process of planning and developing instruction. Consciously working back and forth through the steps of an ID model will add speed and clarity and insure that key instructional principles are addressed. Instructional design models can also be used to assess existing educational material and help in everyday planning.

A variety of models for instructional system design proliferated the late 1970s and early 80s: Gagné and Briggs, and Dick and Carey, to name a few. One possible reason for this phenomenon involves the establishment of formal education and training departments within both public and private organizations. Faced with the computerized technologies of the times, these organizations require a means to quickly develop appropriate methods by which to educate employees in the new business practices ushered into existence by the information age. Another explanation is that businesses, especially consulting organizations, are becoming increasingly required to demonstrate value-added not only to their organization, but to the clients they serve. The evaluation and continuous improvement components of contemporary instructional design models of make far strides from the early develop-and-implement models of the middle of the century in this aspect.

SYSTEMS APPROACH TO INSTRUCTIONAL SYSTEMS DESIGN (ISD)

The system approach, rooted in the military and business world, was developed in the 1950s and 1960s, and has dominated educational technology and educational development since the 1970s.

Instructional design has successfully established a fairly broad knowledge base, with foundations in psychology and other professional practices. The systems approach to instructional design was often accredited to James Finn. Seels (1989) described Finn as the father of the instructional design movement because he linked the theory of systems design to educational technology and thus encouraged the integrated growth of these related fields of study. Finn also made educational technologists aware that technology was as much a process as a piece of hardware (Seels, 1989).

The onset of World War II introduced the huge problem of training thousands of military personnel quickly and effectively. The answer at the time was an enormous influx of mediated learning material: films, slides, photographs, audiotapes, and print materials. In the 1960s, the military was rapidly infusing instructional systems development into their standard training procedures. This period was distinguished by the articulation of components of instructional systems.

The systems approach views a system as a set of interrelated parts, all working toward a defined goal. Examples of systems include the human body and a community. Parts of a system will depend on other parts for input and output. The entire system uses feedback from stakeholders to determine if the goal is achieved. In 1962, Robert Glaser employed the term instructional system and named, elaborated, and diagrammed its components. He also synthesized the work of previous researchers and introduced the concept of “instructional design,” submitting a model, which links learner analysis to the design and development of instruction.

In the field of education, the systems-approach model first focused on language laboratories. The instruction can be viewed as a systematic process in which every component is crucial to achieve the goal of successful learning. These components include the learner, instructor, instructional materials, and the learning environment. The many

components of the system interact to achieve learning. The focus is on what the learner will be able to know when the instruction is concluded.

THE ADDIE MODEL

The ADDIE model has been in use for training development for several decades. Almost all ISD models currently in use are based on the generic ADDIE. The systems approach does not prescribe or promote any particular teaching methodology. No one method will be appropriate for all objectives or for all students. Rather, it is a vehicle that helps teachers to think more systematically and logically about the objectives relevant to their students, and the means of achieving and assessing these (Chen, 2005). These early efforts of ISD in education led to several ISD models that were developed in the late 1960s.

The current version of the systems approach is a process comprised of a series of phases. Sometimes referred to as the ADDIE model, the systems approach of instructional design contains the following major phases: analysis, design, development, implementation, and evaluation.

- Analysis
- Determine the instructional goal
- Analyze the instructional goal
- Analyze the learners and context of learning
- Design
- Write performance objectives
- Development
- Develop instructional strategies
- Develop and select instruction
- Develop assessment instruments
- Implementation
- Implement the system
- Revise the instruction if necessary
- Evaluation

- Design and conduct the formative evaluation of instruction
- Conduct summative evaluation

Each step receives input from the previous step and provides output for the next step. A system is modified if the goal is not achieved. Each component is carefully linked. The ADDIE model is possibly the best known design model, and is frequently used in academic circles.

THE DICK AND CAREY MODEL

Today, Walter Dick and Lou Carey are widely viewed as the torchbearers of the approach with their authoritative book *“The Systematic Design of Instruction”* (1978). While a number of versions of the ISD model exist, the Dick and Carey model is very popular in current instructional design programs.

Dick and Carey’s model, a systems-approach model for designing instruction, is based on the assumption that there is a predictable link between a stimulus and the response that is produced in a learner. It describes the phases of an iterative process that starts by identifying instructional goals and ends with evaluation. This model includes analysis, design, development, formative evaluation, plus needs assessment in a nonlinear relationship (Dick & Carey, 1978). The designer needs to identify the sub-skills the student must master that, in aggregate, permit the intended behavior to be learned, and then select the stimulus and strategy for its presentation that builds each sub-skill.

The following is a list of the elements of Dick et al.’s model explained in *“The Systematic Design of Instruction.”*

1. Determine the instructional goal
2. Analyze the instructional goal
3. Analyze the learners and contexts
4. Write performance objectives
5. Develop assessment instruments
6. Develop instructional strategy
7. Develop and select instruction
8. Design and conduct formative evaluation
9. Revise instruction
10. Use summative evaluation

Establishing an instructional goal or goals is typically preceded by a needs assessment. The needs assessment is a formal process of identifying discrepancies between current outcomes and desired outcomes for an organization. Dick et al. described the performance objectives as a statement of what the learners would be expected to do when they have completed a specified course of instruction, stated in terms of observable performances.

The technique of hierarchical analysis is applied for goals in the intellectual skills domain to identify the critical subordinate skills needed to achieve the goal and their interrelationships. Formative evaluation is used to collect data and information that is used to improve a program, conducted while the program is still being developed. And finally, summative evaluation is conducted after an instructional program has been implemented and formative evaluation completed to present conclusions. The Dick and Carey model describes all the phases of an iterative process that starts by identifying instructional goals and ends with summative evaluation. This model is applicable across a range of context areas (e.g., K-12 schools to business to government) and users (novice to expert).

THE RAPID PROTOTYPING MODEL

Some researchers feel that conventional ISD models place too much emphasis on procedures and not on principles. They argue that conventional ISD models prescribe global tasks such as prepare

the draft version of your instructional material and fail to provide guidance in the selection of appropriate instructional strategies and tactics. As a result, the rapid prototyping methodology has been used in software engineering. Generally, rapid prototyping models involve learners and subject matter experts (SMEs) interacting with instructional designers in a continuous review and revision cycle.

A typical rapid prototyping model uses templates for various types of task for the sake of efficiency. Much time and other resources are saved by focusing on critical content and key steps and producing a lean instructional package. Improvements to this core package are added gradually after it is implemented.

Tripp and Bichelmeyer's rapid prototyping model is a four level process that is intended to create instruction for individual lessons as opposed to entire curricula. The process stages include:

- Perform a needs analysis
- Construct a prototype
- Utilize the prototype to perform research
- Install the final system

This model relies on expert instructional designers to utilize heuristics as well as their past experience and intuition to guide the design (Hoffman & Margerum-Leys, n.d.)

R2D2

Willis (1995) proposed the recursive, reflective, design, and development model (R2D2). This iterative model is based on constructivist theory and has four general guiding principles that apply to the entire ID process: *reflection*, *recursion*, *non-linearity*, and *participatory design*.

Reflection involves critically considering work to date and making changes based on personal analysis as well as feedback from a collaborative

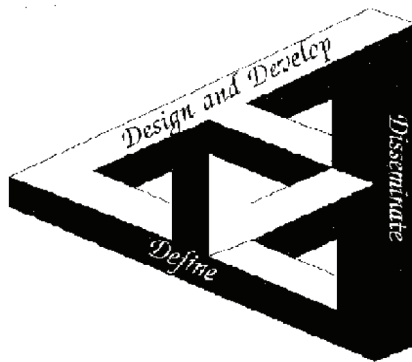
team. The approach stresses the importance of thinking about and revising ideas, plans, concepts, and procedures based on observation and analysis of what is happening in the context of practice (Chen, 1998). The recursive nature of the process involves making the same decisions several, even many, times throughout the design and development process so that initial decisions or designs are not necessarily the "final" ones. Non-linearity refers to the lack of a prescribed sequence of steps in the R2D2 design process. A designer using the R2D2 model can commence the design process with a vague plan and gradually develop, refine, and revise the plan through group interaction. The designer can elect to begin with any number of tasks through task analysis; there is no required "beginning point." The fourth principle, participatory design, refers to the involvement of a design team, which usually includes instructional designers, experts on the subject matter as well as aspects of the instructional process, specialists in graphic design and other supporting fields, and end-users (Chen, 1998). Participatory design means representatives of each type of stakeholder are involved in all aspects of the design and development process. The participatory design approach stresses the need for the team to develop approaches and solutions based on input and feedback from the team.

With R2D2, the ID team is expected to actively reflect on and analyze work to date and regularly revise and rework both the material being developed and the models that underlie its development (see Figure 1).

THE ICARE MODEL

According to its main proponents, Hoffman and Ritchie (1998), the ICARE model is distilled from basic instructional design practice, adapting various systems or "steps of instruction" to what seemed to be particularly useful components for an

Figure 1. A graphical representation of the R2D2 instructional design (ID) model. The model has three focal points (define, design and develop, and disseminate). The nature of this graphic, which has no obvious beginning or ending and constructs an “impossible world” perspective, represents the two Rs of the R2D2 ID model: recursion and reflection (Willis, 1995).



online course. For instance, in converting a course to distant learning units, a conventional 20-credit module is broken down to 20 units worth 9 hours of study each. The model has the following five distinctive but interrelated components that are applied to individual lesson/lecture known as a unit:

1. Introduction
2. Content
3. Apply
4. Reflect
5. Extend

Introduction involves reflection and determination as to how the model fits into the context of the learners' classroom. The next step is connecting the educational material with the learner's real-world environment, and presenting the new material initially with ample explanations for appropriate conceptual scaffolding. Then designers have to apply the material during simulation and providing feedback on the learner's progress, including performance assessment. After these three steps, reflections and extension follow.

THE ASSURE MODEL

This ASSURE model developed by Heinich, Molenda, Russell, and Smaldino provides an acronym to help practitioners remember the steps they must work through (Heinich et al., 2001). It incorporates Gagne's events of instruction to assure effective use of media in instruction. The ASSURE model was modified to be used by teachers in the regular classroom. The ASSURE model applies these six processes that teachers and trainers can use to design and develop the learning environment for their students.

- Analyze learners
- State objectives
- Select instructional methods, media, and materials
- Utilize media and materials
- Require learner participation
- Evaluate and revise

FUTURE TRENDS

Every ID model has some attributes not universally seen in all the others, such as inclusion of context analysis as a function of the design process, sequencing of test development, and the formative evaluation. Because of the limitations of two-dimensional graphic representations and to simplify a discussion of the activities of instructional design, instructional design models have an unintended, yet starkly apparent attribute of being sequential. Designers from every experience level may sometimes follow this sequence; however, more commonly circumstances may cause the designer to modify the sequence of design activities. Many times the steps within a certain phase may occur concurrently.

The growth of instructional design is relatively brief. Only during the last century have scholars done in-depth studies into learning theory and systematic approaches to instruction. Until re-

cently, technologies have limited the number and diversity of learners an instructor could address and involve. New breakthroughs in hardware and software technologies open the doors to new possibilities. Jacobs and Dempsey (2002) present three emerging influences that will impact the future of instructional design: object-oriented distributed learning environments, artificial intelligence (AI), and the fields of cognitive science and neuroscience.

OBJECT-ORIENTED DISTRIBUTED LEARNING ENVIRONMENTS

Objects permit the reuse of code and materials, saving time and resources needed by programmers, and expanding compatibility of applications. While most electronic learning content is currently developed for a specific purpose such as a course or a situational performance intervention, the reusable learning object (RLO) content is modular, freestanding, able to satisfy a single learning objective, and transportable among applications and environments. As organizations make significant investments in digital learning content, they seek greater assurances of portability, platform independence, and longevity, and reusability of digital content (Resnick, 2002). The development and acceptance of “open standards” helps safeguard investments in content development because they enable integration with other campus systems and facilitate content sharing.

Object-oriented distributed learning environments present several new challenges to ID models. There is a growing body of literature relates to game design and larger issues surrounding new media theory. Some of this work has already been applied to education (Aldrich, 2004), but much more could be done to apply gaming and principles of virtual world to instructional design.

ARTIFICIAL INTELLIGENCE (AI)

Artificial intelligence involves the computer working to supply responses to student input from the computer’s database. The development of artificial intelligence will permit control over instructional environments and activities. This is especially apparent in the improvement of course management, which is a key aspect of instructional design. Computers are particularly good at keeping track of information and providing guidance in solving problems. Therefore, learning management systems (LMS) are likely to become more routinely available to learners, instructors, and managers in the future and intelligent tutorials will most likely become common place.

Researchers including Muraida, Spector, and Gros discussed the use of automated instructional design (AID) tools in military courseware development. According to them, AID tools are especially useful in situations where instructional design expertise is lacking and subject-matter experts and others are responsible for developing instruction. AID tools may eliminate some traditional ID tasks such as storyboarding and test generation (Kasowitz, 1998). There are four types of tools that guide users through the ID process: expert systems, advisory systems, information management systems, and electronic performance support systems. Authoring tools are also mentioned as popular mechanisms for supporting the production of computer-based instruction. The strength of AID tools lies in their ability to guide novices and non-ID professionals through the process of creating effective instruction.

COGNITIVE SCIENCE AND NEUROSCIENCE

As discussed in previous sections, historically, instructional design grew out of educational psychology and became integrated with instructional

technology (Dick, 1987; Merrill & Wilson, 2005; Reiser, 2001). Advances in the areas of cognitive science and neuroscience will encourage more accurate monitoring of human learning based on individual activity. A recent special issue of *Educational Technology* (May-June 2004) began a dialogue between researchers associated with two fields: instructional design and learning sciences (Wilson, 2005). The learning sciences (LS) field enjoys higher academic status due to its closer ties to psychology and cognitive science, which are seen as more basic and rigorous disciplines within the academy. On the other hand, ID holds the practitioner advantage. This is a powerful advantage in that ID trains professionals for both academic and non-academic jobs. Instructional designers are seen as having more relevance to everyday concerns of practice, training, education, and commerce (Wilson, 2005).

Within the field of instructional design, researchers and practitioners have observed two constant refrains:

- On the one hand, it is said that ID practitioners rarely work according to theories. They merely work intuitively (Gros et al., 1997).
- On the other hand, it is maintained that much of ID theory is no longer applicable in the current context of rapid change, global communication, and high technology (English & Reigeluth, 1996).

These two prevalent views seem to suggest that there is a tension between theory and practice. According to modern instructional theorist, there has been call for instructional design to shift process driven analysis to learner driven analysis.

Reigeluth (2004) spoke of the “balanced diet” provided by ID’s broad concern for design, development, implementation, management, and evaluation. Wilson (2005) also calls for a more balanced approach by increasing servings of often-neglected aspects of design, particularly

the moral and value layers of meaning, human-computer interface, and the aesthetic side of our work. The foundations or pillars of practice need to go beyond learning theory, and beyond the various ID models depicting the life cycle of design.

Many ID professionals also propose that while most of the current discussions focus on traditional ID models, there is a growing concern both within and without the field about the efficacy of instructional design and its contribution to the learning community. Recent attacks on ISD have devalued it as being archaic, inflexible, and ineffective (Hadley, 2004). While instructional design models are helpful in mapping the intricacies of a design problem, they are sequenced of design decisions without the knowledge required to make them. As a result, models consistently fall short of real-world training problems.

CONCLUSION

As presented, instructional design is a field that affiliates with a number of disciplines including educational psychology, information studies, and instructional technology. It is a discipline that applies theory to practice—learning theory to instructional design practice. Gagné himself said that, “In seeking a way of dealing with multiple objectives other than serially, we perceive a need for treating human performance at a somewhat higher level of abstraction than is usual in most instructional design models.” (1990). There is simply no right way to plan an educational project. However, ID practitioners can borrow the planning techniques and analytical tools, which can be from established models and applied to inform and improve the finished product. This should be part of the toolkit of any competent designer (Hunter, n.d.).

The generic ADDIE process has been the mainstay for many instructional designers over the past two decades. Other than that, instructional design is so eclectic that many researchers in the

field have raged debates for years over basic definition, terminology, and procedures. Some claim that the systems thinking that formed the core of ISD is outdated and inappropriate for instructional design and development; what is needed is more rapid prototyping and user-centered design and development (Spector, 2004). This led many ID researchers and practitioners to consider where we have been and wonder how they have survived.

Key to this merger between learning theories, instructional theories, designers, and technologists is a broad view of technology that included process technologies such as procedures, models, and strategies intended to achieve defined educational outcomes. This allowed instructional designers who saw their efforts largely as an implementation of learning principles to bring their work into line with instructional technology, and use technology-based environments as laboratories for their designs (Wilson, 2005).

As military training and simulation move into the 21st century, ID must look to more mature design fields for direction. Design disciplines such as architecture, musical composition, and automobile design are not characterized by the processes they use, but by the skills of the designer and the craftsmanship of the product. Many researchers argue that the value of instructional design is not found in a process or the models but in a designer (Hadley, 2004). By re-valuing the foundations, we will position ourselves to build fundamentally solid designs, and successfully differentiate ourselves from communities such as learning sciences. The benefit of doing so would be improved learning and more efficient instruction.

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KEY TERMS AND DEFINITIONS

Instructional Design: Instructional design, also known as instructional systems design, is the analysis of learning needs and systematic development of instruction. Instructional designers often use Instructional technology as a method for developing instruction. Instructional design models typically specify a method, that if followed will facilitate the transfer of knowledge, skills, and attitude to the recipient or acquirer of the instruction.

Instructional Technology: The use of technology (computers, compact disc, interactive media, software, hardware, video, audio, peripherals, teleconferencing, etc.) to support learning.

Needs Assessment: Used to determine if an instructional need exists by conducting a needs assessment using some combination of the following methods and techniques.

Performance/Learner Analysis: Used to identify learner/trainee/employee characteristics

and individual differences that may impact on learning/performance such as prior knowledge, personality variables, aptitude variables, and cognitive styles.

Project Management: Project management is the application of knowledge, skills, tools, and techniques to a broad range of activities in order to meet the requirements of the particular project. A project is a temporary endeavor undertaken to achieve a particular aim. Project management knowledge and practices are best described in terms of their component processes. These processes can be placed into five process groups: initiating, planning, executing, controlling, and closing—and nine knowledge areas—project integration management, project scope management, project time management, project cost management, project quality management, project human resource management, project communications management, project risk management, and project procurement management.

Rapid Prototyping: The use of rapid prototyping methodologies is to reduce the production time by using working models of the final product early in a project tends to eliminate time-consuming

revisions later on, and by completing design tasks concurrently, rather than sequentially throughout the project. The steps are crunched together to reduce the amount of time needed to develop training or a product. The design and development phases are done simultaneously and the formative evaluation is done throughout the process.

Storyboard: (see figure in Appendix) The process of sketching the content on planning worksheets or with development software. As was true of the flowchart for computer programmers, the storyboard does not have to be a work of art. Graphics can be hand drawn. The idea of storyboarding is to give the production team enough information so each member can take the storyboards and begin to develop his/her portion of the final product. The client and/or the subject matter expert will work closely with the development staff in creating the storyboard.

Task Analysis: Used to determine if it is a training/incentive/organizational problem. That is, identify who has the performance problem (management/workers, faculty/learners), the cause of the problem, and appropriate solutions.

APPENDIX

Figure 2. A storyboard template

Storyboard Template	
Project:	Date: Screen ____ of ____
Links from screens:	Links to screens:
Screen description:	
Functionality/Interactivity:	
640	
480	
Background:	Color Schemes:
Text Attributes:	Stills:
Video:	Audio:

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Chapter 1.9

Contemporary Instructional Design

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INTRODUCTION

This article discusses the principles of two qualitatively different and somewhat competing instructional designs from the 1950s and 1960s, *linear programmed instruction* and *programmed branching*. Our hope is that an understanding of these ideas could have a positive influence on current and future instructional designers who might adapt these techniques to new technologies and want to use these techniques effectively. Although these older ideas do still see occasional mention and study (e.g., Brosvic, Epstein, Cook, & Dihoff, 2005; Dihoff, Brosvic, & Epstein, & Cook, 2004), many contemporary instructional designers are probably unaware of the learning principles associated with these (cf., Fernald &

Jordan, 1991; Kritch & Bostow, 1998; McDonald, Yanchar, & Osguthorpe, 2005).

BACKGROUND

An important difference between these instructional designs is associated with the use of feedback to the learner. Although we could provide a student with a score after completing an online multiple-choice quiz, applications that provide more *immediate feedback* about correctness upon completion of each individual question might be better. Alternatively, we could provide *adaptive feedback* in which the application provides elaboration based upon qualities of a particular answer choice.

Following is a discussion of two qualitatively different instructional designs, one providing im-

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mediate feedback regarding the correctness of a student's answer, the other providing adaptive feedback based on the qualities of the student's answer. Suitability of one design or the other is a function of the type of learner and of the learning outcomes that are desired.

SOME CLASSIC CONCEPTS OF INSTRUCTIONAL DESIGN AND OUTCOMES

Although the idea of non-human feedback would seem to imply a mechanical or electronic device, other methods could be used. Epstein and his colleagues, for example, have used a multiple-choice form with an opaque, waxy coating that covers the answer spaces in a series of studies (e.g., Epstein, Brosvic, Costner, Dihoff, & Lazarus, 2003); when the learner scratches the opaque coating to select an answer choice, the presence of a star (or not) immediately reveals the correctness of an answer. Examples of the designs discussed next are based on paper books, but they are easily adaptable to technologies that use hyperlinks, drop-down menus, form buttons, and such.

Linear Programmed Instruction

The programmed psychology textbook of Holland and Skinner (1961) asked the student a question on one page (the following quote starts on page 2) and then asked the student to turn the page to find the answer and a new question:

A doctor taps your knee (patellar tendon) with a rubber hammer to test your _____.

The student thinks (or writes) the answer and turns the page to find the correct answer ("reflexes") and is then asked another question.

Questions or statements are arranged in sequentially ordered *frames* such as the previous single

frame. A frame is completed when the student provides a response to a stimulus and receives feedback. Skinner contended that this method caused learning through *operant conditioning*, provided through positive *reinforcement* for stimuli that are designed to elicit a correct answer (c.f., Cook, 1961; Skinner, 1954, 1958).

Skinner (and others who use his methods) referred to his method as *programmed instruction*, which incorporates at least the following principles (cf., Fernald & Jordan, 1991; Hedlund, 1967; Holland & Skinner, 1961; Skinner, 1958; Whitlock, 1967):

- Clear learning objectives.
- Small steps; frames of information repeat the cycle of stimulus-response-reinforcement.
- Logical ordered sequence of frames.
- Active responding by a student who works at his/her own pace.
- Immediate feedback to the response in each frame with positive reinforcement for correct answers.

A technique in programmed instruction is to help the student a great deal at first, and then gradually reduce the cues in latter frames; this is called *fading* (Fernald & Jordan, 1991; Reiff, 1980). If correct responding suggests that a student is learning at a quick rate, *gating* can be used to skip over frames that repeat prior information (Vargus & Vargus, 1991). The programmer is expected to use information about student performance to make revisions; if the student is not succeeding, then it is due to a fault of the program, not to an inability of the student (Holland & Skinner, 1961; Vargus & Vargus, 1991).

Programmed Branching

Crowder (e.g., 1959, 1963) and others (e.g., Pressey, 1963) were critical of Skinner's approach, arguing that students not only learn from know-

ing a correct answer, but also learn by making mistakes. Crowder distinguished between his *automatic tutoring device* and the Skinner-type *teaching machine*, proposing that the automatic tutoring device is more flexible in allowing the student to receive an explanation when an error is made. Crowder (1959, pp. 110-111) provides an example of how this approach could be used in a programmed textbook:

In the multiplication of $3 \times 4 = 12$, the number 12 is called the product and the numbers 3 and 4 are called the

Page 15 quotients.

Page 29 factors.

Page 43 powers.

In this *programmed branching* method of Crowder, the student is taken to one of several possible discussions depending on the qualities of the answer.

While Skinner's design would be expected to work only when stimuli elicit correct answers, Crowder's design allows for mistakes and must be designed to anticipate particular mistakes. Crowder believed that this method caused learning through *cognitive reasoning*. Whatever answer is chosen by the student, the programmed textbook (or machine) makes a *branch* to a discussion associated with issues relevant to the answer that was chosen. This is followed by a return to the same question if the student had made an incorrect choice, or a jump to new a *frame* containing the next question if the student had made a correct choice.

Learning Outcomes

Many issues have been raised over the years about programmed instruction methods. Reiff (1980) discussed several criticisms:

- It does not take into consideration the sequence of development and readiness to learn (e.g., children of different ages or children vs. adults).
- It develops rote learning skills rather than critical thinking skills.
- Students can in some implementations cheat.
- The encouragement to respond quickly could develop bad reading habits.

Crowder's *programmed branching* design, which has received far less attention and study than Skinner's ideas, would seem to answer at least some of these criticisms. Crowder's design provides an explanation to both correct and incorrect answers, so the learner is not rewarded for cheating or working too quickly. Since the explanation is tied to the learner's thinking at the time a choice was made, Crowder's design would appear to be better to develop critical thinking skills, but might not be so good at developing rote learning skills. Crowder's design would appear to be better suited to students who have a greater readiness to learn, while perhaps not so well suited to a student who is at an earlier stage of learning a subject.

The previous discussion suggests that each of these designs is useful, but that each is useful in different kinds of situations and that the *learning outcomes* of each approach might be different. Skinner's teaching machine, for example, might be more useful in situations where students are learning lists and definitions. The automatic tutoring device, on the other hand, might be more useful when the student is already at a higher level of understanding whereby s/he can now use reasoning to derive an answer, or in situations where the student understands that there are degrees of right and wrong without concrete answers. The Skinner-type teaching machine might be better suited to "lower-order" levels of learning, while the Crowder-type automatic tutoring device might be better suited to "higher-order" levels of learning.

Although many ideas have been proposed with regard to a hierarchical perspective on “lower” and “higher” levels of learning, the most well-known, “Bloom’s Taxonomy” (A Committee of College and University Examiners, 1956), originated in about the same timeframe as the ideas of Skinner and Crowder. “Bloom’s Taxonomy” proposes that the objectives of learning lie on a hierarchical continuum: (1) knowledge of terminology and facts, (2) comprehension of translation and paraphrasing, (3) application, (4) analysis, (5) synthesis, and (6) evaluation.

“Bloom’s Taxonomy” is actually only Part I of a two-part work. The previously mentioned first part is known as the *cognitive domain*. Part II (Krathwohl, Bloom, & Masia, 1964) focuses on the *affective domain*: (1) willingness to receive ideas, (2) commitment to a subject or idea, (3) feeling that an idea has worth, (4) seeing inter-relationships among multiple ideas, and (5) the integration of ideas as one’s own.

FUTURE TRENDS

Fernald and Jordan (1991) discussed several reasons as to why programmed instruction might have fallen out of use since the decades of the 1950s and 1960s:

- It was seen to dehumanize the teaching process.
- Educators feared that it might be too effective and threaten their jobs.
- The importance of the learning principles was not understood.
- Applications were often not effectively designed.

Technology, economics, and attitudes have since changed. As economics and student demand push us to use distance education methods, the

first two arguments would seem to become more diminished in the future.

It is hoped that this article assists in diminishing the latter two arguments by introducing instructional designers to the principles discussed in this article and by encouraging instructional designers to create more effective designs with regard to appropriateness for a particular student audience and with regard to the type and level of learning outcomes that are desired. By better understanding the past, we can better affect the future.

Curiously, there has been less attention devoted to Crowder’s ideas of adaptive feedback than to Skinner’s ideas of immediate feedback and reinforcement. We continue see occasional research devoted to related issues, such as issues of immediate vs. delayed feedback (e.g., Brosvic et al., 2005; Dihoff et al., 2004; Kelly & Crosbie, 1997) or of allowing students to keep selecting answers from a multiple-choice set until the correct answer is finally discovered (Epstein et al., 2003). However, we still can only speculate with regard to conditions under which a Skinner-style of instructional design would be better and when a Crowder-style of design would be better. It is hoped that this article generates greater awareness of and use of these designs in new technologies, but also that greater interest in these ideas will stimulate more research into the learning mechanisms associated with them.

CONCLUSION

New technologies such as Web browsers now make it relatively easy for educators with the most modest of skills to present instructional frames in a linear sequential ordering or as branches that are dependent on the student’s selection of answers from a list. In adapting some of these older ideas to newer technologies, we hope that instructional designers will be better equipped to select appropriate methods by considering:

- the student's level of readiness for learning
- the basis for learning when different instructional designs are used
- the qualitatively different kinds of learning outcomes that are possible with different instructional designs

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KEY TERMS AND DEFINITIONS

Adaptive Feedback: Immediate feedback in the form of an explanation or discussion that is tailored to the qualities of the student’s answer.

Automatic Tutoring Device: A device that uses programmed branching and adaptive feedback. Learning results from cognitive reasoning.

Cognitive Reasoning: Learning through the process of thinking about an issue; the student learns new ideas and relationships by relating an issue to previously learned material.

Frame: A small piece of information or a statement to which the student is exposed, such as a

page with a single question. In linear programmed instruction, a frame includes a stimulus, a response, and reinforcement (positive feedback).

Hierarchy of Learning: The concept that learning can be sequentially ordered along a continuum from lower-order to higher-order. “Bloom’s Taxonomy” is one of many that have been proposed.

Linear Programmed Instruction: A design whereby a series of frames are presented to the student in a specific sequential order. The student actively responds to stimuli in each frame and receives immediate feedback to that response. Learning results through operant conditioning.

Operant Conditioning: Learning through immediate positive feedback (reinforcement) regarding the correctness of an answer; the student learns to respond in a particular way to a particular question or issue (stimulus). Fading can be used by gradually reducing stimulus cues in subsequent frames when material is repeated.

Programmed Branching: A method whereby the student is taken to one of several possible explanations or discussions depending on the qualities of an answer that is given to a question. Gating is a simple skip of frames that repeat prior information when a student’s answers suggest that the material has been adequately learned.

Teaching Machine: A device that uses linear programmed instruction whereby frames present a question followed by feedback of the correct answer. Learning results from reinforcement of the student’s correct answer.

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Chapter 1.10

Instructional Design Methods Integrating Instructional Technology

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ABSTRACT

Effective teaching begins with effective planning of instruction. Planned instruction with technology integrated appeals to students and accommodates students' needs. Students expect technology to be utilized to support the learning process because of their acquaintance with a variety of technologies at a very early age. Educators must be aware of the needs and expectations of students and then design courses that integrate technology based on these identified needs and expectations. A critical element required to integrate technology into the learning environment successfully is the instructional design process. The instructional design process provides a framework for systematically planning, developing, and adapting instruction

based on learner needs and content requirements. With the instructional design process, educators evaluate student needs, plan the lesson objectives, design the instructional content, and create assessments. Evaluation and revision of each of the instructional components is continually modified to meet the changing needs of the learners and the advancement of technology.

INTRODUCTION

Educators today integrate technology into the classroom to create various instructional opportunities for students. There are four primary reasons why educators should integrate technology into the instructional process to create new and varied instructional opportunities to support student learning. First, educators need to develop

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and design instruction that will build student understanding. The term “understanding” is best defined through the following three principles:

1. Understanding is a function of learning facts and core principles of a topic
2. Understanding is the product of actively relating new knowledge with prior knowledge and experiences
3. Understanding is a consequence of using and managing intellectual abilities well. (Sherman & Kurshan, 2005)

Developing and supporting student understanding includes keeping the student actively engaged in the instruction while at the same time appealing to students’ various learning styles.

A second reason for educators to integrate technology into the instructional process is because there is a need to plan instruction that will motivate students to learn. According to Sherman et al. (2005), “the lack of interest is generally the number one reason that students give for not learning to mastery level” (p. 11). Technology-based instruction can stimulate students’ interests to explore, discuss, and compare their knowledge with others.

It is important to note that instructional technology, in and of itself, will not directly improve student understanding. In fact, a primary reason that instructors use technology in their instruction is to increase motivation to learn. Motivation is indeed one of the necessary components of learning. According to the self-efficacy theory of motivation (Bandura, 1978; Salomon, 1981), a direct relationship exists between instructional technology (how and when it is used in the teaching process) and student learning because of the motivation factor. Researchers believe a student’s attitudes, beliefs, and values influence their motivation to gain understanding of a topic or discipline (Clark & Sugrue, p. 350). At the same time, the level of knowledge or skills needed

to successfully utilize the technology is also important to the learning process. According to Clark and Sugrue, if students view instructional technology to be within a moderate range of difficulty to use, then they will invest time and effort to learn from this instructional medium. If the students find the instructional medium is too challenging, their motivation to participate and learn is reduced (p. 359).

Third, students expect the use of technology to be a part of the learning process. Students are using technology very early in their lives for non-academic activity; therefore, they are more likely to use technology in all aspects of their lives especially in their educational careers. “Students believe computers are helpful and they will use them more in the workplace,” (Dooling, 2002, p. 22). In addition, Ellis reports that students have very high expectations of technology-supported learning (2004). Educators aware of these expectations will focus on course designs that integrate technology. Therefore, planning instruction with the student’s expectations and needs in mind will help the student to be successful in achieving the instructional objectives.

The fourth reason for integrating instructional technology into the classroom is because educators are searching for new and more effective ways of communicating with students. Students should be provided opportunities to communicate with instructor, with peers and with the content. Understanding of new concepts in the course content is developed through various types of interactions and media.

It is also important to note that integrating technology into instruction is not a “quick fix” that will automatically improve student learning. In fact, the integration of technology into a poorly planned lesson will not transform the instruction into a well-designed or effective instructional opportunity for students. In fact, when technology is integrated into a poorly designed lesson, the learner will many times feel frustrated and

confused. Without the proper support mechanisms in place in schools such as aligned curriculum, appropriate assessment techniques, and ongoing professional development opportunities for teachers, technology integration by itself will not change the fact that students may not achieve the academic goals for the course.

Therefore, the educator's challenge is to plan instruction that integrates technology and ensures that it is an integral and manageable component of instruction. The instructional goal will guide the technology that is used. When technology is combined with a well-planned curriculum that includes appropriate instructional strategies to integrate technology, then student learning (understanding) can be enhanced.

Instructional technology is an integral part of teaching and learning in today's classroom. This chapter will identify and explain some of the key terms related to instructional technology and instructional design. In addition, information will be provided on student expectations for instruction and implications for educators. The purpose of this chapter is to address the following questions:

- What is instructional technology?
- What is instructional design?
- What are the benefits of using instructional design methods?
- Why is the ADDIE model recommended as a beginning methodology for instructional design?
- What are students' expectations of instruction?
- What are the implications in planning instruction that integrates technology?

BACKGROUND

Educators who plan to integrate instructional technology successfully into the learning environment need to be familiar with the instructional design

process. Instructional design is the process and the framework for systematically planning, developing, and adapting instruction based on identifiable learner needs and content requirements (University of Idaho, 2004). "The most widely used methodology for developing new training programs is called instructional systems design" (Kruse, 2004). With this process, educators will carefully evaluate the students' needs, plan the lesson goals, design the instructional content, and create assessments with students' expectations in mind. Therefore, the methods of instructional systems design play a key role in planning effective instruction. The ISD methods should be used to identify the instructional technologies that are needed to help the learners to achieve the goals and objectives of the instruction.

Instructional systems design (ISD) methods are a step-by-step process to help educators evaluate the needs of the students, identify what is to be learned, specify the process through which the lessons will be learned, plan the actual design, develop instructional materials, and evaluate the effectiveness of the instructional components (Hains, 2000). The ISD approach considers instruction from the perspective of the learner rather than from the perspective of the content, (Morrison, Ross, & Kemp, 2001). Morrison et al. (2001) state that through the instructional design model, the following questions are addressed:

- What level of readiness do individual students need for accomplishing the instructional objectives?
- What instructional strategies are most appropriate in terms of objectives and learner characteristics?
- What media or other resources are most suitable to help the student to learn the objectives?
- What support is needed for successful learning?

- What revisions are necessary throughout the instructional process? (p. 4)

The ISD process is based on a set of components working together to achieve a goal with learners' needs in mind. The steps usually involve the following four phases: design, development, evaluation, and revision.

According to the University of Idaho, the design phase includes determining the need for instruction, analyzing the learners' needs, and establishing goals for the instruction. The development phase includes reviewing current content, creating new content, organizing content, and selecting delivery methods. In the evaluation phase, the designer reviews the goals and objectives of the instruction and develops an evaluation strategy. During this phase, students' feedback is collected and analyzed. In the final phase of revision, information from the evaluation phase is implemented to improve the quality of the instructional experience.

The ISD steps are continually evolving based on the needs, success, and feedback received from students and instructors. As noted earlier, there are several sequential steps to be implemented by the instructor in order to move students through levels of understanding and application. There are criticisms that the ISD models are too linear and too inflexible (Kruse, 2004). However, when all of the ISD phases are used interchangeably, the ISD process can prove to be very productive in helping students to achieve the instructional goals. The ISD process should be flexible, allowing the instructor to move freely among the various phases of the design, as dictated by the needs of the learners.

In addition, technology has a very important role in the instructional process. "Technology should be the servant and not the master of instruction. It should not be adopted merely because it exists, or because an institution or faculty fear being left behind the parade of progress without

it" (Gentry, 1995). Therefore, instructors/instructional designers should first identify what it is that the students should learn and then decide if and when it would be appropriate to integrate technology into the learning process.

Instructional Technology Defined

"Instructional technology is defined as the theory and practice of the design, development, utilization, management, and evaluation of processes and resources for learning" (Seels & Richy, 1994, p. 1). To better understand this definition, Hains (2000) describes each of the four components used to define instructional technology as:

1. **Instructional design and development:** The process of specifying conditions for learning and developing the products that focuses on these conditions. This component would include instructional systems design, message design, instructional strategies design, and learner characteristics analysis.
2. **Media utilization:** Includes the selection of the communication medium and the delivery system. Examples of this component would include the use of a course management system like Blackboard™, Angel™, or the use of instructional video and audio components, or even a course Web site with use of e-mail and blogs.
3. **Management:** This component of the term relates to all of the responsibilities associated with the management of the technologies including acquisition, maintenance, delivery of services and management of information.
4. **Evaluation:** Includes using evaluation methods that will provide timely and accurate information to those involved in an education technology design effort.

"The purpose of instructional technology is to affect and effect learning" (Seels et al., 1994, p.

12). It is critical to understand that the main goal of providing instruction is “learning.” The means to understanding and learning is the instruction that is planned. Therefore, the instructor and the instructional designer plans and utilizes instructional technology to help students build upon prior attained knowledge, skills and attitudes, and use technology as a tool to enhance learning.

Instructional Design Defined

Instructional design (also known as instructional systems design) is defined as the analysis of learning needs, identifying instructional goals and objectives, and the systematic development of instruction. Instructional designers will use instructional technology as a method for developing instruction when appropriate to meet the goals of the instruction and to meet the needs of the learners. Instructional design models typically specify a method that if followed will facilitate the transfer of knowledge, develop skills and adapt or encourage attitudes of the learner

In summary, instructional design is the systematic planning of instruction. Instructional design is the process of specifying conditions for learning (Hains, 2000). Instructional design is the step-by-step process used for identifying students’ needs, the design and development of instructional materials, and the evaluation of the effectiveness of the instructional intervention (Kruse, 2004). Planning for instruction is an organized process where instructional materials are thoughtfully created and are planned to deliver instruction that is most effective for the student. The goal is for each student to learn in an environment that provides opportunities for full potential of the student.

Benefits of Instructional Design Methods

According to Kruse, the systemic approach to instructional development has many advantages

when it comes to the creation of technology-based instruction. Some of the advantages noted are: (1) ability to create engaging metaphors or themes, (2) designing learning activities that are effective in meeting the students’ expectations and needs, and (3) the opportunity to engage and possibly motivate learners by the use of technology (Kruse, 2004). Roblyer (2000) adds that instruction can be designed to integrate technology in ways to help the student to remedy identified weaknesses. Once more, the early phases of the ISD process would allow the instructor to become aware of the students’ weaknesses and be able to offer instructional opportunities to address these individual needs.

In addition, designing instruction that provides students the opportunity to build their skills and conduct self-evaluations through the use of technology can be very beneficial. Instruction can also be designed to develop technological and visual literacy (Roblyer, 2000). These skills will better prepare students for high demand jobs in the business world.

Thomas Friedman, in *The World is Flat*, identifies the United States as a global, information-based economy with an increasingly diverse workforce. Therefore, there is a great need for a better-trained workforce who is capable of using technology to improve services, increase quality and raise production. As a result, instruction should focus on using technologies that will prepare students for the workforce.

Embry (2005) reported in one study published in October 2005 by the National School Boards Association (NSBA), 90% of the respondents reported that the use of technology in the classroom has increased educational opportunities for students. This was evidenced by students being more engaged in learning, having a stronger ability to communicate and possessing increased critical thinking skills. Technology is indeed valuable to learners and utilizing appropriate instructional design methods will help to develop a better, well-designed opportunity for learning.

The ADDIE Model

Many instructional design models are based on the ADDIE model. The ADDIE model represents the following components: analysis, design, development, implementation, and evaluation (Kruse, 2004). In Figure 1, the flow of information within the phases is illustrated with the larger arrows. The smaller arrows illustrated how the flow of information can be reversed to the previous phase at any point in the sequence as identified in the instructional analysis conducted in each phase. The ADDIE model of instructional design is recommended as a beginning framework ISD model because it is based upon sound pedagogical principles of instructional development. This model provides the systematic steps needed to ensure that sound and theoretical based instruction is being delivered. When planning instruction, ADDIE provides a process for addressing the instructional challenges and learner needs.

The phases involved in the ADDIE model are defined as follows:

1. **Analysis phase:** Determine the components necessary for the next phases of development. Seek answers to a variety of questions including: Who is the learner? What is the

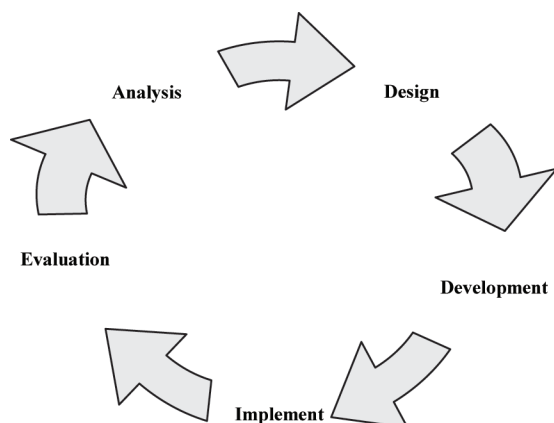
instructional goal of the lesson? What are the delivery options? What instructional technology, if any, would enhance student learning? What will the students do to determine competency? What is the timeline? What are the online pedagogical considerations?

2. **Design phase:** The systematic method of research, planning, developing, evaluating, and managing an instructional process.
3. **Development phase:** Addresses the tools and processes used to create instructional material. This stage includes story boards, coding, graphic user interface, and creating all multimedia elements.
4. **Implementation phase:** During this phase, an implementation plan is developed. This plan establishes the implementation timeline and procedures for training the facilitators or the learner, and delivering the final product.
5. **Evaluation phase:** A systemic process that determines the quality and effectiveness of the instructional design as well as the final product. Evaluation is an ongoing activity conducted at each phase of the ADDIE model.

Educators, who are familiar with the ADDIE model and use it as the instructional design process, may find they are selecting instructional technology that will support and enhance learning to help student achieve the instructional goal. Instructors are then able to provide a learning environment that will encourage active learning and higher level thinking skills, especially reflection, problem solving, flexible thinking, and creativity (Hopson, Simms, & Knezek, 2002).

The ADDIE model enables standardized development of learning solutions as the educator moves through the five phases or steps. Each step of the process, from the analyses of the learners to the final evaluation of the learner's instructional experience, should be thoroughly planned and monitored to identify solutions for

Figure 1. The ADDIE model



the instructional need. The ADDIE model should be used as a continuous process that allows the educator to monitor and update instructional and assessment components to meet the needs and expectations of the learner. The ultimate goal in applying the ADDIE model, as it is with any instructional design model, is to plan and design instruction that provides the student the content and resources needed to help them to achieve the instructional goals.

Students' Expectations of Instruction

With ISD methods, instruction is planned based on the students' needs and expectations. Therefore, it is important to identify some of the expectations of students today.

In 60 interviews and three focus groups with postsecondary students, the following summarizes the basic instructional needs of learners:

1. Students not only anticipate, but expect technology to be integrated into the instructional process
2. Students see technology as both motivating and challenging
3. Students expect to learn the technology first in order to apply the technology toward learning the subject matter content
4. Students expect their time and resources to be adequately used to help them learn
5. Students expect their instructors to be familiar with the latest technology and be motivated to use technology in their classroom instruction
6. Students expect technology to allow them to have access to the instructor, their classmates and to course information
7. Students expect the convenience of communicating with their instructors by submitting their homework, assignments, and quizzes via technology

8. Students prefer the convenience of using technology at home even though they may not have access to the latest software and hardware required by the instructors

Based on the students' expectations previously listed, it is clear that technology integration into the instructional process is very important. Instructional technology should be utilized as a tool for learning. In the interviews and focus groups students anticipated that they will apply the same skills used in the classroom as they will use in the workplace to analyze, manipulate and summarize information. The use of instructional technology should be more than just drill and practice, tutorial, games and simulations. Educators should plan to integrate instructional technology when it supports the overall goals of the instruction, improves communication, and provides the students greater access to the instructional information and course content.

Advances in technology are changing the dynamics of teaching and learning in education; all educational levels are using technology as a learning tool (Hains, 2000). Today's younger students are also using technology, but they are using it more for non-academic activities (Center for Media Research). The 2005 American Kids Study was conducted to evaluate American children ages 6-11 multimedia and product usage. Approximately 5,400 children responded to the questionnaires sent to households with children 6-11 years old. They were interviewed for MRI's Survey of the American Consumer. The survey period was March 8-August 1, 2005.

As shown in Table 1, it was found that gaming is the top online activity, CD players outnumber MP3 players for music listening. In the American Kids Study, it was reported that during the survey period more than half, 59%, of the 6-11 age group went online in the last 30 days and 8.1% went online every day. Forty-two percent of the respondents played games online, while 23.1%

percent actually worked online for academic reasons. More girls than boys were reported using e-mail and just 2.6% of all of the respondents visited a chat room during the reporting time. Today's students are using technology more in their daily activities. Students are using technology in a variety of ways including entertainment and communications. Even though the numbers are low for younger students, some students are beginning to use technology in their academic interests. This will result in the need to integrate technology in their lessons to help students to research, explore, and find solutions to problems throughout their academic careers.

Implications for Technology Integration

The primary goal of instruction is to make students as successful as possible in learning the content of the course. The benefits of instructional design methodologies for instructors include providing clear and well define instructional components that are well-organized to help the students achieve the goal of the instruction. When the instructional materials are planned well, presented sequentially, designed to address student needs, the students will be more successful in the classroom and the instructor can assess that learning has occurred.

Faculty who are interested in designing instruction using technology reports that ISD methods are beneficial to educators in several ways. These include:

- Instruction is developed more with the students needs in mind. This includes identifying any prerequisite skills that may be lacking and need to be addressed before the student is moved into an academic arena ill prepared.
- Instruction is usually more organized and is sequential because the instruction is planned based on the learning outcome.

Therefore, instructors are able to offer more meaningful instruction.

- Instruction that is well-designed should lead the student to be successful in the assessment. The assessment methods are identified and are based on the goal and objectives clearly stated early in the ISD process.
- Technology is seen as a tool used in the ISD process. Technology is beneficial to help the learner understand and apply the concepts.
- Finally, ISD methods offer continual testing and feedback for each phase of the instruction design process. Therefore, instruction and assessments can be adapted to meet the changing needs of the learners.

When instruction is planned or designed with technology integration, the instructor's role in the learning process will become that of a facilitator of learning. True integration of technology will promote different advantages and disadvantages for the student/learner. According to reports in the NBEA Yearbook 2004, advantages will include: (1) incorporating all five senses of the learner, (2) student comprehension is increased, "Comprehension is raised to 80 percent when one sees, hears, and interacts with instructional materials" (p. 219). This comprehension rate is very high when compared to 20-30% with just site and sound respectively, (3) students have better control of their own learning, (4) cooperative learning can also be an advantage when integrating technology, (5) technology integration offers instructors the opportunity to offer a student more individualized instruction and finally, (6) the use of a variety of communication methods such as bulletin boards, e-mails, online discussion boards, blogs, and chat rooms.

Some of the disadvantages associated with planning instruction that integrates technology include: (1) lack of access to the most advanced

Table 1. Source: Mediamark Research, The American Kids Study, 2005

Selected Findings, 2005 American Kids Study			
	% All Kids	% Boys	% Girls
Online usage			
Gone online in last 30 days	59.0	56.3	61.8
Goes online every day	8.1	7.6	8.7
Online activities in the last month			
Played online games	42.6	40.0	45.4
Did stuff for school/homework	23.1	20.8	25.5
Used e-mail	10.5	7.6	13.6
Used instant messenger	6.5	5.6	7.4
Went to chat rooms	2.6	2.7	2.5
Listen to music via...			
Car radio	74.0	72.0	76.1
CD player	62.8	56.5	69.5
Portable CD player	48.4	44.8	52.3
Stereo	39.5	39.2	39.8
Computer	25.5	23.1	28.1
Walkman that plays tapes/cassettes	8.3	8.2	8.4
Portable MP3 player	4.2	4.3	4.1
MP3 player	4.1	4.2	4.0
Gaming			
Played video, Internet, computer game, last 30 days	84.2	89.3	78.7
Play video, Internet, computer game every day	20.3	28.9	11.1
Things you have in your room			
CD player	59.8	54.1	65.8
TV	56.3	59.0	53.4
Video game system	36.1	47.1	24.4
Stereo	28.6	28.0	29.2
DVD player	26.7	27.6	25.6
Computer	16.8	17.9	15.6
Internet access	6.6	7.0	6.1

technology. Despite great strides in incorporating technology into U.S. schools, we still fall short of providing a seamless, convenient, robust, and reliable technology support structure for all

students and teachers (Means, 2002); (2) lack of educator's ability to stay up-to-date on the latest technology; (3) lack of time to devote to planning and designing instruction that integrates technol-

ogy; (4) the technology that is integrated may be too advanced for the learners and that could decrease the students' ability to learn; (5) some course content and instructional activities do not readily lend themselves to the use of technology.

FUTURE TRENDS

The need for flexible learning environments and approaches to teaching reflects a transformation of how instruction will be conducted and delivered in the future. This flexibility will be noticed in areas such as offering distance-learning courses to provide instruction in a variety of locations, as well as providing more mobile and accessible instructional components for students. Time and location are quickly becoming a non-issue when it comes to accessing instructional information. For example, a student may download streamed audio or video lectures and have access to those components through ipods at any time.

Emphasis for the future will be in more online course development, distance education components, ethics in an e-learning environment, instructional materials and the Internet use in the classroom, pedagogical and technological challenges of the Internet, managing and measuring technology based courses, and intellectual property rights with educational delivery (NBEA Yearbook, 2004). In addition to these trends, there will be the challenges of constant technological change, public accountability, competition for students, opportunities for professional development, restricted and decreased funding, and the need to educate all students regardless of their financial status and location.

Furthermore, teaching and learning have evolved to the use of instructional technologies in the educational process across all disciplines. Various disciplines are currently accessing course management systems such as Blackboard™, Web CT™, or Angel™ to integrate technology into the

learning environment with the use of case-based reasoning, electronic portfolios, threaded discussions, reflective journals, and other instructional strategies. Traditional face-to-face instruction will be further enhanced with the use of the course managements systems and the tools they offer. The traditional face-to-face instruction such as lectures, role modeling, simulations, team/group work, will be integrated into the learning environment via the use of technology.

In addition, the acceptance of learning outcomes will be a crucial requirement of the future. Students will need to be able to transfer courses and knowledge to different educational institutions and different learning environments. Therefore, diversity and the evolution of technological savvy students are continuing trends for the future.

CONCLUSION

Effective teaching begins with effective planning. Instructional design represents the systematic planning process for instructional events including technology integration. Planning and integrating technology into the instructional process can indeed provide an opportunity for higher student motivation, increased speed of communication, improve students' technology skills, and ease of access to resources.

Bringing real-world problems into the classroom is a very important asset of technology integration. Problem-solving environments have been developed to help students to better understand the workplace they will be a part of in the near future. Technology integration offers interactivity that makes it easier for students to revisit specific parts of the instruction to explore, test ideas and receive feedback.

Learning through real-world resources that are provided in technologically-rich instruction is not a new idea. For a long time, schools have made efforts to give students concrete experience through

field trips, laboratories, and work-study type programs. Technology integration into the learning environment offers powerful tools for addressing time, money, and resource constraints. Because of the resource savings as well as the opportunity to enrich the student's learning, educators should plan to integrate instructional technology into the instructional process whenever appropriate.

It is also important to understand that the instructor must have an understanding of how people learn and retain information when they attempt to engage the learner through the use of technology. Students expect meaningful learning and the use of technology to develop their critical thinking and problem solving skills. Students also expect their instructors to be familiar with the technology and demonstrate technological skills. Instructors will benefit directly by using course management techniques with technology. At the same time, they will serve as a mentor to their students demonstrating how technology can help in problem solving as well as in managing time and resources.

In addition, instruction will be most effective when it is planned with the students' needs and expectations in mind. The instructional design process can serve as the step-by-step process for educators to design and develop their units of instruction. By using the ISD model, educators will offer more enriching instructional opportunities for students and will plan and prepare to integrate technology into the instructional process where it is most beneficial for the learning outcome.

Finally, a recommendation is for instructors to apply the ADDIE model as the instructional design process when designing instruction that integrates technology. Instructors, then, will be able to provide a complete learning environment that will encourage active learning and higher level thinking skills, especially reflection, problem solving, flexible thinking, and creativity. The ADDIE model is very effective when planning instruction with the use of course management

systems. This model can be just as effective when designing instructional video, audio, text-based, and online instructional components. Each step in the ADDIE model has an outcome that will feed to the subsequent step. Each step is evaluated, then adjustments and improvements made, as the designers continue to move to the desired outcome.

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KEY TERMS AND DEFINITIONS

ADDIE Model: A foundational instructional design process that represents five basic components of planning and designing instruction: analysis, design, developments, implementation and evaluation. This instructional design model enables standardized development of learning solutions as the educator and the instructional designer moves through the five phases of development.

Analysis Phase: Determining the needs for instruction, analyzing the learner's needs, and establishing goals of the instruction to begin the design phase.

Design Phase: The designer continues with the subject matter analysis and then moves into the application of instructional strategies according to the content type, the user interface is designed and needed materials are collected.

Development Phase: Production begins with a continued review of the current course content, creating new content, organizing content, selecting delivery methods and technology requirements

Implementation Phase: Create an implementation timeline, establish procedures for training the facilitators or the learners, and make revisions as needed (after the evaluation phase) to prepare the final product.

Evaluation Phase: A systemic process that determines the quality and effectiveness of the designed instruction as well as the final product.

Evaluation is an ongoing process—it occurs throughout the ID process.

Instruction Design Models: Systematic guidelines instructional designers follow in order to facilitate the transfer of knowledge, skills, and attitude to the recipient. The ID models typically specify a method that will create well-planned, logical, attainable, and sequential instruction. ID models are visualized representations of an instructional design process. (Example of ID models include: Dick & Carey Model, ADDIE Model, Kemp Model, ICARE Model, and AS-SURE Model.)

Instructional Design Theory: Guides the practice of the instructional designer and offers explicit guidance on how to better help learners to achieve the instructional goals established for the lesson or instructional activity.

Instructional Designer: An individual who applies a systemic methodology based on instructional theory to design and develop content and curriculum, learning support resources, and delivery and assessment methodologies.

Instructional Systems Design: The analysis of learning needs and systematic development of instruction. ISD is the process and the framework for systematically planning, developing and adapting instruction based on identifiable learner needs and content requirements.

Instructional Technology: Defined as the theory and practice of the design, development, utilization, management, and evaluation of the processes and resources for learning.

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Chapter 1.11

Using Design Patterns to Support E-Learning Design

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ABSTRACT

Design patterns have received considerable attention for their potential as a means of capturing and sharing design knowledge. This chapter provides a review of design pattern research and usage within education and other disciplines, summarizes the reported benefits of the approach, and examines design patterns in relation to other approaches to supporting design. Building upon this work, it argues that design patterns can capture learning design knowledge from theories and best practices to support novices in effective e-learning design. This chapter describes the authors' work on the development of designs patterns for e-learning. It concludes with a discussion of future research for educational uses of design patterns.

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INTRODUCTION

The instructional design of e-learning course materials directly affects student learning outcomes, but research suggests that many of the instructors developing online courses have not received training in interaction or instructional design (Braxton, 2000; Clark, 1994; Tennyson & Elmore, 1995). Hirumi (2002) found that novice course designers find it difficult to incorporate the types of meaningful interactions needed in online courses. Also, inexperienced educators can have difficulties in the application of learning theories to course design. According to Wilson (1997), theories are written as hard science, and novices require a different type of representation to support their initial learning needs. As further stated in Wilson (1999), "the plurality and multiplicity of models and theories can be daunting to both

researcher and practitioner.” As a result, making the transition from this wealth of information to actual design practice can be difficult for all but experienced educators and instructional designers.

Design patterns have emerged as an approach for capturing design knowledge from theories and best practices in a form that is understandable and useful for novices (Alexander, Ishikawa, Silverstein, Jacobson, Fiksdahl-King, & Angel, 1977). Design patterns and their use in the development of effective learning designs are currently important areas of research.

The purpose of this chapter is to introduce design patterns as a strategy for representing and disseminating instructional design and learning theory research. First, a review of the literature provides a definition for a design pattern and gives the history of design patterns usage and reported benefits in other disciplines. We then examine how design patterns can be used in education to represent and disseminate learning theory research and educator best practices in the context of e-learning design. We discuss our current research with design patterns for e-learning design, which advocates the development of an underlying design framework and support environment for design pattern development and use. Examples of design patterns developed from this work are provided. Finally, we conclude with areas of future research.

BACKGROUND

What Is a Design Pattern?

Design patterns have been defined in the literature in a number of ways. As provided in one of the earliest definitions from the field of architecture, a design pattern “describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice” (Alexander et al., 1977).

They further describe a design pattern as “a three part rule, which expresses a relation between a certain context, a problem and a solution” (Alexander, 1979). In a definition almost 20 years later from the field of software engineering, a design pattern is described as a “particular prose form of recording design information such that designs which have worked well in the past can be applied again in similar situations in the future” (Beck, Coplien, Crocker, Dominick, Meszaros, Paulissch, & Vlissides, 1996).

Originating in the field of architecture, design patterns have been used to capture expert knowledge, experiences, and design best practices within many different domains (Alur, Crupi, & Malks, 2001; Borchers, 2001; Gamma, Helm, Johnson, & Vlissides, 1995; Graham, 2003; Tidwell, 2005). A large part of their value is attributed to their ability to serve as a design aid to disseminate this knowledge to a novice designer. Although many formats and templates exist for formulating a design pattern, four elements are typically present:

1. The *pattern name* identifies the pattern and provides a way to communicate about the pattern. Choosing a good name is considered vital as it becomes a part of the design vocabulary (Gamma et al., 1995).
2. The *problem* section describes when to apply the pattern explaining both the design problem that is addressed and the context surrounding it.
3. The *solution* section describes the elements that make up the design to solve the problem. References to other design patterns that support the solution are also typically provided.
4. An *example* section provides specific implementations of the solution. Depending on the discipline, the examples may be textual descriptions or pictures.

Formulating design knowledge in terms of problems and solutions is regarded by some to provide designers with more concrete design

information not readily available in other forms of design knowledge representation such as design guidelines or design principles (Mahemoff & Johnston, 1998a; van Welie, van der Veer, & Eliens, 2000). The objective of most design pattern research is in the development of a collection of design patterns that provide a vocabulary for representing and communicating design knowledge in a field. Different classifications have been used to describe a pattern collection often depending on the degree of structure and connectivity the pattern collection possesses (Appleton, 2000). A *pattern language* is a collection of design patterns that have been connected and interlinked (Alexander et al., 1977). Mahemoff and Johnston (1998a) assert that generativity is the chief benefit of a pattern language. Because the patterns in the language form a cohesive structure, the designer is able to begin with a certain context and work through all of the relevant patterns to generate a design. A *pattern catalog* typically refers to a pattern collection that has a relatively low level of structure and organization. Little cross-referencing exists among patterns, and each pattern gives a relatively independent solution (Appleton, 2000; Schmidt, Johnson, & Fayad, 1996). Derntl and Botturi (2006) also discuss the notion of a *pattern system*, which includes a pattern language and tools to support use of the language. They define a pattern system as “a conceptual system, which consists of the pattern language and some formulation of meta-language features, e.g., instructions about how to use the patterns, the underlying value system and philosophical background, as well as other relevant information and requirements.”

A key question in examining the literature on design patterns is: Why patterns? Three main benefits for pattern usage are often cited: (1) they serve as a *design tool*; (2) they provide for concise and accurate *communication among designers*; and (3) they *disseminate expert knowledge to novices* (Viljamaa, 1997). The reuse of design solutions is one of the most cited rationales for the

use of design patterns (Erickson, 2000). Another cited reason for the popularity of design patterns as discussed in Erickson (2000) is in their ability to provide a “lingua franca,” a common language that can be read and understood by those even outside the design profession the pattern language addresses.

In many disciplines including education, design guidelines and principles have been used to represent design knowledge. It has been argued that guidelines suffer problems involving selection, validity, and applicability (van Welie et al., 2000). Mahemoff and Johnston (1998b) state that design patterns are concrete in contrast to abstract design guidelines and principles and when based on underlying design principles, they can capture the philosophies of good design. Chung, Hong, Lin, Prabaker, Landay, and Liu (2004) describe three ways design patterns differ from other formats such as guidelines and heuristics for capturing and presenting design knowledge:

First, patterns offer solutions to specific problems rather than providing high-level and sometimes abstract suggestions. Second, patterns are generative, helping designers create new solutions by showing many examples of actual designs. Third, patterns are linked to another hierarchically, helping designers address high-level problems as well as low-level ones.

USAGE OF DESIGN PATTERNS

Architecture Design Patterns

Design patterns originated in the field architecture as an approach for improving the design of modern architectural structures (Alexander et al., 1977). The objective was to create a body of knowledge of design solutions to reoccurring problems encountered in architectural design and

to present this knowledge in an understandable and useful form that could be used by architects and the general public. Christopher Alexander and colleagues represented this knowledge in what they termed a “pattern,” a narrative form consisting of textual descriptions and pictures that describe a design problem and its solution. A pattern language consisting of 253 design patterns was developed to support both architects and the public in designing quality architectural structures, a quality they contend was being lost in modern architectural design. The design patterns range from addressing large design issues such as the design of neighborhoods and communities to smaller scale patterns that deal with the design of houses and rooms. The patterns were ordered hierarchically within a pattern language with each pattern referencing the smaller scale patterns that support it and the larger scale patterns that it supports. All patterns are presented in the same narrative structure and format consisting of the following elements:

- The name of the pattern
- A validity ranking indicating the degree to which the authors have confidence in the pattern’s solution
- A picture showing an archetypical example of the pattern
- The context for the pattern
- The problem statement and description
- The solution to the problem
- A diagram of the solution
- References to smaller scale patterns needed to complete the pattern

In one of the volumes of this work, *The Oregon Experiment*, readers are provided with the application of the design patterns in an experiment to redesign the campus of the University of Oregon (Alexander, Silverstein, Angel, Ishikawa, & Abrams, 1975).

Software Engineering Design Patterns

The greatest impact of design pattern usage can be seen within the software engineering community. The goal has been to use design patterns to create a collection of design best practices to support software architecture and design. Gamma et al. (1995), often referred to as the Gang of Four (GoF), published the first influential collection of design patterns in the software engineering community. They developed a catalog of 23 design patterns that capture and present solutions to problems in object-oriented software design. More than a decade later from the GoF text, design patterns and resulting research have a strong presence within software engineering, most notably to support object-oriented software development (Alur et al., 2001; Metsker & Wake, 2006).

The presentation of design patterns changed with their adaptation to software engineering. Gamma et al. (1995) introduced a new format for presenting design patterns (see Table 1). Instead of the narrative format used in architecture, a longer and more explicitly labeled template was used. Another change is the lack of the strict hierarchical ordering that existed in the architecture design patterns. According to Viljamaa (1997), this change can be contributed to the iterative nature of software development, which makes it difficult to impose a hierarchical structuring. Software engineering design patterns also contain software code to illustrate an implementation of the pattern, and due to their technical content, they are not easily understood by users without some software development training.

Design Patterns in Interaction Design

Design patterns have been used within the human–computer interaction (HCI) field to support different levels of interaction design ranging from

Table 1. Software engineering design pattern template (Gamma et al., 1995)

Name and Classification	The name conveys the essence of the pattern and the classification is based on the pattern's purpose in the design process.
Intent	Explains what the pattern does, its rationale, and the design problem addressed.
Also known as	Gives other names for the pattern if any exist.
Motivation	Illustrates the design problem and shows how the pattern solves the problem.
Applicability	Gives the situations in which the pattern can be applied and gives examples of poor designs that the pattern can address.
Structure	Gives a graphical representation of the classes in the pattern.
Participants	Lists the classes and/or objects participating in the design pattern.
Collaborations	Shows the way the objects and classes collaborate.
Consequences	Addresses how the pattern supports its objectives along with the trade-offs and results of using the pattern.
Implementation	Gives the pitfalls and techniques needed when implementing the pattern.
Sample Code	Code fragments on how the pattern might be implemented in C++ or Smalltalk.
Known Uses	Examples of the pattern found in real systems.
Related Patterns	Addresses how the patterns are related and identifies other patterns to be used.

user interface and hypermedia design to social and cognitive design issues (Borchers, 2001; Thomas, Danis, & Lee, 2002; Tidwell, 2005). One objective has been to use design patterns to embody HCI guidelines and design principles, which have been considered by some as not very useful in solving specific design problems (Mahemoff & Johnston, 1998a; van Welie et al., 2000).

Van Welie et al. (2000) introduced a categorization for HCI design patterns based on the kind of design problem the design patterns address. They suggest that just as architectural patterns have the focus of creating quality living environments, HCI patterns need to have a focus, and it should be on usability. They also argue that design patterns should focus on problems of the end users, not necessarily problems of the designers. For example, within education, the student participating in the learning experience would be considered the end user. They state that, "each pattern that focuses on the user's perspective is also usable for designers but not vice versa" (van Welie & Traetterberg, 2000). As shown in the user interface design pattern presented in Figure 1, they include the design principle in the design pattern

and a rationale for how and why the design pattern works. They state that without the rationale section, it is impossible to see whether or why the solution given is good.

Borchers (2001) suggests that the concept of design patterns can be applied to not only architecture, software engineering, and HCI, but can be used to capture design knowledge in any application domain where software is being created. In this research, design patterns were used to capture software and user interface design issues as well as the knowledge from the music domain in the design of interactive musical systems.

There has been no clear consensus on the structure or focus of HCI design patterns. A taxonomy for HCI design patterns has been proposed by Borchers (2000b) along three main dimensions, including:

- *level of abstraction* - Interaction design patterns can address very large-scale issues that comprise a user's complete task or they can address smaller scale, slightly more concrete topics that describe the style of a certain part of the interaction. They

Figure 1. User interface design pattern: Warning (van Welie et al., 2000)

HCI Design Pattern Example

Design Pattern: Warning

Problem: The user may unintentionally cause a problem situation, which needs to be resolved.

Principle: Error Prevention (Safety)

Context: Situations where the user performs an action that may unintentionally lead to a problem.

Forces:

- Work may be lost if the action is fully completed.
- The system can or should not automatically resolve this situation so the user needs to be consulted.
- Frequency of occurrence.
- The number of ways in which the problem can be resolved.
- The likelihood that the user intentionally does the task, e.g. the user wants to do it.
- Some actions are difficult or impossible to recover from.
- Users may not understand why an action could be damaging.
- Users may not understand the consequences or options.
- The severity of the problem if it occurs i.e. how bad is it?

Solution:

Warn the user before continuing the task and give the user the chance to abort the tasks.

The warning should contain the following elements:

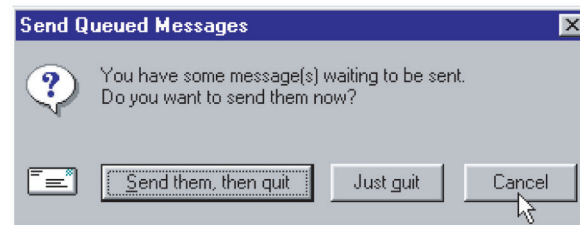
- A summary of the problem
- The condition that has triggered the warning
- A question asking the users if continue the action or take on other actions.
- Two main choices for the user, an affirmative choice and a choice to abort.

The warning might also include a more detailed description of the situation to help the user make the appropriate decision. The choices should be stated including a verb that refers to the action wanted. Do not use Yes/No as choices. The choices are answers to the question that is asked. In some cases, there may be more than two choices. Increasing the number of choice may be acceptable in some cases but strive to minimize the number of choices.

Rationale:

By stating the triggering condition, the user can understand why the warning appears. Once that is understood the question leaves the user with only two options. By providing only two options, the choice is made simple for the user: continue or abort. More options make it increasingly difficult for the user to make a decision. By using a verb in the option the user immediately knows what the user is choosing for whereas Yes/No choices require the user remember exactly what the question was. The solution decreases errors and increases satisfaction.

Examples:



This screenshot comes from Eudora 4, if you try to exit the program. It shows that even three choices can be acceptable.

Known Uses: Eudora, Installshield installers (when exiting)

can also deal with low-level questions of user interface design that look at individual user interface objects.

- *function* - Patterns can be classified into those that address mainly questions of (visual, auditory, etc.) *perception* (interface output), and those that deal with interface input, or, more specifically, *manipulation* of some kind of application data, or *navigation* through the system.
- *physical dimension* - Some patterns will address questions of *spatial* layout, while

others deal with issues of *sequence* (discrete series of events, e.g., a sequence of dialogs), or with continuous *time* (such as a design pattern about good animation techniques in the user interface).

Pedagogical Design Patterns

The goals of design pattern research in education have been twofold. One objective has been to use design patterns as a teaching tool to assist students in gaining design skills as in the computer

science education research of Borchers (2002) where design patterns were used to teach user interface design skills to undergraduate students and in similar research where design patterns have been used as a teaching tool for computer programming related courses (Gelfand, Goodrich, & Tammaia, 1998; Nguyen & Wong, 1999; Preiss, 1999). The second and most prevailing objective is in using design patterns to capture knowledge in teaching and student learning to assist in the design of successful learning opportunities for students. This knowledge may be captured from instructional design and learning theories and expert best practices and experiences. Such design patterns are often referred to in the literature as pedagogical design patterns, learning design patterns, or e-learning design patterns when developed for online course design.

The Pedagogical Patterns Project (PPP), which began in 1996 evolved out of this latter objective to use design patterns to capture the knowledge of experienced educators in learning and teaching object-oriented technology (Sharp, Manns, & Eckstein, 2003). The project began by collecting design patterns from various pattern authors, which varied in focus from curriculum issues to teaching and learning specific object-oriented concepts. The example design pattern presented in Figure 2 is from the earlier work of the project and addresses the problem of exposing students to complex programming problems. These earlier design patterns are referred to as proto-patterns because they had not gone through a rigorous review process and were not a part of a pattern language (Sharp et al., 2003).

In the most recent work of the PPP, the effort has changed in scope moving from the collection of proto-patterns that were largely focused on object-oriented teaching to the development of four pattern languages to address various issues of teaching and student learning (PPP, n.d.; Sharp et al., 2003). The four pattern languages include:

1. Patterns for Active Learning – A pattern language that focuses on pedagogy to promote active learning.
2. Patterns for Experiential Learning – A pattern language that focuses on pedagogy that promotes experiential learning.
3. Teaching from Different Perspectives – A pattern language provides some successful strategies to assist teachers in helping learners examine course material from different perspectives.
4. Feedback Patterns – A pattern language provides some successful strategies to assist teachers in providing feedback to students.

A detailed discussion of how the pattern languages evolved from the original collection of proto-patterns is also provided in Sharp et al. (2003). The design patterns have also changed in presentation (see Figure 3) to the format originally used in architecture because they felt it was more informative and provided better support for connecting the design patterns into a pattern language. In this updated form, each design pattern is divided into four sections separated by “****”; the first section establishes the context for the problem, the second section describes the forces and the design problem addressed, the third section presents the solution with consequences and limitations to the solution, and the last section provides examples and additional information concerning the solution (PPP, n.d.). The work of the PPP has not been without criticism regarding the scale, scope, and method for the development of design patterns (Fincher & Utting, 2002). However, there is no consensus in the literature on the format, content, or level of detail of pedagogical design patterns.

Figure 2. Pedagogical design pattern: Fixer Upper (abridged) (PPP, n.d.) ©2000 Joseph Bergin. Used with permission

Examples of Pedagogical Design Patterns	
Design Pattern: Fixer Upper Giving a student or group of students a large artifact that is generally sound but with carefully introduced flaws can both introduce a complex topic early and serve as a way to introduce error analysis and correction. Students are asked to repair and discuss the artifact.	Contributed by Joseph Bergin
Problem/ Issue Too often students work on only "toy" problems because they may not have the experience or skill to build large artifacts from scratch and there is only just so much time. But all realistic problems are large and the day in which small problems were interesting is about past. We want to get students to work on large artifacts without overwhelming them. On another front, students also have difficulty when unexpected errors arise in their own work. Compiler and run time error messages, for example, often leave them lost.	
Audience/Context The pattern can be used in several courses and at several levels. It can be used very early in programming courses and in teaching analysis and design. It can also be used to show the overall structure of a solution methodology.	
Forces We often need to introduce students to a new field requiring mastery of several topics. Students often fail to see how the topics fit together when introduced sequentially. They also often fail to have a grasp of the means of locating and correcting errors. Fixing a larger artifact than can be created by students is generally within their grasp. It gives them a better sense of scale of interesting problems and permits them to integrate a number of issues into the solution of a single problem. Students can benefit from seeing larger problems than they can solve at their current state of development. They also need critical analysis skills and the ability to evaluate programs, designs, etc. (See Lay of the Land and Larger Than Life).	
Solution Give students an artifact, such as a program or design. The artifact proposes to be the solution to a problem, but while generally correct, the instructor has purposely introduced flaws into the program, design, or whatever. The artifact should be fairly large and should contain a number of flaws. Most of the flaws should be simple and obvious to most readers. There should be one or two deeper flaws. Ask the students to find and correct the flaws. Ask them to discuss the nature of the flaws found and the reasons for their changes. Finally, ask them to discuss the overall structure of the artifact and draw inferences from it.	
Discussion/ Consequences/ Implementation This pattern allows students to actively work with larger artifacts than they can develop completely themselves. They benefit since finding flaws in their own work is a valuable skill. In programming, students see lexical, syntactic, and semantic errors. In design, they can see the effect of incorrect partitioning of responsibility. It is important that the overall structure of the artifact be sound. If it is a program it should be well designed and written, with good choice of identifiers. If it is an analysis or design document, its overall structure should be sound with a clear map to the problem statement. The best way to develop such an artifact is to start with an excellent solution to a problem and then doctor it by introducing flaws. There must be different kinds of flaws, but probably not structural flaws if you are dealing with novices. This latter rule can be broken if the artifact is introduced later in the course rather than at the beginning, at a point at which structure is the main issue.	
Example Instances This pattern has been used to teach 1. Beginning programming. Here the artifact is a program illustrating a number of syntactical constructs that have not yet been introduced in class. (It has been used as the first assignment.) The program can be large enough that its structure is not obvious. Two or three classes with several short methods each is about right. One part of the program might be more complex. Together with the driver, there should be three or so pages of code. The errors can be mostly syntactical and lexical, so that the compiler can find them. One or two semantic errors should also be introduced, so that the program does not perform as expected. More serious and perhaps for more advanced students is the failure to fulfill a precondition contract. Ten to fifteen errors is about right if most are easily caught. Even a single class can be introduced that has a flawed public interface. Students can be asked to analyze the consequences of this in relation to the likely current and future use of the class. 2. Introduction to design. Here a problem is presented and a design for the solution. Six to ten major elements in the design is about the right scale. The design should have a few simple flaws, such as missing message paths or missing functionality within a class.	
Contradictions This must be carefully used if student honesty is an issue. It is easy for one student to point to the locations of errors in C++ programs, for example. One way to address this is to use large artifacts that require teamwork. Another is to ask questions concerning the structure as well as the errors. Finally, the students can be asked to examine the artifact before they are given the full set of questions that will be asked about it. Some students are frustrated by such large artifacts. The instructor must be prepared to provide support and encouragement that the real world really is like that and that it is ok to initially (a) be frustrated and (b) lack knowledge.	

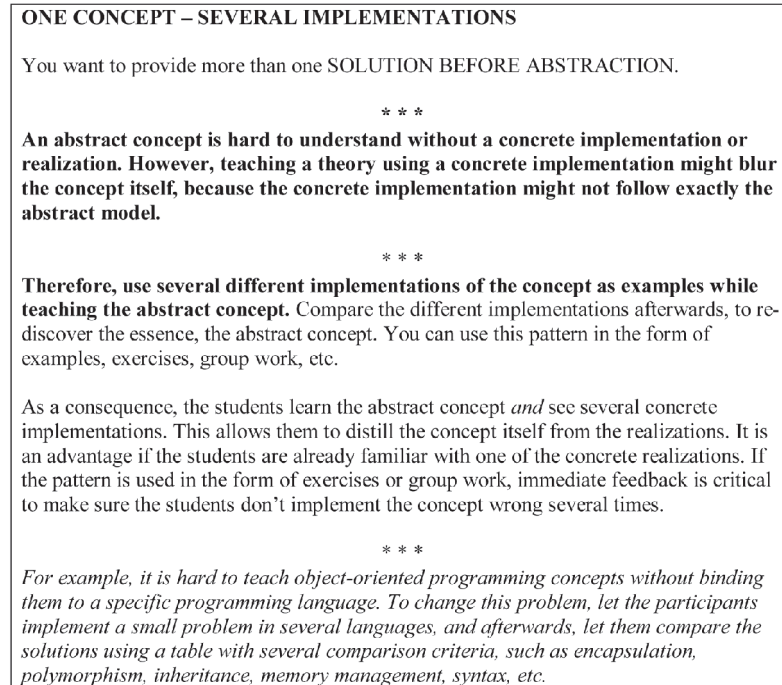
HOW EFFECTIVE ARE DESIGN PATTERNS?

An examination of the literature reveals limited empirical data on the effectiveness of design patterns in supporting novice designers and the quality of the designs produced by pattern users. Mostly from within the software engineering community, descriptions of positive experiences with design patterns have been reported (Beck & Cunningham, 1987; Beck et al., 1996; Cline, 1996; Schmidt, 1995). Prechelt, Unger-Lamprecht,

Phillippsen, and Tichy (2002) describe the first controlled experiments with design patterns in the area of software maintenance. They report that design patterns aided users in completing software maintenance tasks faster and with fewer errors.

Borchers (2002) describes his experience with using patterns to teach interaction design to undergraduate students. Design patterns were covered as part of the course content and given to students to use during their first design assignment. He reports that most students were able to relate several design patterns to problems

Figure 3. Pedagogical design pattern from the patterns for experiential learning language: one concept, several implementations (PPP, n.d.)



they were facing with their designs and that the patterns helped the students to retain the design knowledge. Dearden, Finley, Allgar, and McManus (2002) describe a study to evaluate design patterns as a tool for participatory design. They claim novice Web designers were able to produce feasible design sketches of a travel Web site using design patterns and that using the patterns enabled participants without experience in Web design to participate in the design of a Web site. However, no claims were made to the quality of the designs produced by the users due to the limited amount of time participants worked on them and because they were only paper-based sketches. Also from the HCI community, Chung et al. (2004) describe two studies to evaluate the usefulness of design patterns in supporting the design tasks of novice designers in ubiquitous computing. They also evaluated the usefulness of the design patterns in improving communication between designers and

supporting the creation of higher-quality designs. Again not statistically significant, they report the designs created by participants who used design patterns were generally rated higher by judges and that the design patterns helped novice and experienced designers, assisted in communication between designers, and aided designers in avoiding some design problems early in the process.

We believe that data from control studies on design pattern effectiveness is limited due to experimental design difficulties. Spector and Song (1995) discuss the difficulties of measuring the effectiveness of design support methods due to the fact that design-based tasks can be very individualized and quite time consuming to develop. Prechelt et al. (2002) also discuss these challenges and note that difficulty often arises in experiments that attempt to evaluate a specific form of an information source. Because of these challenges, the design of such studies is a nontrivial

task. We have encountered this difficulty within our research (Frizell, 2003, 2006), an issue we discuss in a subsequent section.

DESIGN PATTERNS USAGE IN E-LEARNING

Much of the current research with pedagogical patterns has been in the area of Web-based instructional design or e-learning design. E-learning design can be defined as “the application of learning design knowledge when developing a concrete unit of learning [via an electronic medium], e.g. a course, a lesson, a curriculum, a learning event” (Koper, 2005). Learning design knowledge in this context encompasses beliefs about teaching and student learning derived from a number of sources including educator experiences, best practices, and educational theories. Design patterns have been proposed to capture and disseminate design knowledge from all the aforementioned sources to support both e-learning design and development (Avgeriou, Papasalouros, Retalis, & Skordalakis, 2003; E-LEN, n.d.; Goodyear, 2005; Jegan & Eswaran, 2004; Retalis, Georgiakakis, & Dimitriadis, 2006). Our research lies within this realm and is discussed in the following section.

TOWARDS A PATTERN LANGUAGE FOR E-LEARNING DESIGN

In this section, we describe our research towards the development of a pattern language for e-learning design. We have currently developed 26 design patterns that cover various issues in e-learning design (Frizell, 2003). The focus is to support novices in the design of collaborative and active e-learning environments, which incorporate the support and guidance a student may need to be successful in such an environment. Our research is based on the view that principles from learning theory and instructional design research can

be used to support effective e-learning design, but that this knowledge needs to be captured and presented in a way that supports instructors in its use (Frizell & Hübscher, 2002a). We also advocate that e-learning design patterns should be based on an underlying design framework or philosophy, an issue first discussed by Mahemoff and Johnston (1998a) regarding the development of HCI design patterns. This approach towards the development of design patterns is considered a value-laden approach where the values inform the development of the patterns (E-LEN, n.d.; Fincher & Utting, 2002). The E-LEN consortium notes that e-learning patterns should be used to express educational values and that it is better to be explicit about the educational values than claiming the development of value-free patterns.

PROPOSED E-LEARNING DESIGN PATTERNS

In developing the design patterns, we examined the literature on learning theories and instructional design to identify pedagogical best practices and design principles that support effective learning design. Through this process, we identified 10 design principles that provide a framework for the development of e-learning patterns. The framework presented in Table 2 contains principles that advocate the design of collaborative and active Web learning environments (Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Brown, Collins, & Duguid, 1989; Jonassen, 1999; Kearsley, 1999; Kearsley & Schneiderman, 1999; Oliver & Herrington, 2000). There is also a focus on providing rich and diverse course content to students (Merrill, 2002; Spiro & Jehng, 1990). Pedagogical principles that emphasize the importance of incorporating structure, support, and guidance into a course’s design are also included in the framework (Gagné, 1985; Kearsley, 1999; Merrill, 2002). In developing the framework, we considered the information content, learning ac-

Table 2. Design framework for e-learning patterns

- | |
|--|
| 1. Design for interactivity |
| 2. Provide problem-solving activities |
| 3. Encourage student participation |
| 4. Encourage student expression |
| 5. Provide multiple perspectives on content |
| 6. Provide multiple representations of data |
| 7. Include authentic content and activities |
| 8. Provide structure to the learning process |
| 9. Give feedback and guidance |
| 10. Provide support aides |

tivities, and support structures that can be included in a course to enhance student-learning outcomes.

Table 3 provides an overview of the e-learning design patterns that have been developed based on this design framework. The name and a statement of the design intent of each pattern are listed. The design patterns embody the design philosophy represented by the 10 principles listed above and provide novice course designers with a useful way of looking at this often difficult to understand pedagogical information. We do not suggest that this collection of design patterns cover all possible design problems that may arise in course design and while an initial study with users has been conducted (Frizell, 2006), the design patterns can benefit from continued critiquing or shepherding to refine the patterns and to identify additional patterns.

We categorized the e-learning design space based upon the model presented by Oliver and Herrington (2000) for the design of Web-based learning environments based on principles from situated learning theories. Using this model, the design patterns are structured into three distinct but congruent design categories: (1) design patterns that focus on design problems related to course *content*, (2) design patterns that focus on student *learning activities*, and (3) design patterns that focus on providing a *learning support* structure. This categorization allows for the development of e-learning patterns that focus on both the problems students face in being successful in online environments and the problems instructors

face in designing effective online environments. *Content* design patterns assist with design problems related to the presentation and structure of course materials. In developing the design patterns to be included in this category, the focus was on providing rich and diverse course content and on providing structure and guidance in the presentation of course materials. Currently, nine design patterns have been developed to address design problems pertaining to these design goals. *Learning Activity* design patterns provide solutions to problems concerning the creation of collaborative and active e-learning environments. Currently, eight design patterns have been developed that address building learning communities, encouraging student participation, encouraging student expression, and problem solving. *Learning Support* design patterns address problems with providing support to students. The focus was on the creation of design patterns concerned with providing guidance and feedback to students.

Due to space limitations, we present only two of the design patterns in detail. A complete description is available in Frizell (2003). The design pattern shown in Figure 4 named *Information Representation* provides a strategy for providing diverse course content. The design pattern named *Post Requirement* (see Figure 6) provides a strategy for involving students in course activities and addresses the problem of getting all students to participate. A format consisting of six elements—*name*, *context*, *problem*, *solution*, *examples*, and *references*—was chosen to describe each design pattern. We believe this format provides designers with those key features needed to fully understand a design pattern without including too much information so that the pattern becomes difficult to read and follow. The reference section is used to validate the pattern and provides additional resources for those users who are interested in the theory behind the pattern. Borchers (2000a) speaks to the need for patterns to give empirical evidence of their validity without making the pattern unreadable

Table 3. E-learning design patterns (Frizell, 2003)

Content Patterns	Design Goal
• Course Goals	Provide students with course objectives
• Course Layout	Organize course design decisions
• Course Path	Organize and link course content
• Foundation	Help students recall previously learned information
• Information Bridge	Help students make connections between lessons
• Information Chunks	Provide structure to course content
• Information Representation	Provide content in multiple representational forms
• Points of View	Provide students with multiple perspectives on course content
• Syllabus	Inform students of course content and expectations
Learning Activity Patterns	
• Active Student	Encourage student expression and increase student participation by getting them involved in course activities
• Course Interactions	Increase course interactions
• Group Work	Increase course interactions through group activities
• Learning Community	Encourage students to communicate
• Peer Evaluation	Encourage student expression
• Post Requirement	Encourage student participation in group discussions
• Problem Practice	Provide problem-solving activities
• Real World	Provide problem-solving activities in the context of real world usage
Learning Support Patterns	
• Communication Tools	Support student communication
• Discovery Orientation	Support student exploration
• Facilitated Discussion	Support student communication
• FAQ	Provide students with immediate feedback
• Feedback	Give students feedback on course activities and assignments
• Learner Guidance	Provide support to students in understanding and completing course activities
• Moderated Discussion	Support student communication
• Question Time	Provide students with immediate feedback
• Student Input	Gather student feedback on the course

with lots of statistical information. The examples included in the design patterns are obtained from the literature or from existing courses.

FIRST EVALUATION OF THE DESIGN PATTERNS

We conducted a study to investigate the effectiveness of our e-learning patterns in supporting

novices and to gain insight on problems and limitations that may exist in end user's abilities to use design patterns. Our research questions included: Are design patterns effective in supporting the design tasks of novices? Can end users apply the knowledge represented in design patterns more effectively than guideline representation? In this section, we summarize the design and results of the study.

Figure 4. E-learning design pattern example

*E-learning Design Pattern Examples***Design Pattern: Information Representation**

Context: Use when you are presenting complex material to students and you want to maximize their understanding.

Problem: Presenting complex information in only one form (e.g. a textual description) may hinder some student's ability to effectively understand the material.

Solution: Therefore, provide students with opportunities to study complex information in a variety of representational forms. Depending on the type of information, it may be best represented textually through descriptions, analogies, and examples, and/or visually through diagrams, illustrations, or animations. See also the pattern *Points of View*, which also address presenting diverse instructional content to students.

Examples: The following examples illustrate how course concepts can be represented in different ways. The examples are from a research project that examined the effects multiple representations of computer algorithms had on student learning (Hübscher-Younger, 2002).

SELECTION SORT

Pseudocode:

```

SelectionSort (SortArray, ArraySize)
begin
  for I in 1..ArraySize-1 loop
    Pos = I;
    for J in I+1..ArraySize loop
      if SortArray[J] < SortArray[Pos] then
        Pos = J;
      end loop
    if Pos != I then
      temp = SortArray[I];
      SortArray[I] = SortArray[Pos];
      SortArray[Pos] = temp;
    end loop
  end SelectionSort

```

Explanation:

I find that this algorithm is best explained with an example. Let's take an array of size 10 with the following numbers:

63 24 5 17 49 52 19 44 67 12

The algorithm starts from the beginning of the array and searches for the smallest value in the array. In this case, the number 5 is what it finds. It then swaps that number with the number in the first

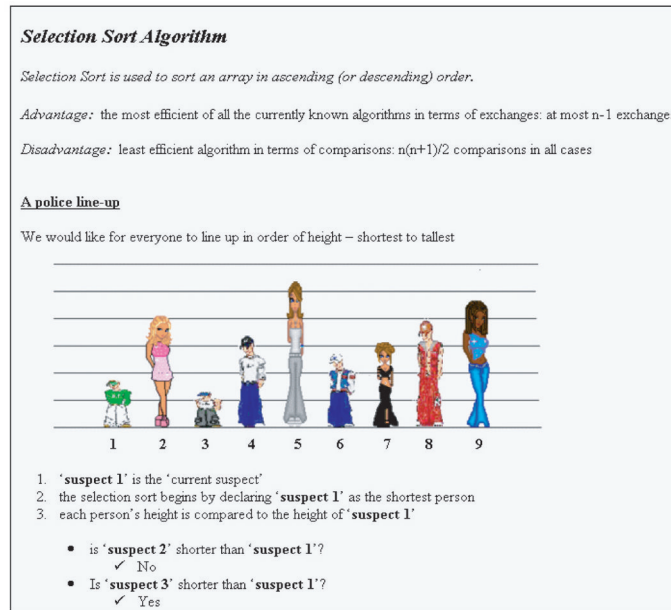
Methodology

Participants. Twenty-nine computer science graduate students participated in the study. Based on data from the preliminary questionnaire, 45% has some familiarity with software engineering design patterns, while only 17% had some teaching experience mostly as graduate teaching assistants. None of the students indicated having taken any type of education class that focused on teaching and student learning. This suggests the participants were knowledgeable on the subject matter used in the design task (i.e., design of

online C++ programming course), but novices to instructional design.

Procedure. The experimental design was between-groups with the participants being given the same design task to complete. The difference was in the method of design support that was provided to them. One group had access to a Web site containing a subset of the developed e-learning design patterns and the other group had design guidelines. The guidelines were primarily represented as two to three line paragraphs with no accompanying examples. To minimize the effects of having the information not only in different form but also contain different content,

Figure 5. E-learning design pattern example (continued)



Representation of the Selection Sort algorithm using text and colorful graphics of people's heights to explain how the algorithm performs a sort (from Hübscher-Younger, 2002).

References:

- Hübscher-Younger, T. (2002). Understanding algorithms through shared representations. Unpublished doctoral dissertation, Auburn University.
- Merrill, M. (2002). First Principles of Instruction. *Educational Technology Research and Development*, 50(3), 43-59.
- Oliver, R. & Herrington, J. (2000). Using Situated Learning as a Design Strategy for Web-based Learning. In B. Abbey (Ed.), *Instructional and Cognitive Impacts of Web-Based Education* (pp. 178-191).

we looked for guideline information that provided content as similar as possible to the information represented in the design patterns. However, there was no optimal way to reproduce the exact same information contained in all the sections of the patterns into a guideline without trying to rewrite the guideline as a design pattern.

The design task for the study consisted of the *selection* and *justification* of useful and applicable design patterns or design guidelines by participants for the design of an online C++ programming course. Participants were asked to provide both *why* they considered the guideline or design pattern useful and applicable to the course's design, and *how* they would use this knowledge to affect the course's design. We chose this design task instead of the design of a course module for evaluation

because we wanted to observe the participants while they interacted with the design patterns. We did not consider the 10–20 hours reported in the literature needed to design a course lesson for evaluation feasible for our study (Thomas, 2000). Spector and Song (1995) also report on the significant amount of time ranging from weeks to months it can take users to produce a course module that warrants evaluation. Based on the design task, the factors considered in evaluating design pattern effectiveness include:

- **Design task results:** An analysis of participant's task results, which includes the number of patterns or guidelines selected, the appropriateness of the selections, the

Figure 6. E-learning design pattern example

Design Pattern: Post Requirement

Context: Use when you want to encourage student participation in course bulletin board discussions.

Problem: Bulletin boards (i.e. threaded discussions) can be used for course communication. However, some students will have a tendency to lurk and read the comments of others, but never contribute to the discussions. Students will still need encouragement to get involved. Such encouragement is especially needed for students who are new to online learning or professionals with busy work schedules (Kearsley, 1999).

Solution: Therefore, make participation in online discussions a requirement of the course. This can be done by giving bonus points as an incentive or making participation a component of the course grade. For many, this will provide the motivation to contribute. Making posting a requirement requires involvement from the instructor as well to facilitate and moderate discussion (Kearsley, 1999). See the Learner Support patterns, *Facilitated Discussion* and *Moderated Discussion*.

Examples: In the following example, students are required to contribute weekly to course discussions. Motivation to participate is provided by making it a component (15%) of the final grade for students.

**References:**

Kearsley, G. (1999). *Online Education: Learning and Teaching in Cyberspace*.
 Kearsley, G. (1998). A Guide to Online Education. Available from
<http://home.sprynet.com/~gkearsley/online.htm>

reasoning given by users for the selection, and the time taken to complete the task.

- **Problems encountered:** Any difficulties observed or reported by users in completing the task.
- **User satisfaction:** A measure of participant's opinions of the design support method after completing the design task. Participants were given a questionnaire after completing the task and asked to rank the method on usefulness, applica-

bility, understandability, learnability, and effectiveness.

The study occurred over a 2-week period with subjects participating one at a time. Participants signed up for 75-minute sessions, but were allowed as much time as needed to complete the design task.

Results summary. Participant's data were studied for any noticeable differences between pattern users and guideline users in the level of

understanding or applicability in the information provided when answering the questions of why an item was selected and on how it would be used. There was no consistency in the data provided that would suggest that one group had a higher level of understanding when compared to the other group. However, several participants from the design guidelines group asked for more clarification on the guidelines and asked the evaluator to provide example usages of the guidelines. One participant from this group commented that more details were needed to help fully understand many of the guidelines. Results from the user satisfaction questionnaire yielded no significant differences between groups regarding the usefulness, applicability, understandability, learnability, and effectiveness of the design patterns or design guidelines.

While data analysis of the results was inconclusive in measuring design pattern effectiveness, and no significant differences were found between design pattern and design guideline usage, users rated the design patterns favorably, reported few problems in understanding the design knowledge presented in them, and indicated the design patterns exposed them to design issues not previously considered. An experimental design that focused on the selection and justification of design patterns by users proved to be insufficient for measuring effectiveness. In future research activities, we intend to explore extensions and possible alternatives to the experimental design used in this first study.

FUTURE TRENDS

Design patterns have emerged as a powerful approach for capturing design knowledge to promote reuse of designs and provide design support to novices. To support wide spread adoption and use of design patterns within education, we highlight three main areas of future research: (1) standardization of the design pattern form in education, (2) the integration of design pattern research with

current research efforts in learning objects, learning design, and learning management systems, and (3) the development of software tools to facilitate the creation, sharing, and use of design patterns. The structure of design patterns and pattern languages and their use within education is still in the exploratory stage. A number of formats and techniques for the development of pedagogical design patterns have been proposed. The design patterns that are currently available also vary significantly in level of detail and focus. Fincher and Utting (2002) have characterized what they term the functional and nonfunctional requirements for pattern languages. However, given the array of what currently exists, further research is warranted on the development of frameworks or models for the development and use of pedagogical patterns. This research must address standards for the structure of pedagogical patterns and criterion for the characteristics that must be present.

Within the education literature, there is a shift towards reuse of design solutions and in addition to design patterns, research into learning objects (Wiley, 2002) and learning designs (Koper & Tattersall, 2005) exists. While there have been some attempts to analyze the relationship among these approaches, further analysis is needed. Several research efforts have also discussed ways software tools may prove beneficial for developing and using design patterns (Budinsky, Finnie, Vlissides, & Yu, 1996; Chambers, Harrison, & Vlissides, 2000; Dearden et al., 2000; Greene, Matchen, & Jones, 2002). Although no formal studies have evaluated the effects of software tools on design pattern usage, tool support may greatly harness the benefits of design patterns. Chambers et al. (2002) found that the problem that may exist in pattern application is in the designer understanding his problem and deciding which design patterns help solve it best. We have explored the combination of e-learning design patterns within a design environment that supports the process of selecting and applying design patterns and have investigated techniques for integrating design

pattern into learning management systems (Fritzell & Hübscher, 2002b; Mondle, 2005). Further research is needed to gain more insight on user experiences with design patterns and to evaluate the designs created with design patterns. This data can benefit the development of pattern support tools and design environments as we gain more insight into the process users follow when using design patterns and how those activities can be effectively supported

CONCLUSION

This chapter has described the concept of design patterns and provided a historical overview of their use in a number of different disciplines to capture and disseminate design knowledge. The use of design patterns has moved from architecture, most notably into software engineering, and also to the HCI and education communities. Software engineering design patterns differ from the original architectural design patterns in that they provide specific implementation details and are best understood by designers with some background in the field. Design pattern research within HCI and education are more closely related to architectural design patterns in that there is a focus on the end user's experience with the product being designed and also specific implementation details are left to the designer. The potential of design patterns and pattern languages within e-learning design is great. Continued research is needed to ensure that design patterns live up to their press, have wide spread adoption and use, and make effective and lasting contributions to the practice and understanding of educational design.

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KEY TERMS AND DEFINITIONS

Design Pattern: An approach for capturing, representing, and sharing design knowledge that promotes the reuse of design solutions.

E-Learning: The delivery of educational content through computer and communication technology.

Instructional Design: A process for the design and development of instructional materials and learning activities based on learning theory research.

Learning Design: The use of learning design knowledge to design education.

Learning Management System: A software application that supports the management and delivery of instructional materials and learning activities.

Learning Theory: Philosophies describing the learning process.

Pattern Catalog: A collection of related design patterns.

Pattern Language: A structured collection of design patterns within a particular domain.

Pattern System: A pattern language and tools to support use of the language.

Pedagogical Design Pattern: An approach for capturing, sharing, and disseminating design knowledge concerning teaching and learning.

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Chapter 1.12

Visual Design of Coherent Technology–Enhanced Learning Systems: A Few Lessons Learned from CPM Language

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ABSTRACT

Visual instructional design languages currently provide notations for representing the intermediate and final results of a knowledge engineering process. As some languages particularly focus on the formal representation of a learning design that can be transformed into machine interpretable

code (i.e., IML-LD players), others have been developed to support the creativity of designers while exploring their problem-spaces and solutions. This chapter introduces CPM (computer problem-based meta-model), a visual language for the instructional design of problem-based learning (PBL) situations. On the one hand, CPM sketches of a PBL situation can improve communication within multidisciplinary ID teams; on the other hand, CPM blueprints can describe the functional

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components that a technology-enhanced learning (TEL) system should offer to support such a PBL situation. We first present the aims and the fundamentals of CPM language. Then, we analyze CPM usability using a set of CPM diagrams produced in a case study in a ‘real-world’ setting.

INTRODUCTION

For several years, the IMS-LD specification (IMS, 2003b) has been the subject of converging theoretical and practical works from researchers and practitioners concerned with Learning Technologies.

The IMS-LD specification is now well documented (Hummel, Manderveld, Tattersall, & Koper, 2004; Koper et al., 2003; Koper & Olivier, 2004) and widely used for the semantic representation of learning designs. A *learning design* is defined as the description of the teaching-learning process that takes place in a unit of learning (Koper, 2006). The key principle in learning design is that it represents learning activities and support activities being performed by different persons (learners, teachers) in the context of a unit of learning. These activities can refer to different learning objects that are used/required by these activities at runtime (e.g., books, software programs, pictures); they can also refer to services (e.g., forums, chats, wikis) used to communicate and collaborate in the teaching-learning process.

Thus, IMS-LD is an educational modeling language that provides a representation of the components of a learning environment in a standardized XML schema that can be executed by compliant e-learning platforms. According to the classification framework defined in Botturi, Derntl, Boot, and Gigl, (2006), IMS-LD is an example of a finalist-communicative language: it is not intended to enable designers to produce intermediate models of the learning design being studied, nor to provide significant methodological

support for designers to build a final representation complying with the IMS-LD specification.

Initially, designers had to use XML editors (like *XMLSpy*) to benefit from all IMS-LD expressive capabilities (levels A, B, C). *Reload*, a tree and form based authoring tool, was the first editor to significantly improve this situation. Chapter XV of this handbook provides an extensive presentation of currently available IMS-LD compliant tools (Tattersall, 2007):

- LD-editors like *Reload* (Reload, 2005), *CopperAuthor* (CopperAuthor, 2005), etc.
- *Visual tools to support practitioners in the creation of IMS-LD compliant designs by means of using collaborative pattern-based templates* (Hernández-Leo et al., 2006).
- Authoring environments for IMS-LD designs like the *ASK Learning Designer Toolkit – ASK-LDT* (Sampson, Karampiperis, & Zervas, 2005).
- Runtime engines able to interpret a LD-scenario like *CopperCore* (Vogten & Martens, 2003).
- learning management systems able to interpret LD scenarios: *dotLRN* (Santos, Boticario, & Barrera, 2005), *LAMS* (Dalziel, 2006), *Moodle* (Berggren et al., 2005), etc.

However, standards like IMS-LD (2003) and IEEE LOM (2002) start from the principle that even though learning theories are not pedagogically neutral, neutral reference models and standards can still be designed: ‘*The aim is not to set up a prescriptive model but an integrative pedagogical meta-model which is neutral since it models what is common with any pedagogical model*’ (Koper, 2001); this assumption promotes the concept of de-contextualized learning objects that can be specified once, and then reused to design learning scenarios relying on instructivist

(acquisition metaphor) or constructivist (knowledge creation metaphor) principles.

This chapter proposes another way to address the design of learning scenarios. On the one hand, we consider that socio-constructivist learning scenarios must be designed in context. On the other hand, we think that even the final results of an instructional design (ID) process should clearly state the mapping between the contextualized activities specified by designers and the functionalities provided by a given learning management system (LMS).

In the first section, we present various on-going research work focusing on languages defined to help designers represent and share ideas about a learning scenario under study. Such languages are called ‘generative-reflective languages’ in (Botturi, Derntl et al., 2006). The second section introduces CPM (cooperative problem-based meta-model) language, a visual design-language focusing on the design of problem-based learning (PBL) situations; we present its syntax and semantics that rely on UML language. Then, we try to understand CPM usability from an analysis of a set of CPM diagrams produced in the framework of a real-world case study. This study illustrates CPM language expressivity; it also states that even though designing PBL situations with CPM notation remains a complex knowledge engineering activity, good practices can concretely improve designers’ efficiency and confidence. Finally, the concluding section summarizes both CPM characteristics and proposals for improvement.

BACKGROUND

In this section, we only focus on current research work that could lead practitioners (teachers, educators, designers) to consider ID languages as adequate tools to explore their problem-spaces, not only to share ideas within a design team, but also to prepare the implementation of coherent technological enhanced learning systems.

Situated learning presupposes that meaning is both incorporated within the learning design as well as being prone to interpretation and shared understanding (Stahl, 2006): “*a blind spot of activity-centered models is their missing ability to describe the relation between the program (the learning design) and its context*” (Allert, 2004).

Thus, modeling coherent social systems for learning requires going beyond selecting and sequencing activities and resources, but also deciding and documenting for what purposes they are being used. This means that roles and activities are to be represented and assessed in context (Derntl & Hummel, 2005). With this purpose in mind, Allert (2005) introduces the concept of second-order learning objects (SOLOs) which are resources that provide and reflect a strategy (generative strategy, learning strategy, problem solving strategy, or decision-making strategy). SOLOs provide means for structuring information or modeling certain aspects of the real world: they represent sets of interrelated concepts that can be used to describe the domain of concern. The use of different SOLOs will thus allow a designer to look at a system from different points of view (e.g., organizationally, structurally, and from social points of view).

Pawlowski (2002), Pawlowski and Bick (2006) introduce the didactical object model (DIN) which extends the aims of current educational modeling languages by introducing specifications for contexts, experiences and acceptance. The concept of reusability is, in this case, extended since it should be possible not only to share scenarios as technical specifications but also to exchange didactical expertise about such scenarios (from the knowledge of their context of use, of concrete experiences reported by the actors involved in its use).

Schneemayer (2002), Brusilovsky (2004), and Paramythis and Loidl-Reisinger (2004) extend the context notion to the environment context which clarifies the real characteristics of the LMS (or any other software) from which the learning situation is being exploited. This leads to an approach for

the engineering of learning situations aiming to specify the learning situation together with the LMS which will later enable students to learn from this situation.

Works of Botturi (2003), Botturi, Cantoni, Lepori, and Tardini (2006) promote the adaptation of fast prototyping for the specific issues of e-learning project development with very particular stress on human-factor management (*i.e.*, the *eLab* model). They developed a visual design language called E²ML (cf Chapter VII of this handbook) to support fast prototyping to enable a developing interdisciplinary team to function (including educators and teachers). Outcomes of the language include better communication within the design team, availability of precise design documentation to evaluate designs and figure out agreed and more feasible solutions.

Despite having quite different objectives, the works that we have listed in this section (including those conducted in the framework of the IMS-LD initiative) share the fact that they address the complexity of ID. Developing future technology-enhanced learning (TEL) systems requires an interdisciplinary team with both pedagogical and technical skills: communication and minimal agreement on means and ends are conditions for success within such a team.

From the point of view of teachers and educators, ID languages can be communication catalysts (Botturi, Derntl et al., 2006) if these actors feel that the concepts of the language are in tune with the characteristics of the learning situation to be described and will enable them to explore, document and share their design decisions with others.

On the one hand, Allert (2005) states that teachers and educators need dedicated languages which reduce complexity by reflecting instruction (and the process of ID) according to specified criteria (p. 41): *i.e.*, formalization, compatibility and interoperability criteria (IMS, 2003b) are to be considered since most educators are now aware that the introduction of technologies in education has important consequences on any design process.

On the other hand, such instructional languages must not neglect didactics, which is the science of learning and teaching; even if in the domain of training (reproductive forms of learning), the learning design is often limited to the planning and sequencing of non-contextualized activities and resources. Pawlowski and Bick (2006) state that designing situated-learning requires languages that can precisely describe the context and the dynamics of the tutoring/learning activities and resources.

Our work on visual ID languages started just before Koper (2001) published his first results on the Educational Modeling Language (the precursor of the IMS-LD specification). From the very beginning, we intended to propose a visual design language that could be useful for both educators and developers of TEL systems. From the point of view of educators, the language requirements were:

1. To enable designers to represent learning-tutoring activities in context.
2. To reduce complexity by reflecting instruction (and the process of ID).

In the following sections, we shall first present the characteristics of the language; then we shall study the language usability from an analysis of its use on ‘real-world’ case studies.

CPM LANGUAGE

CPM stands for **cooperative problem-based learning meta-model**. It is a visual design language that we developed at the LIUPPA Laboratory (Laboratoire Informatique de l’Université de Pau et des Pays de l’Adour, France) as a specialization of UML language. CPM language focuses on the design of problem-based learning (PBL) situations. We decided to work on such a dedicated language because we consider with Allert (2004) and Pawlowski and Bick (2006) that:

1. Pedagogical meta-models are not neutral
2. There is an important need for design languages that specifically address generative learning (learning in context, situated learning).

According to the ID classification scheme defined in Botturi, Derntl et al. (2006), it is a visual (notation level), layered (stratification level), semi-formal (formalization level) language promoting multiple perspectives (more than one view) upon the same entities. In the next paragraphs, we present the aims of the language and the information model captured by CPM language. Fundamentals of both its abstract syntax (the CPM meta-model) and its concrete syntax (the CPM profile) are then discussed. Finally, we briefly present three real-world case studies, which have enabled us to experiment on the usability of CPM language.

Aims of CPM Language

Even though learning by doing activities promoted by a PBL scenario may seem to be natural activities, PBL situations must be scripted. In the context of PBL, the support focuses on mentoring, motivating, creating simulated crises, showing how failures result from poor communication and lack of foresight, identifying and promoting areas in which teams and individuals have to make progress. Thus, PBL is different from traditional instructional methods which emphasize the content: This means the main focus is on the learner and genuine problems (Norman & Spohrer, 1996). Guided by tutors who take only a facilitator role, learners are engaged in active and meaningful cooperative learning. They collaborate with each other by using tools to represent problems, to generate solutions, to discuss different perspectives, to lead experiments and simulations, or to write reports, etc. The driving force is the problem given, the success is the solution of it, and apprenticeship is a condition for success. Thus,

the object of any PBL activity is an ill-structured problem under study and the expected outcomes of a PBL activity are (Miao, 2000):

- Acquiring knowledge and skills which can be transferred to solve similar problems at individual level.
- Constructing shared knowledge and promoting mutual understanding at group level.

To address such objectives, our challenge was to explore UML modeling capabilities for the PBL domain and to adapt the semantics of this language, when required, using meta-modeling techniques.

UML is a standard controlled by the object management group (OMG) which is widely known as a design catalyst within teams of software developers Costagliola, De Lucia, Orefice, and Polese (2002), Ferruci, Tortora, and Vitello (2002). Readers needing a basic understanding of the UML language will find a useful introduction in chapter IX of this handbook.

UML language can be used as a sketch, blueprint or programming language (Fowler, 2005). In sketch usage, developers use UML to communicate some particular aspects of the system being studied. In the blueprint usage, the idea is to build a detailed design for a programmer to use in coding software. Blueprints may be used for all the details of a system or the designer may draw a blueprint for a particular area. In programming language usage, developers draw UML diagrams that are compiled directly into executable code, and UML becomes the source code.

Our studies demonstrated that UML is too general to correctly address PBL domain and interdisciplinary issues (Sallaberry, Nodenot, Marquesuzaà, Bessagnet, & Laforcade, 2002). Yet, UML activity diagrams are explicitly considered in (IMS, 2003a) as useful formalisms to capture requirements and build learning specifications. A UML-based language proved to supply more support to the interdisciplinary team of developers

by means of well known (but debatable) UML features: standard notation, communication power, gateway between models and implementation platforms including software components and services.

Thus, we developed CPM, a specialization of UML language for PBL which we implemented by means of a profiling mechanism (OMG, 1999). This language addresses most of the design process, covering the different stages of conceptual and functional designing. This was a matter of differentiating two target audiences.

On the one hand, *educators and designers* use CPM language to draw models (similar to UML sketches) focusing initial requirements of a PBL situation including the PBL domain, situated roles of learners/teachers, learners skills, predicted obstacles which the educators want learners to overcome, goals and criteria for success within the PBL situation, resources available to learners, etc.

On the other hand, CPM language addresses *instructional engineers*. Their work involves designing a viable solution, in coordinating all the actors involved in the development team. Knowledge of UML is a prerequisite for such engineers who use CPM language to draw various models which capture different points of view or outlooks on the same PBL situation (pedagogical, structural, social, or operational). This set of models makes up the learning/tutoring scenario which can be planned (in terms of steps and learning/tutoring events) but cannot be totally predetermined at design time since PBL addresses generative learning (Allert, 2005). The blueprints they produce are expressed in terms of the concepts appearing in the sketches produced by educators, thus facilitating discussion and agreement.

CPM sketches and blueprints prepare the detailed design stage that involves mapping those agreed CPM models with platform-independent models (PIM), e.g., IMS-LD (Laforcade, 2004) or LMS abstractions (Renaux, Caron, & Le Pallec, 2005). Even though we implemented a toolset to generate Level A IMS-LD compliant models from

our CPM models, abstractions of LMSs are our favourite platform-independent models. The idea consists in mapping conceptual design models with components representing abstract views of the services provided by an LMS: such a mapping leads designers to use the CPM language in order to specialize and contextualize the services supplied by an LMS according to the specificities of the activities to be fulfilled.

The CPM Information Model

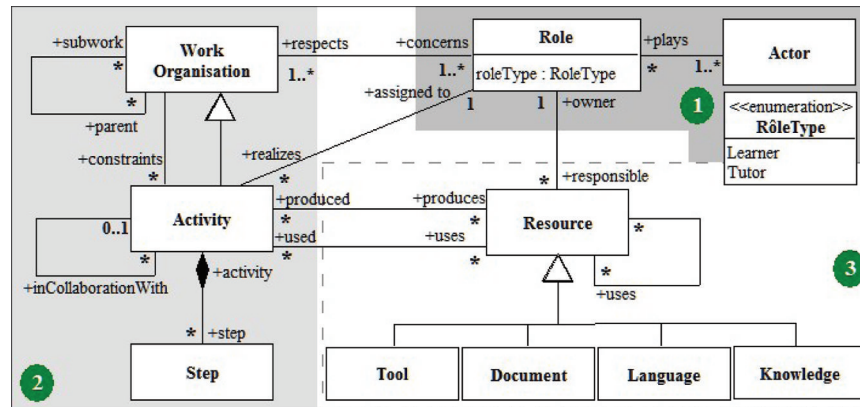
CPM relies on an information model depicted in Figure 1 (Nodenot, 2005). It is composed of three blocks:

Block 1 (gray area at the top) deals with the modeling of the situated roles played by the very actors involved in a PBL situation. *Roles* can be assigned to individuals or to groups of actors. All roles do not imply the same knowledge and know-how; according to their learning goals and responsibilities, roles will often use specific *resources* to perform their learning/tutoring *activities*.

Block 2 (gray area at the left) deals with the *work organization* (rules that can constrain the way activities will be conducted by roles). This *work organization*, including collaborative work, can be decided by designers (learning scenario) or it can be in charge of the actors at runtime. When described at design stage, the organization rules may constrain the *activities* and *resources* at the learners'/tutors' disposal. *Activities* can be further detailed in terms of *steps*, enabling designers to elicit the way important learning/tutoring events should be taken into account when they are raised at runtime.

Block 3 (white area at the bottom right) deals with the *resources* used by actors. *Knowledge* can represent activity prerequisites/post requisites, information about what can be learned from available documents, etc. A *language* is useful to the extent it forces actors to use a fixed set of vocabulary when they try to reach agreements in collaborative activities or when they are asked

Figure 1. The CPM conceptual information model



to describe what they know, what they would like to know, etc. *Documents* and *tools* represent contextualized artifacts enabling actors to conduct assigned activities.

The CPM Toolset

From the CPM information model (to be compared with the IMS-LD Information model), we first built the abstract syntax of the language (the CPM meta-model) whereas its concrete syntax was represented through the CPM profile.

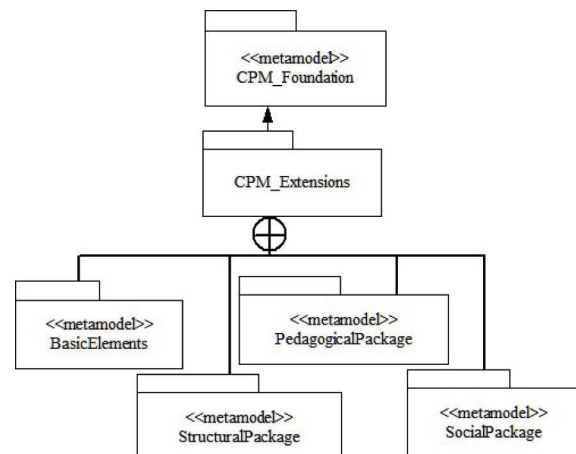
The CPM Meta-Model

To construct the CPM meta-model, an interdisciplinary team started with 35 concepts and divided them into two groups. First, concepts were selected which related to the necessity for the educators to produce a PBL situation's conceptual design (using terminology from works by (Develay, 1993) and (Meirieu, 1994) and includes notions like *Learning Goal*, *Obstacle*, *Success Criterion*, etc.). Then, several concepts were identified which are useful to describe a) the learning scenario (its structure and its dynamics) or b) the tool-environment provided to actors to conduct their learning/teaching activities. These concepts are borrowed as often as possible from the IMS-LD terminology (e.g., *Activity*, *Activity-Structure*, *Role*, etc.). They are

located in packages and sub-packages (see Figure 2): the *CPM_Foundation* (defined as a subset of UML 1.5) and the *CPM_Extensions* which adds the necessary concepts needed to describe PBL situations.

Among CPM extensions, cognitive concepts necessary to trace the learning/tutoring behaviors of the actors are included in the *PedagogicalPackage*. This package deals with information used to model the components of a PBLs: misconceptions of the learners, predicted obstacles that a teacher wants the learners to overcome, goals and success criteria of the PBLs, resources available to the learners, etc. The *StructuralPackage* includes

Figure 2. The packages of the CPM meta-model



concepts necessary to describe the PBL scenario and to break it down into simpler learning/tutoring activities. Lastly, the *SocialPackage* deals includes all the concepts necessary to manage co-operative work including sharing of resources and of learning/tutoring activities.

There are interconnections between the concepts within these packages. Figure 3 presents two extracts: on the left, a *Structural Package* extract and on the right a *Social Package* extract. Grey concepts refer to elements from the *CPM_Foundation* package (see UML 1.5).

- *ActivityConcept* particularizes the UML concept of operation; it is a general concept to depict any hierarchy of activities.
- *LearningPhase* is used to sequence a learning scenario; its semantics are close to the *Act* IMS-LD Concept, except that an IMS-LD *Act* can only be broken down into one and only one sublevel. Since it specializes the *ActivityConcept*, the *LearningPhase* concept can be used to describe a scenario with a hierarchy of acts including a hier-

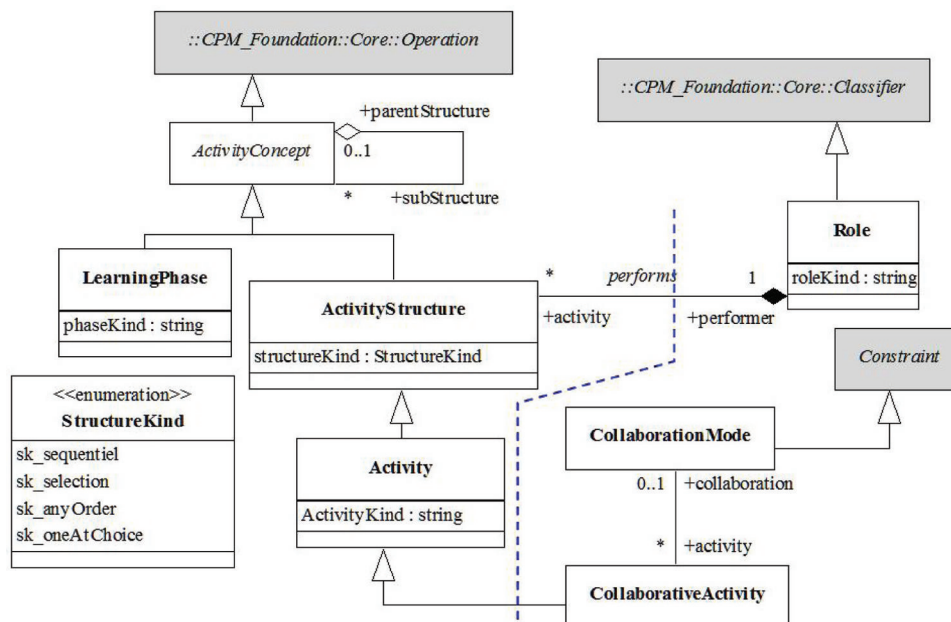
archy of scenes from which different roles will carry out particular activities.

- The *ActivityStructure* and *Activity* concepts are also specializations of *ActivityConcept*; they respectively represent a group of activities and a particular activity assigned to one role. Activity Structures can be of different types (i.e., the *structureKind* meta-attribute).
- The *CollaborativeActivity* concept also specializes the *ActivityConcept*; the meta-model states that such an activity is performed by one and only one role (a role can be assigned to a group of concrete actors). Cooperation is not explicit in our meta-model since we decided to describe cooperation by means of role sharing and resource sharing (i.e., the CPM conceptual information model presented in Figure 1).

The CPM Profile

To enable designers to draw diagrams that are consistent with such a meta-model, we implemented

Figure 3. Interconnections between the concepts of the CPM meta-model packages



the CPM profile. A profile uses the extension mechanisms of UML in a standardized way, for a particular purpose. It merely refines the standard semantics of UML by adding further constraints and interpretations that capture domain specific semantics and modeling patterns.

Like any UML profile, the CPM profile promotes *Stereotypes* which are defined for each specific meta-class of the UML meta-model. Thus, for each concept of the *CPM_Extensions* package, we defined a particular stereotype attached to a specific UML meta-class (the Base meta-class) which the CPM concept directly or indirectly particularizes. We also defined alternatives which are other UML meta-classes to enable designers to use a CPM concept in alternative UML diagrams than those suited to its Base meta-class. For example:

- A *Role* is a stereotype defined for the *UseCases::Actor* meta-class (i.e., Figure 5) (a UML actor is something or someone who supplies a stimulus to the system operations).
- But we also promoted alternative meta-classes (i.e., Figure 6): *ActivityGraphs::Partition* (to enable designers to use the CPM *Role* concept in UML activity-diagrams), *Core::Classifier* (to enable designers to use the CPM *LeaningPhase* concept in UML Class Diagrams).

This mechanism which was already used in OMG(2002a) means that *ActivityGraphs::Partition* and *Core::Classifier* are proxy notations of the *UseCases::Actor* meta-class.

Icons are associated with stereotypes to reduce the designers' cognitive load and to enhance visual appropriation of the CPM models. Tagged values are attached to the different stereotypes; they represent meta-attributes (e.g., *phaseKind*, *structureKind*, *roleKind*, etc.) of the *CPM_Extensions* concepts.

We provided designers with an authoring environment supporting CPM language. This was developed alongside the *Objectteering/UML* CASE tool. This prototype allowed us to verify the coherence between the CPM profile entities (concrete syntax) and the CPM meta-model meta-types (abstract syntax). It also enabled us to store complete case studies (e.g., the SMASH case study) as well as reusable design patterns in the objectteering shared repository. The current release of this CPM language is available within a module that can be integrated in and used with the free-of-charge-version of the *Objectteering/UML Modeler*.

In the next sections, we shall denote a CPM stereotype with the << >> symbol (e.g., the <<activity-structure>> stereotype. A UML metaclass will be highlighted in italics (e.g., the *ObjectFlowState* metaclass). For the purpose of the case studies that we shall be presenting here, model elements which are instances of the CPM stereotypes will appear in italics (e.g., the *Testimonies analysis* <<activity-structure>>).

REAL WORLD CASE STUDIES DESIGNED WITH THE CPM LANGUAGE

Chronologically, we started with the SMASHPBL situation that addresses 10 to 12 year- old pupils who must piece together eye-witness accounts to identify the causes of a bicycle accident. We set up an interdisciplinary team including two teachers, two CPM specialists, and two developers mastering the Moodle LMS. This team used CPM language to formalize the teaching/learning objectives, to imagine and to detail a cooperative learning scenario that could take advantage of available communication tools (chat, forum, etc.). The proposed scenario was then tested in real conditions during four half days within a classroom where groups of pupils assisted by their teacher

had to cooperate according to the constraints of the specified learning/tutoring activities (using dedicated resources—see Figure 3). Dedicated tools (e.g., a dedicated e-whiteboard to help pupils share their understanding of the actors' spatial position when the accident occurred) were then developed to support learners activities; the scenario was then partly implemented for the Moodle LMS.

Proposed by Vignollet, David, Ferraris, Martel, and Lejeune (2006), the PLANET-GAME case study focused on the didactic transposition (see the initial requirements analysis in Figure 2; see also the account in Chapter XII) of a learning game about astronomy. Assisted by a primary teacher, we used CPM language to describe the conceptualization level that 12 year-old pupils can reach and, in the meantime, we selected different scientific properties of these planets: their distances from the sun, their day durations, their year durations, their compositions, their average temperatures, etc. This domain study led us to set more detailed learning/tutoring objectives from which we defined a learning scenario and tutoring strategies (Nodenot & Laforcade, 2006).

The GEODOC case study is an on-the-road project that leads us to formalize CPM scenarios putting the focus on learning/tutoring objectives dedicated to text comprehension as applied to geography. Learning activities which we formalized with CPM language include actual and inferential questions about what is being read (identification and localization of toponyms, topological identification, mapping-out of routes, etc.). This project investigates not only the specialization of LMS services according to formalized learning/teaching scenarios, but also the use of on-the-shelf computational applications in relation with the taught domain (e.g., *Postgis* and *GoogleEarth*).

In the next section, we briefly present the script of a learning scenario and we refer to the figures denoting the CPM diagrams produced in the course of the design of such a scenario. This

will help us give concrete expression of the lessons learned from CPM language.

The Act 2 of the SMASH PBLs: What is this Scenario About?

During *Act 2* (i.e., the IMS-LD terminology), learners (who were previously divided into different groups) have to analyze allocated testimonies. While some groups (that is, *Investigator role 1 to 3*) have access to a limited set, others can read the full set of testimonies (i.e., *Investigator role 4*). The scenario leads all groups (there are several concurrent groups playing *Investigator role 1 to 3* while a unique group of learners plays the *Investigator role 4*) to exchange information about what they learned/understood from the accounts of the testimonies (each group will produce a *belief graph*) and then to write a single *accident report* that all groups must finally acknowledge. The learning scenario is supervised by the *Session manager role* and by a tutor (i.e., the *PoliceChief role*) whose job is to help learners develop an exhaustive analysis of the available testimonies at their disposal.

From a pedagogical viewpoint, such scenario script encourages the groups of learners to confront their own ideas of road safety (knowledge, know-how, attitudes) with the safety rules promoted by road regulations (Highway Code).

In the subsequent text, the reader will find several figures produced with CPM language to specify the *Act 2* learning scenario. The model elements produced during the design process were all stored in the repository provided by the *Objectteering* UML Case tool (i.e., Figure 5) from the set of CPM diagrams produced by the ID Team in charge of the project. Each model element stored in the repository can be used in several diagrams: use-case diagrams, class-diagrams, activity diagrams, state-machines diagrams, etc. Among the different diagrams that were produced

in the course of this project, the following were chosen for this chapter:

- Figure 6 and Figure 7 describe the roles taken by the actors and the coarse-grain activities they performed during *Act 2*.
- Figure 8 describes the resources that *Investigator role 1* can use and produce when performing their dedicated activities.
- Figure 9 details the sequencing of the different coarse-grain activities and the conditions that resources must fulfill to accept transitions from one activity to another.
- Figure 10 and Figure 11 detail the *Testimonies Analysis* <<activity-structure>>.

In the next section, we shall use these figures to elicit the lessons that we learned about CPM language usability. However, from the information given about *Act 2* in this subsection, we strongly encourage the reader to begin by analyzing the semantics conveyed by this set of interrelated CPM diagrams.

Lessons Learned from CPM Language

This section presents the lessons we learned about the usability of CPM language to edit/produce a learning scenario. From the three case studies summarized above, we drew two important lessons:

- Although CPM adopts the jargon that many pedagogues and educational designers already use, producing a set of coherent CPM models for a given case study is still a complex activity.
- Even though most pedagogues are not able to produce a set of CPM coherent models by themselves, both pedagogues and developers can contribute to and benefit from such design models.

Several observations led us to formalize these lessons. To give concrete expression to these observations, we shall rely on CPM models from the SMASH PBL; we shall particularly focus on the *Act 2* learning scenario (the end of the previous section) leading learners to investigate the causes of a bicycle accident from a set of eye-witness testimonies:

Lesson U1: *Although CPM adopts the jargon that many pedagogues and educational designers already use, producing a set of coherent CPM models for a given case study is still a complex activity.*

During the conducted case studies, we noticed that designers encountered difficulties when seeking to organize efficiently the different kinds of model elements that they were eliciting at design time (see Lesson U1, Observation 1). From the analysis of encountered difficulties and observed solutions, we propose a structuring model, which proved useful to organize the different model elements under study within cohesive packages.

We also noticed (see Lesson U1: Observation 2) that without human assistance, most educational designers did not know which notation was the most appropriate to represent their design intents. Yet, when the same educational designers gained experience about both the UML notation and about the CPM meta-model, most could produce expressive yet simple CPM diagrams.

Finally, Lesson U1—Observation 3 shows that designers were sometimes frustrated because they were confusing CPM with a drawing tool: in particular, some did not clearly understand why the provided toolset (editors and wizards) considered some diagrams whose model elements did not conform with the CPM meta-model as erroneous.

Lesson U1, Observation 1: *Relevant model elements must be conveniently organized by designers within packages. CPM diagrams must also be attached to packages.*

Real world case studies that we specified with CPM language had in common that they could not be mastered by a single designer. All the modeling elements could not be represented in the same UML class diagram; learner, tutor roles, learning goals and success criteria had to be contextualized according to the steps of the learning process; both dynamics and structure of resources and activities had to be specified, etc. Relying on our experience in designing such case studies, we argue that in most cases, what is needed is an approach that structures the design of complex learning scenarios at different levels.

Packages are UML constructs which enable the grouping of model elements, making UML diagrams simpler and easier to understand. Packages themselves may be nested within others; they are depicted as file folders and may be Subsystems or Models. When we designed CPM language, we decided to provide designers with two stereotypes (see caption in Figure 5 which extends the *Package* metaclass: the *Learning Process* stereotype to break down the learning process into subprocesses and the *Learning Package* stereotype to group other model elements. In the course of our case studies, we learned efficient ways to exploit these stereotypes for organizing model elements. For instance, Figure 5 describes the packages used in the SMASH PBLs:

This is a snapshot of the browser which enables a designer to edit the SMASH learning scenario. At root level, experience led us to create three learning packages whose model elements are exploited by the *Learning Process* package called the *SMASH Scenario Process*. At the bottom of the figure, worth noting is the *SMASH Scenario* denoted as an activity diagram used to generally describe how the different acts of the *SMASH Learning Process* are sequenced.

The model elements (and graphical views) of these four acts are then detailed within the *SMASH Scenario Process*.

In the snapshot of Figure 5, the details of the *Act 2 Process* were expanded. At this level, it

will be observed that the package structure is the same as the one at root level: Act 2 shows a *Local Roles Package*, a *Local resources Package*, a *Local Learning Roles Package*, and an *Act 2 Scenes Package* which contains all the scenes within Act 2. This structuring promotes the contextualization of roles, learning goals, resources and learning activities. For example, the expanded *Act 2—Local Roles Package* shows different *Actor* stereotypes, which are model elements used during Act 2 to specialize the tutor role and the Learner role (i.e., the *Global Roles Package*).

It is worth noting that this approach is in tune with Derntl & Motschnig-Pitrik (2007), which encourages designers to elicit hierarchies of both learning goals and documents.

Lesson U1, Observation 2: *Among available CPM diagrams, designers must adequately choose those which can help them to produce some simple yet coherent perspectives of the relevant model elements.*

First, let us recall that UML is a language enabling designers to describe an abstraction of a system that focuses on interesting aspects (models) and ignores irrelevant details. A perspective (view) focuses on a subset of a model to make it understandable.

Choosing UML to describe learning scenarios requires rethinking current uses and to elicit new uses of UML diagrams for dealing with the complexity of learning scenarios. From an educational point of view, a learning scenario is a system that must be described in terms of learning roles, learning goals, resources made available to the learners, learning and tutoring interactions/activities, events used to regulate learners' activities, etc.

From previous works (Sallaberry et al., 2002) we predicted the new uses of UML diagrams that CPM language encourages. As stated in the section devoted to the presentation of the CPM profile (see Figure 4), a CPM stereotype such as the <<Role>> Stereotype can extend either the

Figure 4. An extract of the stereotypes provided to designers by the CPM profile

Stereotype	Metaclass	Icon
Activity	Core::Operation	
	ActivityGraphs::ActionState	
	ActivityGraphs::SubactivityState	
	UseCases::UseCase	
	Core::Classifier	
Learning-Phase	Core::Operation	
	ActivityGraphs::ActionState	
	ActivityGraphs::SubactivityState	
	UseCases::UseCase	
	Core::Classifier	
Role	UseCases::Actor	
	ActivityGraphs::Partition	
	Core::Classifier	

Actor metaclass (to represent it in use-case diagrams, or the *Partition* metaclass (to represent it in Activity diagrams) or the Classifier metaclass (to represent it in Class diagrams).

During the course of our experiments, we noticed that designers (educators and computer-scientists) encountered two types of difficulties when trying to map their design intentions with available notation (those provided by the different types of diagrams available). First, most designers were inclined to start from a visual notation (e.g., the notation for class diagrams) and then tried using this specific notation to represent all perspectives of the model being studied, even if such a notation was not convenient for all aspects of the model. Second, we noticed that designers had questions about the notation they would be advised to use, particularly at the beginning of a learning scenario design process.

The case studies we have conducted provide useful answers to these difficulties. Let us focus on the intention, “role models involved in a learning scenario.” If we consider the CPM information model given in Figure 1, designers should address different perspectives for roles. What are these?

How are they involved in the *Work Organization* that the learning scenario promotes? What are their responsibilities in the various (possibly collaborative) activities suggested to be performed in the scenario? What kind of resources do they exploit to carry out such activities? Applied to Act 2 of the SMASH PBLs, Figure 6 and the following are CPM diagrams which focus on the different perspectives listed above.

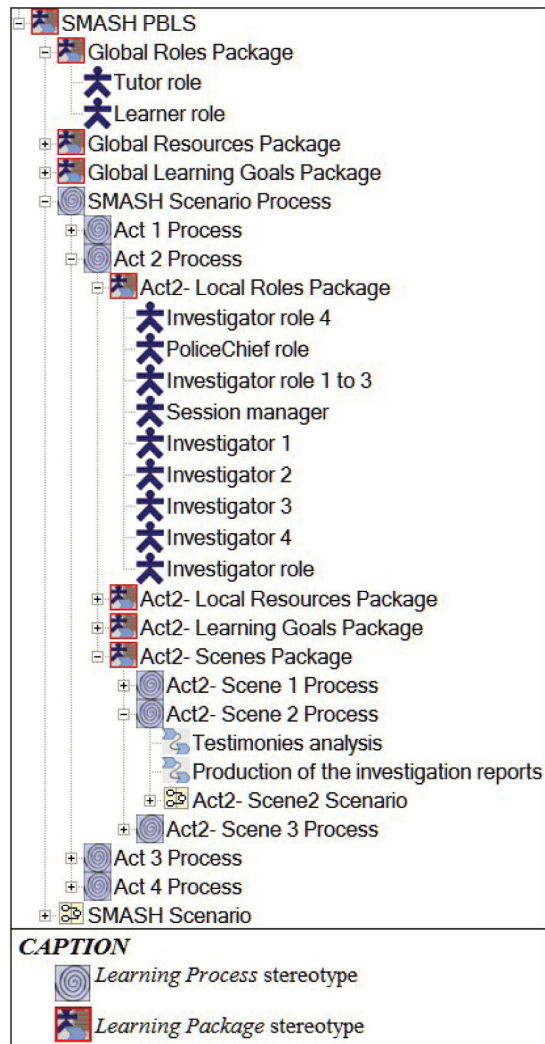
In Figure 6, SMASH roles specialize the *Class* metaclass. This class diagram shows that the *Learner* role and the *Tutor* role (from the *Global Roles Package*) were specialized to enable designers to denote all actors playing an important roles during Act 2. All roles are played by human beings except the *PoliceChief* role (we chose a detailed view of the *Tutor* role model element to make the *roleKind* tag-value visible). Figure 7 offers another perspective for these SMASH roles:

In this use-case diagram, roles specialize the *Actor* metaclass. This perspective focuses on the activities carried out by roles during Act 2. Each *role* either *performs* activities or *assists* other roles performing those activities. Like in IMS-LD, activities that can be broken down into simpler ones (e.g., *Testimonies analysis*, *Time and document management* or *Production of the investigation reports*) are depicted with the stereotype <<Activity-structure>>.

Figure 8 is another class diagram which designers sketched to focus on the resources used and produced by each role during Act2 (there is a dedicated class diagram for each leaf role that appears in Figure 6). Resources which are produced have the tag-value *output* while others have the tag-value *input*.

The different figures provided in this section clearly show that the different perspectives provided to describe the roles in Act 2 are complementary (all of them can be reached from the model elements browser presented in Figure 5). Other types of diagrams will be presented in Figure 10 (an Activity diagram) and in Figure 11 (a state-machine diagram) to respectively detail

Figure 5. The SMASH PBL browser



the *Testimonies analysis* model element and the beliefgraph model element that appeared in Figure 7 and Figure 8.

These figures also show that UML notations must be understood by designers to enable them to produce simple yet coherent perspectives of the learning scenario being studied. Table 1 provides a synthesis of the practices we noticed during our case studies. To build this table, we took into account only diagrams which appeared in the last version of the design produced for each of our case studies.

The reader may be surprised that we do not recommend the use of the object diagram for the definition of roles and of resources. In fact, experience led us to consider that concrete roles appear only when the scenario is deployed on a platform (LMS) and used by concrete (groups of) learners. It is only at deployment time that the *Investigator role 1* stereotype is instantiated and played by concrete learners. And for similar reasons, the resources produced and used by *Investigator 1* are represented as classes (i.e., Figure 8) and not as objects.

Lesson U1, Observation 3: To succeed in producing a perspective, designers must agree on both the UML notation and the CPM meta-model which

Figure 6. A class diagram representing a hierarchy of SMASH actors

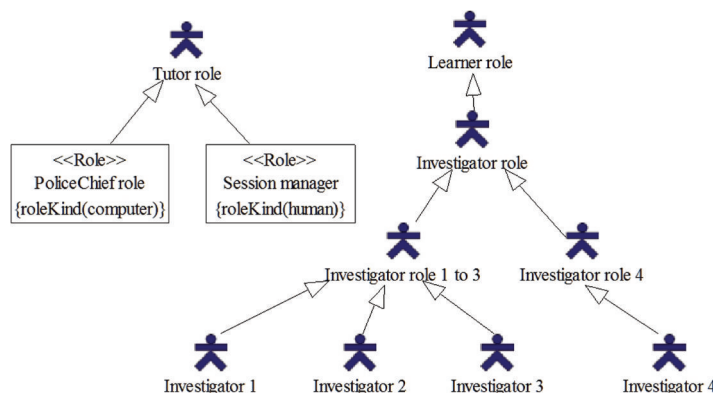


Figure 7. A use-case diagram representing the activities in which the different roles are involved

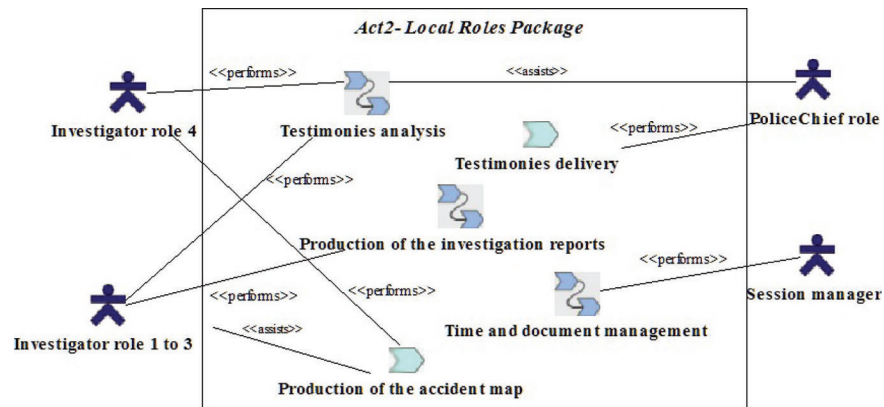


Figure 8. A class diagram describing the resources used and produced by the role Investigator 1

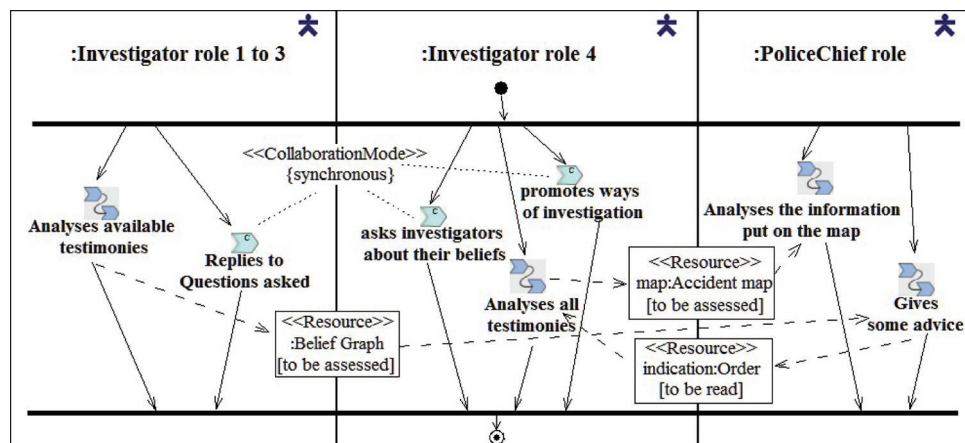


Table 1. Best practices for CPM diagrams

	Use
Activity Diagram	External analysis of the learning scenario
	Description of collaborative activities
	Internal analysis of activities and activity-structures
Use Case Diagram	Activity cut-out
	Role identification
Class Diagram	Learning goal description
	Role description
	Resource description
	External analysis of activities and activity-structures
	Description of the concepts from the domain model
State Machine Diagram	Description of the active classes (resources, roles, learning goals, activities)
Object Diagram	Instances from the domain model (concepts being studied, knowledge and know-how that learners must acquire)

both define the rules that the model elements in a CPM diagram must fulfill.

During our experiments, designers were at first surprised (and a bit confused) that they were constrained by both the rules of UML notations and of the CPM meta-model. On the one hand rules from the UML notations, they could not add, for example, any information about the timeline in the class diagrams being sketched. On the other hand, the CPM meta-model forced them to respect, for example, the following rule: when the <<activity>> and the <<resource>> stereotypes both extend the *Classifier* metaclass (i.e., the class diagram in Figure 8), connection links between such stereotypes must be of type <<Relation>> (the tag-value can either be *input* or *output*). Most designers did not understand such CPM rules, because they did not realize that the same stereotype (e.g., the <<activity>> stereotype) could represent different metaclasses when used in different types of diagrams. For example, in Figure 7, the *Testimonies analysis* model element extends the *UseCase* metaclass while, in Figure 8, it extends the *Classifier* metaclass (i.e., Figure 4 for the available metaclasses of the CPM stereotypes).

The three types of observations presented in this section show that designers need time to gain the necessary experience required to relevantly exploit the CPM language. Our experience also showed that educators can understand the meaning of a set of CPM diagrams but that the (semi) formal nature of CPM language could hinder some educators' commitment in producing such visual designs. They ask for cognitive assistance during the design process: since CPM editors do not allow free drawing, designers require some feedback enabling them to do some opportunistic productions: to-do lists, checklists, wizards, etc.

The first cognitive tools developed were contextual menus that could infer the metaclass to be used from the knowledge of both the diagram type and the stereotype chosen by the designer. In the

framework of our latest project (the GEODOC case study), we also provided designers (educators and computer-scientists) with the best-practices of CPM diagrams and with a set of sample CPM diagrams for each design intent listed in Table 1. Our first experimental results show that such a design team was more efficient (time and design quality) than another team that did not have such documents at their disposal.

But it is already clear that our toolset is still a research prototype that proved expressive capabilities but cannot be distributed to an interdisciplinary team without care and human guidance. Even though the current state of research presented in this section can provide substantial support in understanding PBL scenarios, in designing and documenting new scenarios, it is clear that our approach is specified by rather technically oriented computer science people and a lot of work is still necessary to transform educators into CPM autonomous designers.

Lesson U2: *Even though most pedagogues were not able to produce a set of CPM coherent models, both pedagogues and developers can contribute to and benefit from such design models.*

Through educational expressivity of CPM diagrams, Lesson 1 pinpointed some difficulties encountered by designers who used the CPM toolset. In this section, we present some methodological principles which can help an ID team control the design process complexity.

In the course of the conducted case studies, we first observed that, at any level of the learning scenario analysis (conceptual design, functional design), designers might produce simple yet expressive CPM diagrams (i.e., Lesson U2, Observation 1): it is a matter of focusing on one and only one perspective at a time.

We also noticed that a correct stratification of the learning scenario was important (i.e., Lesson U2, Observation 2) to ensure a smooth transition

between the perspectives drawn during learning scenario conceptual design and those drawn to address the functional design of a TEL system that could manage such a learning scenario at runtime.

Both observations will lead us to elicit a design process in tune with CPM language characteristics.

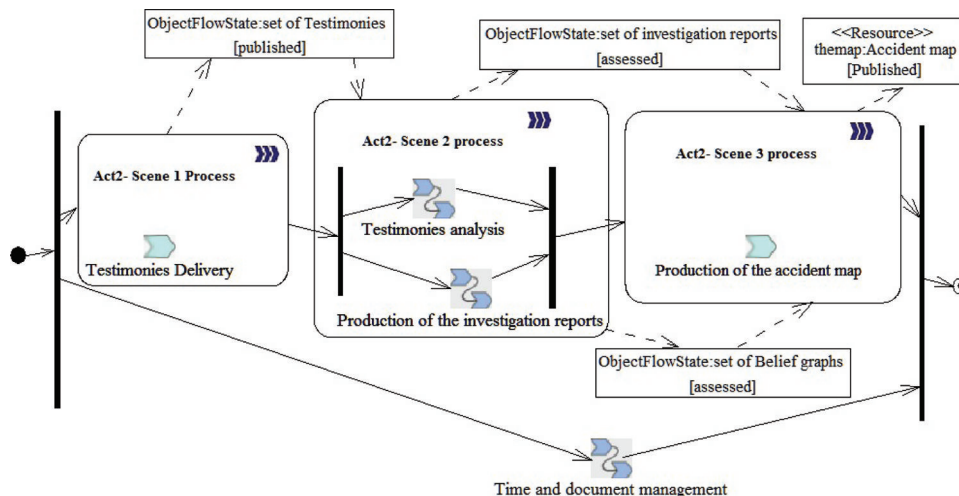
Lesson U2, Observation 1: *Complexity of models can be mastered by designers using the following rule: Design only what is necessary for a given purpose and recognize overdesign.*

Our experience is that most pedagogues can concretely draw various CPM diagrams if they keep in mind that each diagram should focus on one perspective that remains simple and expressive. Consider the *Testimonies analysis* model element which appears in Figure 7 and in Figure 8. None of these perspectives provides information about the activity sequencing planned during *Act 2*. Adding such an information within Figure 7 is difficult since use-case diagrams are not suited to the description of activity sequencing: in general, UML specialists add OCL constraints (OMG, 2002b) to address such difficulty. Drawing another perspective focusing on such activity sequencing is much easier as stated in Figure 9:

In this figure, the reader will notice all activities and all activity-structures that already appeared in the *Act 2* use-case diagram presented in Figure 7: these model elements are grouped together according to the scene during which they are performed by these actors. The information flows between states as *ObjectFlowStates*: these represent some events that should be true either at the beginning (prerequisite) or at the end (post-requisite) of each scene. These different scenes (e.g., the *Act 2- Scene 2 process*) are structuring model elements that can also be easily located in our SMASH Browser (i.e., Figure 5).

We consider that such a diagram can also illustrate what over-design means. At the conceptual design level where educators play the most important role, it would be useless to try to represent exception-handling in such a predicted learning scenario. At runtime, such a script can raise many exceptions (potentially meaningful for educators) that need to be managed (particularly those in relation with *the Time and document management* <<activity-structure>>). But adding exception handling in such a diagram would be likely to complicate the perspective and could mask the key ideas of the scenario, which were already spotted in Figure 9.

Figure 9. An activity diagram describing the sequencing of the activities performed during *Act 2*



As a consequence, we consider that educators relying on CPM for conceptual design should strive for an 80% solution: at this stage, visual design should be used to represent the intermediate and then the final results of the design, thus providing means of communication between educators and computer scientists. All diagrams presented above are still intermediate results of design which helped educators clarifying and sharing their initial ideas.

CPM activity diagrams are other important perspectives to consider because they are a (natural) bridge between the use-case diagrams (which are useful to represent educational roles, goals and activities) and the class-diagrams (that developers need to implement required functionality on a learning platform). During our experiments, such diagrams represented an interesting communication trade-off between our business logic experts (educators and interaction designers) and information technology experts (software designers, learning platform specialists, etc.).

For example, Figure 10 is an activity diagram that details the *Testimonies analysis* <<Activity-structure>>.

Three swimlanes are used to identify the specific activities performed by each role; these swimlanes are consistent with the roles assigned to the *Testimonies analysis* <<activity-structure>> in the use-case diagram presented in Figure 7. In

Figure 10, we can notice that the *Testimonies analysis* <<activity-structure>> exposes four activity-structures (e.g., the *Analysis available testimonies* <<activity-structure>>) that can be further detailed using a top-down approach, some collaborative activities (e.g., *Replies to Questions asked* <<collaborative activity>>), some resources (e.g., the *Belief Graph* <<Resource>> to be assessed when it is updated by any real actor playing the <<role>> called *Investigator role 1 to 3* to 3).

Figure 10 also denotes how designers can describe collaborative activities (i.e., activities with a *c* flag); in the scenario, *Investigator role 1 to 3* cannot initiate any synchronous conversation but this role can read information and answers questions asked by *Investigator role 4* (at implementation stage, and will lead developers to specialize a chat service according to these requirements).

An *ObjectFlowstate* denoting a <<Resource>> can be described with a UML State-machine diagram. For example, Figure 11 represents the lifecycle of the *Belief Graph* model element elicited in Figure 10.

The underlying semantics is the following: each time an investigator adds a belief in his belief graph (e.g., a representation of the following belief: “the white car bumped into the back of the bicycle”), the state of the belief graph

Figure 10. An activity diagram to represent the details of the *Testimonies analysis* activity-structure

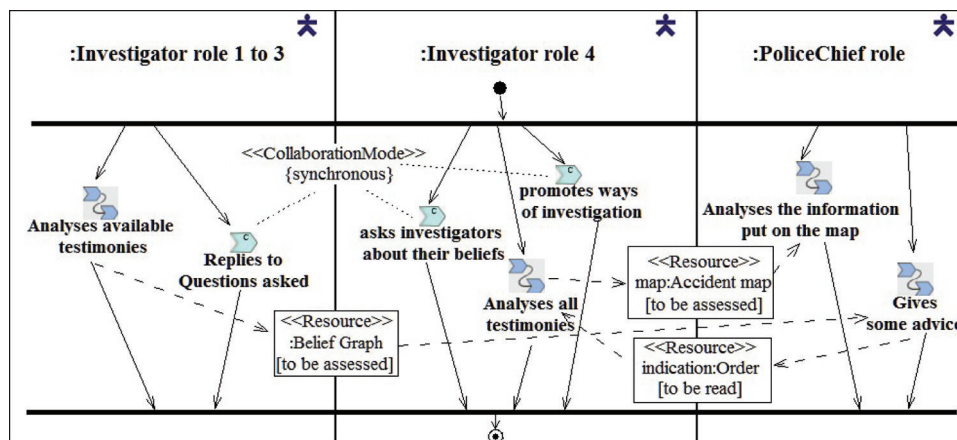
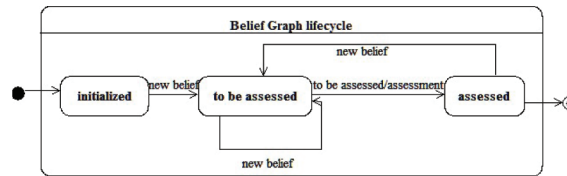


Figure 11. A state-machine diagram to represent the lifecycle of the Belief Graph <<resource>>



changes to “to be assessed” (since the *PoliceChief* role is played by a machine—that is, the class diagram in Figure 6, such a decision will entail particular design concern about the assessment process elicitation).

We noticed that educators encountered various difficulties when seeking to draw some CPM activity diagrams by themselves. It is true that these diagrams are not simple to create but they allow complex system/interaction processing to be represented efficiently. In order to get round this obstacle, we advised educators to produce a use-case diagram (in our example, a use case-diagram detailing the *Testimonies analysis* <<<activity-structure>>>) for identifying the activities of interest and their relationships; information technology designers used such sketches for discussion purposes with them; and together they produced the final 80% solution presented in Figure 10. Interestingly enough, once this deadlock was broken, educators were able to go further in the conceptual design process.

From this set of observations, we learned that when using CPM diagrams for modeling a learning/tutoring scenario, it is important to capture the requirements at a high level of abstraction. Whatever the diagram, the perspective must remain simple. Such an approach allows designers to emphasize important model elements while hiding low-level processing details. Indeed, such details may even obscure the model’s true purpose, which is:

- To identify key activities and dependencies
- To promote exchanges and communication in the ID team.

This is particularly true when drawing activity diagrams. In our experiments, some of these proved to be potential deadlocks that frustrated most educators during the design process. Dedicated cognitive tools (wizards, to-do-lists, etc.) could probably give them more confidence; but we consider that the correct answer will rely on efficient communication in the ID team. With this in mind, sketches (even when they represent intermediate design results) can now play a central role in enhancing such communication.

Lesson U2, Observation 2: *CPM contributes to producing both stratified and multiple perspectives for a given learning scenario. This combination is a key-factor to enable a designer team to collaboratively determine the constraints under which a Technology-Enhanced Learning (TEL) system is to be designed.*

UML is a widely accepted language to describe software systems. With the different perspectives of a TEL system that CPM offers, our profile adopts the same fundamentals (UML notation, UML semantics which we specialized with the CPM meta-model semantics) to also describe the educational context:

- At conceptual level, the language addresses the need to manage educational requirements effectively.
- At functional level, the language addresses the need to describe the required functionality of a TEL System in tune with such educational requirements.

Whatever the design level (conceptual vs. functional), it is very important therefore to communicate design decisions (and understanding) in an unambiguous form to all partners involved in the ID Team (including educators, information technology specialists and platform of learning developers).

In the previous subsections, we showed that CPM enables designers to produce multiple perspectives for a learning scenario. These perspectives favor coherent, unambiguous (within the limit of the UML semantics) but intelligible design decisions. The conducted case studies have also demonstrated that to reach such a goal, these multiple perspectives of a learning scenario should be correctly stratified. During the GEODOC case study, we noticed that, from the very beginning of the design process, some geographers were trying to map some educational goals with functionalities of the Geographical Information System viewer which they had been used to working with previously. Such design decisions were problematic because on the one side, educational goals had yet to be further detailed and on the other, such a detailed analysis failed because the designers were mixing conceptual and functional model elements.

The main gains of a correct stratification are modularity and design simplicity (i.e., Lesson U2-Observation 1 in the previous subsection). Modularity allows easier adaptability when changing requirements; it also allows clear separation of the domains of trust. By starting with the most fundamental educational factors (conceptual design) and designing them to be contextually appropriate, we were able in the course of the conducted case studies to build successive layers design and eventually reach functional design.

Figure 12 is an activity-diagram which exemplifies the frontier between conceptual and functional design. In this figure, some activities denote a <<CPL>> stereotype that represents a functionality offered by concrete software components. Such components may be those provided by most learning platforms (e.g., a

quiz component, a lecture component, a forum component, a whiteboard component, etc.) or they may be specialized components in relation with the domain to be taught (e.g., a Geographical Information System viewer).

In Figure 13, the <<CPL>> stereotypes denote different functionalities that specialize a forum component: Depending on his role, a concrete actor will register differently; the teacher role has rights to add a topic in the forum while the learner role can write entries for the topic that is currently covered.

Both figures were produced in SMASH PBLs to denote the Reciprocal teaching pattern (Palincsar and Brown 1986). The term “reciprocal” describes the nature of the interactions each person has in response to the other(s). Teacher and student take turns assuming the role of a dialogue leader (see Figure 13); sequencing of the concrete activities performed by both roles is formalized by the dedicated swimlanes in Figure 12. The ID team chose this pattern because the designers wanted the students to improve their reading comprehension of the available SMASH testimonies; the designers also wanted them to learn to monitor their own learning and thinking. Thus, in SMASH PBLs, learners’ peers are key actors in the reciprocal teaching pattern. These actors successively play the role of the teacher and the role of the student when trying to understand texts or interviews. Figure 12 details how they move from one role to another and what the responsibilities of each role within the collaboration are. For each text (interview), the teacher role has to select one text. The specification states that the teacher role is the one that formulates statements about his reading and understanding but that the student role is the one that can ask questions and which, at the very end of the discussion, will formulate the agreed statements that can be inferred from the reading.

Detailing how such functionalities should be implemented in a specialized forum is outside the scope of CPM. But the layered nature of CPM

Figure 12. An activity diagram for the reciprocal teaching pattern

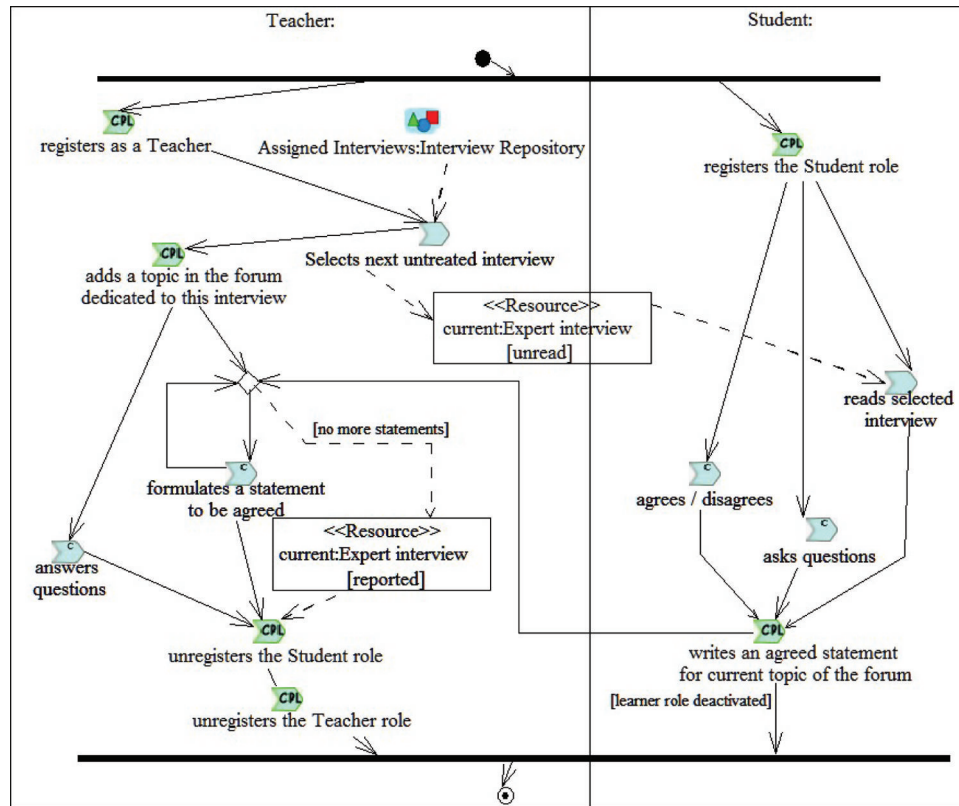
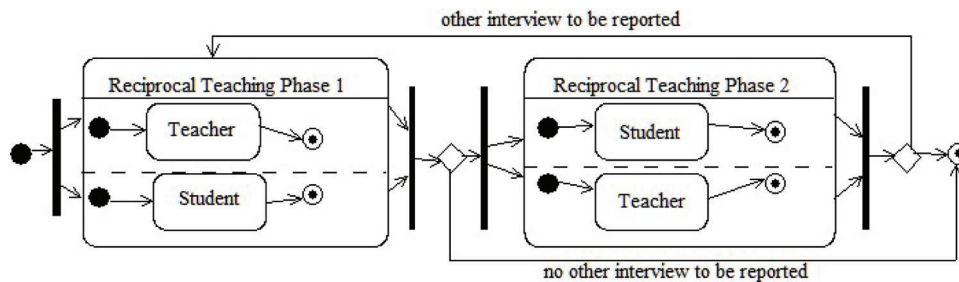


Figure 13. UML state-machine diagram describing both steps of the reciprocal teaching pattern



contributes to the smooth (top-down or bottom-up) transition between the different domains of trust.

Both lessons presented in this section lead us to the following conclusions: even though CPM was specified as a language and not as a design method, experience gained from our case studies enables us to promote a design process in tune with the characteristics of the CPM language. UML is a language; so is CPM. Current object-oriented

methods focus on the specification of the static structure of software objects. A noticeable deficiency of these methods is that they do not provide any help on how requirements are refined, how class diagrams can be derived from scenarios, how to specify the active/dynamic parts of a system, or how such a specification may be transformed into an implementation.

During conceptual design, the analysis of the different case studies that we have conducted promotes the idea of bridging the gap between educational needs elicitation (including requirements elicitation, requirements refinement using a combination of use-case diagrams, of activity diagrams, of class diagrams and state-machine diagrams), and the more formal specification of class diagrams which are required to prepare the implementation of a TEL System (Nodenot, Marquesuzaà, Laforcade, & Sallaberry, 2004). The way we used CPM language is as follows. The specification process starts from the definition of use-cases. Each use-case diagram is refined either by other use-case diagrams or by one or more activity diagrams (representing teaching/learning scenarios). All model elements used in these diagrams are not unrelated parts; they are attributes, messages, etc. which are finally declared in the class diagrams. The behavior of each class is represented by a set of scenarios (activity diagrams/state machine diagrams) covering the events declared in the specification part of the class.

CONCLUSION AND PERSPECTIVES

CPM is a visual, layered, semi-formal, multiple perspectives language dedicated to the description of collaborative learning scenarios with special emphasis on problem-based learning (PBL). By means of the layering mechanism, designers may more easily tackle a complex situation using this graphical and conceptual feature: they start with a coarse-grained description to grasp the global situation and can then decompose each element to get a complete and detailed description (Lesson U2 Observation 1). Next, with the multiple perspectives mechanism, the designers may focus on the sequencing of activities, the behavior of a particular activity, role responsibilities, *etc.* A complex situation may be described through a set of simple and clear views (Lesson U1—Ob-

servation 2). Equally, the combination of these two mechanisms promotes collaboration within a team of designers (Lesson U2—Observation 2). Finally, as CPM is dedicated to a specific type of learning situations, it allows the designer using it to be more likely to be able to describe such situations more quickly than with more general educational languages like IMS-LD. According to model-driven approaches like OMG-MDA (OMG, 2003), these specialized (but limited) languages offer conceptual frameworks for preliminary analysis of learning situations before transforming the resulting models into more operational languages.

Lessons presented in this chapter also reveal some possible ways to improve CPM.

Improvements of CPM

Computer Support for Design Processes

Modeling learning situations is not an easy or usual task for practitioners. Among the several reasons that account for this, we might mention the two most obvious ones. First, practitioners seek to adapt their courses to learners *in situ*, as events occur/happen (opportunistic approach) and they tend to prefer to think in terms of content and coarse-grained activities. Second, in educational sciences, models are driven by learning events to detect and to react upon, rather than by a mere sequence of activities which are more typical within the computer world (i.e., workflow sub-domain). So practitioners are not used to getting involved in highly structured course modeling in their everyday routine. Because we are aware of this, we have already proposed guidelines related to CPM through ‘best-practices’ (Lesson U1-Observation 2) and a design process (Lesson U2-Observation 3) in order to help practitioners. Kent (2002) already pointed out the problem of ‘how to define a model’. He defines it as a

main hindrance for the emerging model driven engineering trend. While he generally highlights work about macro-processes ('the order in which models are produced and how they are coordinated'), Kent affirms the need for the MDE community to work on micro-processes, that is to say 'guidelines for producing a particular model'. We consider therefore that we need to improve *CPM micro-processes*. A related perspective must be to provide a computer support for our guidelines. First, such a support will make the application of guidelines easier (and accelerates it). Next, it limits the occurrence of errors caused by the misinterpretation of guidelines. Finally assisting the definition of a model allows designers to learn guidelines in a better way than by only reading the related document.

We have already worked on the computer support for a method dedicated to IMS-LD (Le Pallec, Moura, Marvie, Nebut, & Tarby, 2006). We intend to transpose this previous work to CPM.

Templates

Starting from scratch is another barrier to practitioners when defining models. The *Objecteering* repository provides a way of reusing existing and approved fragments of CPM models (i.e., Figure 12). UML templates address this issue much better. A UML template is a set of parameters to be applied to model elements before use. Such models have the advantage of clearly rendering explicit both the fixed part and the changing part of a model. Equally, defining a template is driven by reusability and modularity which is not the case when defining new model elements duplicated with copy/cut/paste. The application field of a template is consequently broader. However, using this mechanism, particularly when defining a template, is not an easy task, especially for a non-UML specialist. Even if *Objecteering* may provide a UML template mechanism, future work will likely involve embedding it into a more user-friendly interface.

Model Transformations

The different CPM perspectives are not entirely bound together. The attribute *Testimonies analysis* of *Investigator role 4* (i.e., Figure 10) is not automatically but manually 'deduced' from the link *performs* between *Investigator role 4* and *Testimonies analysis* (i.e., Figure 7). If the link *performs* is removed, the previous attribute will not be automatically removed. Not to impose constraints about the ubiquity of model elements can provide much freedom, and hence flexibility while defining models, especially for practitioners. But in addition to being a source of mistakes, it does not render explicit the repercussion of each action which the designer is performing. To address these two problems, we might consider, for example, developing dynamic transformations between all perspectives so that each action from a perspective should induce logic repercussion on other perspectives. These transformations would be proposed to designers through clickable operations.

Towards Other Conceptual Frameworks

UML and its profile mechanism offers a framework which may prove quickly efficient. First it provides several types of diagrams which enable many aspects to be described. Second, several design processes have emerged from the UML community over the last decade. They describe best-practices related to navigation between previous types of diagrams. Nevertheless, there are some weaknesses. First, defining new modeling concepts with a UML profile requires using (through inheritance) existing UML metaclasses like *Class* or *Actor*. UML profile designers do not necessarily need all inherited attributes or methods. They have to block access to these undesirable properties both in conceptual and graphical ways to respect the semantic of the language they are

designing (this can be achieved through OCL constraints or through *Jcode* (Objectteering, 2006) in case *Objectteering* is used). It is a complex and tedious process if we consider the definition of graphical languages for complex, condensed and non-software engineering meta-models (like IMS-LD). In addition, an efficient profile (that is to say, with conceptual and graphical filtered accesses) generally works only with the UML tool used to define it.

Lastly, for the time being, it is difficult to provide practitioners with a totally free UML-based model editor given that UML efficient tools are still expensive. Moreover using a UML profile means requiring the use of a whole software engineering oriented environment which may constitute a handicap for practitioners.

It is therefore important to explore alternatives like OMG-MOF (OMG, 2007) or Eclipse/EMF (EMF, 2007) environments. Based on a meta-modeling approach, they present some advantages. For example, defining a language starts with defining a meta-model (abstract syntax) which is not created from existing concepts but from scratch. So, there is no need to filter access to model elements because of undesirable inherited features. Another useful functionality of EMF is that creating a meta-model may be done simply by analyzing an XML schema or a DTD. Additionally, there are currently powerful graphical tools like TopCaseD (Farail et al., 2006) and the forthcoming GMF (GMF, 2007) which both allow defining an efficient graphical syntax for a language (concrete syntax). There are of course other facilities which are not as efficient in the UML community, like model transformation engines (GMT for Eclipse (GMT, 2007), YATL for MOF-based models (Patrascioiu, 2004)) and code generation engines like JET (JET, 2007).

But we believe it is still very important to see beyond technology and to maintain a global awareness of how organizational, social and technical issues are impinging on the usability of VIDL.

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Chapter 1.13

History of Distance Learning Professional Associations

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INTRODUCTION AND BACKGROUND

Most of the distance-learning professional associations were founded in the 1990s, at a time when most Internet backbone speeds were T1 or slower. Although scientists in universities, corporate, and military used the Internet for supercomputing capabilities, the predominant academic application was electronic mail. The public was generally unaware of the Internet's existence.

The explosive growth of information and telecommunications has combined to strengthen and diversify the options for school, skills development, technical and professional training, postsecondary credit courses, and special interests. New associations are established everyday to promote innovative educational strategies, as well as ways to leverage technology to provide new ways

of learning online. Each strategy suggested has some measure of support among the professional associations' participants, and represents a way to improve opportunities for distance education, and training:

1. Developing strategic alliances to support and encourage project-oriented coalitions amongst members as the need and opportunity arise.
2. Recommending standards of quality
3. Institution promotion under a common logo within the region and beyond
4. Identifying support markets that are currently unserved.
5. Sharing technological and human resources for development and delivery
6. Conducting applied research and development of distance-education technology and instructional design.

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7. Developing and maintaining a system to provide a central source of current and relevant information on courses and programs, the credit transfer system, and student assistance programs.

MAIN FOCUS: DISTANCE LEARNING PROFESSIONAL

North America

United States

In the U.S., the Director of the Office of Educational Technology in the Office of the Secretary for the U.S. Department of Education is responsible for coordinating programs and policies on virtual education and e-learning, the National Education Technology Plan, Technical Assistance Grants under Enhancing Education Through Technology, and the use of technology to further the mission of the Department and the No Child Left Behind Act (2006).

Founded in 1987, FARNET, the Federation of American Research Networks, was a primary information source for the government and industry during the preprivatization days of the Internet. FARNET's original mission was to coordinate regional and backbone high-speed networks, to promote the general advancement of science and education by assisting in the interchange of information and research using high-speed communication.

Later on, FARNET developed into a forum for state networks to share information. Beginning in the early 1990s, FARNET hosted a series of workshops discussing how the National Information Infrastructure (NII) and the Internet might impact the public sector, including healthcare, libraries, and K-12 education.

In 1995, FARNET opened a policy office in Washington, D.C. to monitor the regulatory environment and communicated developments back

to its membership via an e-mail newsletter called "FARNET'S Washington Update."

In 1996, FARNET received an NSF award to build a clearinghouse for tracking information infrastructure development on a state-by-state basis. The purpose of the States Inventory Project (located at <http://www.states.org/>) is to promote the exchange of information among state and local policymakers so that states may develop their own information infrastructures more efficiently. The State Inventory Project clearinghouse currently has over 4,000 entries in its database, divided into nearly 100 categories for each state, territory, and province.

One of the early associations, the Coalition for Networked Information (CNI, <http://www.cni.org/timeline.html>), was founded in 1990 by the library and information technology communities to enhance scholarship and intellectual productivity. At the end of its first year, CNI has 118 member institutions. In the early years, on their meeting agenda were contemporary issues such as economics of information, Rights for Electronic Access and Delivery of Information (READI) project, Elsevier TULIP Project (one of the earliest examples of instrumented large-scale experiments in electronic journal delivery), Wide Area Information Servers (WAIS), introduction of Gopher (an early tool to find and retrieve directories of information on the Internet), Electronic Theses and Dissertations, and the demonstration of NCSA's Mosaic, the first graphical Web browser.

In 1996, CNI cosponsored a conference, Networked Information in an International Context, with the UK Joint Information Systems Committee, the British Library, CAUSE and the First ACM International Conference on Research and Development in Digital Libraries. As the result of the conference, the Internet 2 Project was launched. CNI was represented on the Applications Council to launch the Internet 2 Project, and worked closely with this effort to help identify advanced networking applications. These associations together facilitated the starting plans of Internet 2,

which is an effort to establish higher education's leadership role in Internetworking.

EDUCOM is another early organization for the enhancement of information technology in higher education. The mission of EDUCOM is as follows: "EDUCOM is a nonprofit consortium of higher education institutions, which facilitates the introduction, use, and access to and management of information resources in teaching, learning, scholarship, and research. EDUCOM's work is done in cooperation and partnership with the broader education and library communities, professional societies, and information industries."

In the 1990s, EDUCOM focused on:

1. Increasing individual and institutional intellectual productivity through access to and use of information resources and technology.
2. Assuring the creation of an information infrastructure that will meet society's needs into the twenty-first century.

EDUCOM's Networking and Telecommunications Task Force (NTTF) monitored the education telecommunications-related changes of the federal government. NTTF was created in 1986 as a vehicle to provide leadership and focus for colleges and universities in identifying and communicating strategic networking and telecommunication policy issues. Its membership is composed primarily of chief information officers from leading universities.

In 1988, NTTF organized the first in what has become an annual conference in Washington, D.C. This conference brought together leaders from government, industry and the public sector to discuss the latest developments in telecommunications policy.

CAUSE is the Association for the Management of Information Technology in Higher Education (<http://www.cni.org/docs/infopols/CAUSE.html>). The mission of CAUSE is:

- To promote more effective planning, management, and evaluation of all information technologies in colleges and universities.
- To help individual member representatives develop as professionals in the field of higher education technology management.

In direct response to the changing nature of campus computing organization and management, CAUSE expanded its mission to reflect an expansion from an earlier focus on administrative computing to incorporate the planning and management of administrative computing, academic computing, telecommunications, and other information technologies in colleges and universities.

EDUCOM and CAUSE were consolidated in July 1998 with a mission to advance higher education by promoting the intelligent use of information technology. While CAUSE's FARNET primarily has concentrated on issues related to Internetworking, EDUCOM's NTTF has been actively involved in a broader range of telecommunications policy issues. Both FARNET and NTTF have played distinct and important roles in the initial development of the Internet in the academic and broader public sector communities. In early June 1998, FARNET merged with then- EDUCOM's NTTF to become Net@EDU, the networking arm of EDUCAUSE, to ensure that the organization maintained an effective policy presence in Washington. Their union within EDUCAUSE allows EDUCAUSE to be more effective as a policy and information resource for its members in the academic/research community.

The membership of EDUCAUSE is open to institutions of higher education, corporations serving the higher education information technology market, and other related associations and organizations. Its programs include professional development activities, print and electronic publications, strategic policy initiatives, research, awards for leadership and exemplary practices, and other online information services. As of spring, 2007,

the EDUCAUSE membership has grown to more than 2,100 colleges, universities, and educational organizations, including 200 corporations, with 16,500 active members. EDUCAUSE has major offices in Boulder, Colorado, and Washington, D.C. It hosts conferences, seminars, and institutes.

The EDUCAUSE regional conference on Information Technology in Higher Education includes the following:

- EDUCAUSE Mid-Atlantic Regional, Midwest Regional, Southeast Regional, Southwest Regional (formerly EduTex), Western Regional, and NERCOMP (An EDUCAUSE Affiliate).
- The CAUDIT -EDUCAUSE Institute is an international event offered every year in Australia/New Zealand.

In addition to CNI, EDUCOM, and EDUCAUSE, there are several other associations that promote distance education. United States Distance Learning Association (USDLA, <http://www.usdla.org>) promotes the development and application of distance learning for education and training. It is a non-profit national association formed in 1987 by Patrick Portway, Smith Holt, and Ralph Mills. The constituents it serves include K through 12 education, higher education, continuing education, corporate training, and military and government training. The Distance Education and Training Council (DETC, formerly the National Home Study Council, <http://www.detc.org/>), founded in 1926, is an association of accredited distance learning/correspondence schools that is dedicated to promoting the high quality in learning opportunities to learners of all ages, regardless of where they live.

American Distance Education Consortium (ADEC, <http://www.adec.edu/>) is a consortium of higher education institutions in the United States that provide distance-education programs via ICT, provides links to member universities, learning resources, and courseware tools.

There are numerous distance-learning professional associations on the regional level. To name a few, the Texas Distance Learning Association (TxDLA, <http://www.txdla.org/>) is a private, non-profit association for distance-learning professionals. TxDLA membership is open to all individuals, statewide, nationwide, and around the world, who are interested in promoting the implementation of effective distance learning. The Centre for Distance Learning Research located at Texas A&M University also sponsored an annual conference Distance Education Conference in Texas (DEC, <http://www.cdler.tamu.edu/>)

Canada

Canada has a long tradition in distance education, arising from the need to provide access to education across the vast expanses of the country.

The Commonwealth of Learning (COL, <http://www.col.org/>) is an intergovernmental organization hosted in Canada by the government of Canada with headquarters located in the Province of British Columbia. It was created by Commonwealth Heads of Government to encourage the development and sharing of open-learning/distance-education knowledge, resources and technologies. As of spring 2006, COL's partners include other Commonwealth agencies, members of the UN System (UNESCO, UNICEF, UNIFEM, UNDP, and the World Bank), national and regional distance education associations, and industry.

Computer Using Educators of British Columbia (CUEBC) <http://www.cuebchorizons.ca/>, and Canadian Association for Distance Education (CADE) <http://www.cade-acad.ca/>, are another two associations in Canada that promote innovative educational strategies, as well as ways to leverage technology to provide new ways of learning online, in the classroom, and in the workplace.

NODE Learning Technologies Network (Network for Ontario Distance Educators) or the NODE (<http://www.thenode.org>) was established in 1996 as the Network for Ontario Distance Educators.

The initial objectives were to promote cooperation among distance educators in universities and community colleges in the province of Ontario, Canada, and to provide leadership for their exploration of new learning technologies. Soon their efforts attracted a wider audience of international community of educators.

Other Canadian associations such as Alberta Distance Education and Training Association (ADETA) (<http://www.athabascau.ca/html/collab/adeta/>), and Canada's Campus Connection (<http://www.schoolnet.ca/campus/en/index.html>) are collaborations between the postsecondary institutions voluntary, non-profit association of individuals and corporate members who are interested in distance education and training.

Australia/New Zealand

The Australian National Conference on Open and Distance Education (ANCODE) held its first meeting in October, 1993. This conference was established to succeed the National Distance Education Conference set up by the then Department of Education, Employment, and Training (DEET). In 1996, the name of the conference was changed to the National Council on Open and Distance Education (NCODE) as part of a process of defining the mission of NCODE.

NCODE-Flexible Learning Australasia was created in 2000 as a result of the restructuring of the former NCODE. In December 2000, the members voted to extend membership to universities in the region and change the name of the organization to NCODE-Flexible Learning Australasia. NCODE - Flexible Learning Australasia became the Australasian Council on Open, Distance, and E-learning (ACODE, <http://www.acode.edu.au/>) in December 2002 with the ratification of a constitution and a new name. The mission of ACODE is "to enhance policy and practice in open, distance, flexible and e-learning in Australasian higher education."

Australian Association of Distance Education Schools (AADES, <http://www.aades.edu.au/>) was formed in 1993 and, as of spring 2006, has in excess of 1,200 members in all Australian states and New Zealand. It is the professional organization representing K-12 school level distance education in the region.

The Open and Distance Learning Association of Australia Inc. (ODLAA, <http://www.odlaa.org/>) is a professional association of members interested in the practice and administration of distance education and open learning. Its membership is open to all persons, organizations and groups interested in the practice and the administration of distance education.

The Distance and eLearning Association of New Zealand (DEANZ, <http://www.deanz.org.nz/>) is a national association committed to fostering growth, development, research, and good practice in distance education, open learning, and flexible delivery systems for education. Its membership is open to individuals or institutions with an interest in distance education and open learning.

Europe

Established in 1991, the European Distance and E-Learning Network (EDEN, <http://www.eden-online.org/eden.php>), is one of the oldest European associations for open, distance and e-learning. Its aim is to foster developments in this constantly evolving field of distance education. Its members include a wide range of institutions including the following countries: Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Federal Republic of Yugoslavia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Ukraine, United Kingdom. Institutions from other parts of the world such as U.S., Israel, South Africa, Canada, and Mexican have also joined.

EDEN supports several workshops, conferences, and journals and publications. Among them, the *European Journal of Open and Distance Learning (EURODL)* is an online journal on open and distance and e-learning.

The European Commission adopted several action plans to promote the development of online education by European universities.

Adopted in 2000, the “eLearning: Designing Tomorrow’s Education Action Plan” aims at promoting digital literacy in Europe. This 3-year plan envisions communication technologies like digital television and satellites playing a larger role in European higher education and training systems.

The “eEurope 2005 Action Plan” was endorsed by the Council of Ministers in the eEurope Resolution of January 2003 aiming to develop modern public services for business and education alike through widespread availability of broadband access at competitive prices and a secure information infrastructure.

One of the e-learning projects supported by the European Commission is EQUOL, which stands for “e-quality in e-learning.” This project establishes a virtual center of excellence that involves key researchers and e-learning practitioners from European institutions of higher education.

One of the latest initiative, “i2010” (European Information Society in 2010, http://europa.eu.int/information_society/eeurope/2005/index_en.htm), will provide an integrated approach to information society and audiovisual policies in the EU, covering regulation, research, and deployment and promoting cultural diversity.

In addition to the government initiatives, the European Association of Distance Teaching Universities (EADTU, <http://www.eadtu.nl/>) is the representative organization of both the European open- and distance-learning universities and of the national consortia of higher education institutions in distance education and e-learning. Based in the Netherlands, EADTU was established in January 1987 by the principals of Europe’s distance-teaching institutions to foster coopera-

tion between European organizations dedicated to higher education through distance-teaching methodology.

Established in 1998, European Federation for Open and Distance Learning (E.F.ODL <http://www5.vdab.be/vdab/test/efodl/top.htm>) is a pan-European network of open and distance learning that provides services to organizations involved in the development, distribution, and use of technology-based open and distance learning.

The European Open and Distance Learning Liaison Committee (ODL, <http://www.odl-liaison.org/>) is another influential non-government organizations in Europe. Established in 1998, the liaison committee agreed to meet on a regular basis and to create a common platform that would be an added value for the networks.

The founder members of the ODL Liaison Committee are:

- Association of European Correspondence Schools (AECS), since 1999 new name: European Association for Distance Learning (EADL).
- Coimbra Group
- EuroPACE 2000
- European Association of Distance Teaching Universities (EADTU)
- European Distance and E-Learning Network (EDEN)
- European Federation for Open and Distance Learning (EFODL)
- European Universities Continuing Education Network (EUCEN)
- International Council for Open and Distance Education - Europe (ICDE-Europe)
- Network of Academics and Professionals (NAP)

Other European associations of distance education are such as Research and Training Institute of East Aegean (<http://www.ineag.gr>) and The Open Learning Foundation (OLF, <http://www.olf.ac.uk/>) is a consortium of UK and European

universities and colleges dedicated to improving the effectiveness and flexibility of higher education. Site includes details of current projects and a catalogue of publications geared to specific online courses, graded by level, in order to provide a cost-effective way to develop flexible learning materials and staff development in their uses.

There are hundreds of distance-education professional associations on the national and regional level in Europe. For example, the Irish Learning Technology Association (ILTA, <http://www.ilta.net/>) has been in existence since spring, 2001, and has a membership throughout the island of Ireland. The British Association for Open Learning Limited (BAOL, <http://www.baol.co.uk>) is an association for open learning in the United Kingdom. Its goals are to build a community with global reach, committed to innovation, excellence, and best practice in learning.

Here is a brief list of other European distance education professional associations:

- British Educational Communication and Technology Agency (BECTA, <http://www.becta.org.uk/>)
- Open Distance Learning Quality Council (ODLQC, <http://dspace.dial.pipex.com/odlqc/>)
- Online EDUCA Berlin (<http://www.online-educa.com/>)

Latin America

In the series of Online EDUCA conferences, Online EDUCA Madrid (<http://www.online-educa-madrid.com/>) is organized in Spain with the aim to encompass Spain, Central and South America, and the rest of the Spanish speaking populations in the e-learning industry. The official conference language is Spanish. Since 2003, over 500 distance education administrators in higher education, business, and government from more than 30 countries come together at Online EDUCA Madrid, making it the key networking venue in

the rapidly expanding sector of e-learning in the Spanish-speaking world. EXPOCAMPUS is a parallel event that takes place alongside the Online EDUCA Madrid conference (<http://aedisi.org/>). This is another forum for e-learning experts of the main Spanish and Latin American universities, which adds further academic value to this international gathering of e-learning professionals in Latin America.

Consorcio - Red de Educacion a Distancia/ Inter-American Distance Education Consortium (CREAD, <http://www.cread.org/>) was founded in 1990 at the International Council for Distance Education World Conference in Caracas, Venezuela. CREAD is composed of a vast network of individuals and institutions throughout North, Central, and South America, conjoining resources and expertise to redefine educational partnerships in the 21st century.

Asociacion Iberoamericana de Educacion Superior a Distancia (AIESAD, <http://www.uned.es/aiesad/>) is another distance education professional association in Latin America.

Middle East

Among the various distance-education professional associations in the Middle East, the Middle East E-Learning Technologies (MELT) is also called the Middle East Learning Technologies Forum. It is a series of conferences and exhibitions coupled with a trade show in Dubai and the Middle East region for e-learning in the Middle East world. The mission of MELT is as follows:

- To provide e-learning buyers/users with objective, well-documented learning from international e-learning experiences in enterprise.
- To provide e-learning buyers/users with objective, well-documented learning from international e-learning experiences in enterprise.

- To provide business executives with a clear overview of e-learning, its potential, its benefits, critical success factors, components, and lesson's learned so far.
- To provide ME e-learning professionals with in-depth tracks on hot topics such as managing and measuring the benefits, instructional design, localization, and so forth.

Other major conferences in the area include the Middle East Forum on Learning Technology, the Global Training and Human Resource Development Forum, the Gulf Education and Training Exhibition, (GETEX), and the Middle East Forum on Academic Research and Reflection.

The Arab Open University (AOU, <http://www.arabou.org/>) is developing a Web-based curricula, and partnering with UNESCO to establish a telecom network between university branches in nine countries. It was established in 1996 under the umbrella of the AGFUND (Gulf Program for United Nations Development Organizations). It has been adopted as a private Arab institution of higher education of special status. The AOU launched its teaching programs in October 2002 in a number of Arab countries including, in the first stage, Kuwait (where the AOU Headquarters is seated), Lebanon, Jordan, Bahrain, Egypt, and Saudi Arabia. AOU has a goal of reinforcing solidarity and unity between Arabs through culture and education.

Africa

One of the earliest African distance organizations, South African Institute for Distance Education (SAIDE, <http://www.saide.org.za/>) was formed in 1992 to assist in the reconstruction of education and training in South Africa by promoting open learning principles and the use of quality distance education. SAIDE cooperates with educational institutions, as well as national and provincial

governments, to translate these approaches into practice.

In view of the fact that developing countries have not benefited from the growth of online resources on distance education, UNESCO has partnered with World Bank in developing a consolidated information database in sub-Saharan Africa called the Sub-Saharan African Open and Distance Learning Knowledge Base (<http://www.africaodl.org/>). The purpose of this knowledge base is to offer an integrated knowledge guide to distance education and open learning. The components of the knowledge base include selected readings, reports of good practice, and other information tools.

Confederation of Open Learning Institutes of South Africa (COLISA, <http://www.col.org/10th/best/colisa.html>) was founded by the University of South Africa, Vista University, and Technikon Southern Africa. It aims at communication between the constituent parties on both academic and administrative levels, organizing workshops, discussions and conferences, creating a forum for sharing of expertise, and establishing a Development Fund for the furtherance of the Joint activities.

Adult Education Network (AEN, <http://home.global.co.za/~proplib/>) promotes the activities of its members, which include clubs, associations, special interest groups, and service organizations in South Africa.

The main objective of the Acacia Initiative (the South African Academic and Research Network, http://web.idrc.ca/en/ev-5895-201-1-DO_TOPIC.html) is to provide a computer network that works to the standards of the Internet, for the use of every academic, researcher, and student in South Africa.

Asia and Pacific Islands

One of the earliest professional distance education organizations, Asian Association of Open

University (AAOU, <http://www.aaou.net/>) was founded in 1987 by a number of open universities in the Asian region as a non-profit organization of higher learning institutions with distance education programs. As of January 2005, there are 71 members in AAOU including 38 full members, 31 associate members, and 2 individual supporting members.

Funded by the Chinese government, the China Education and Research Network (CERNET, <http://www.edu.cn/HomePage/english/index.shtml>) is the first nationwide education and research computer network in China. CERNET plays a pioneer role in China's information initiative such as online enrollment and admission system for universities around the country.

Since its establishment on 27 February 1997, South-East Asian Ministers of Education Organisation Regional Open Learning Center (SEAMOLEC, <http://www.seamolec.or.id/>) has a mission: To assist SEAMEO Member Countries in identifying educational problems and finding alternative solutions for sustainable human resource development through the dissemination and effective use of open and distance learning. Its member countries include representatives from Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam.

The educational division of the UNESCO-Bangkok office fosters educational innovation and research in support of development by sponsoring the Asia-Pacific Programme of Educational Innovation for Development (APEID, <http://www.unescobkk.org/education/aceid/apeid.htm>).

APEID promotes regional cooperation by forming a network of institutions, called Associated Centres, across the region to facilitate educational innovations and, assist Member States build national capacities according to the self-perceived needs of the countries themselves. Associated Centres benefit from the exchanges of insights,

skills and expertise promoted. The APEID-related functions of the Associated Centres include:

- Sharing of innovative experiences with other centres in the network
- Organizing national, sub-national or regional APEID activities such as training workshops, seminars, and development of instructional materials
- Participating in the design, conduct, evaluation and follow-up of the inter-country/inter-project visits and studies
- Participating in the exchange of personnel with other centres
- Facilitating the dissemination and exchange of information on educational innovations related to development.
- Cooperating with other centres in projects of mutual interest and concern

As part of its support for international distance education, COL has sponsored research and planning into the design of telecommunications networks, specifically targeted to the needs and resources of smaller distance education organizations.

The Indira Gandhi Open University (IGNOU, <http://www.ignou.ac.in/>) was established in 1985 with a networking of Regional Centres and Study Centres, all over India. IGNOU has also set up a collaborative project with open universities in Pakistan, Bangladesh, and Sri Lanka. It has also crossed national boundaries, providing higher education as well as assisting other developing countries.

Pacific Islands region contains a large proportion of small states, concentrated in the South and Western Pacific, as well as many key distance-education institutions. The Pacific Islands Regional Association for Distance Education (PIRADE, <http://www.col.org/pirade/>) is sponsored by Commonwealth of Learning.

FUTURE TRENDS AND CONCLUSION

International Center for Distance Learning (ICDL, <http://www-icdl.open.ac.uk/>) of the Open University of UK has established a research center for teaching, consultancy, information, and publishing activities, based at the Institute of Educational Technology (IET). It hosts an extensive database containing more than 300 distance-learning providers worldwide, over 12,000 thousand books, journal articles, research reports, conference papers, dissertations, and other types of literature relating to the theory and practice of distance education; contains a link to free online distance education database.

International Council for Open and Distance Education (ICDE, <http://www.icde.org/>) is a long established international association affiliated with SEAMEO and recognized by UNESCO. Its goal is to provide leadership and facilitate cooperation, development, and communication at the global level in distance and virtual learning. It has global membership of educational institutions, national and regional associations, corporations, educational and agencies in the fields of open learning and lifelong learning

COL has supported the communications of associations for distance-education professionals, and has facilitated the formation of a pan-Commonwealth federation of these associations called Federation of Commonwealth Open and Distance Learning Associations (FOCODLA, <http://www.col.org/focodla/members.htm>). The following regional associations have joined FOCODLA:

- Distance Education Association of Southern Africa (DEASA)
- Distance Education Association of Tanzania (DEATA)
- Open Learning and Distance Education Association of Eastern Africa (OLDEA-EA)

- National Association of Distance Education Organisations of South Africa (NADEOSA)
- West African Distance Education Association (WADEA)
- Zambia Association for Distance Education (ZADE)
- Zimbabwe National Association of Distance and Open Learning (ZINADOL)

The International Association for the Study of Cooperation in Education (IASCE, <http://www.iasce.net/>) is an international non-profit educational association dedicated to the study and practice of cooperation in education, a field that includes the increasingly popular cooperative classroom methods by which students work together in learning teams to master academic content and collaborative skills.

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KEY TERMS AND DEFINITIONS

Commonwealth of Learning (COL): The Commonwealth of Learning (COL, <http://www.col.org/>) is an intergovernmental organization hosted in Canada by the government of Canada with headquarters located in the Province of British Columbia. It was created by Commonwealth Heads of Government to encourage the development and sharing of open learning/distance education knowledge, resources, and technologies. As of spring 2006, COL's partners include other

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EDUCAUSE: EDUCOM and CAUSE were consolidated in July 1998 with a mission to advance higher education by promoting the intelligent use of information technology. The membership of EDUCAUSE is open to institutions of higher education, corporations serving the higher education information technology market, and other related associations and organizations.

Its programs include professional development activities, print and electronic publications, strategic policy initiatives, research, awards for leadership and exemplary practices, and other online information services. As of spring, 2007, the EDUCAUSE membership has grown to more than 2,100 colleges, universities, and educational organizations, including 200 corporations, with 16,500 active members. EDUCAUSE has major offices in Boulder, Colorado, and Washington, D.C. It hosts conferences, seminars, and institutes.

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Chapter 1.14

Using Games to Teach Design Patterns and Computer Graphics

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ABSTRACT

This chapter discusses some possibilities of using computer games to effectively reach didactic goals in undergraduate teaching. Nowadays, undergraduate students belong to the Net generation and usually play different kinds of games on consoles, computers, and the Internet. Some elements such as creativity and abstraction could be included in computer science and information technology curriculums through the use of games as educational methodological resources, due the motivational

factor they inherently have. This learner-centered approach not only contributes to personalizing the knowledge-building process but also permits the consideration of learning styles to adapt different ludic environments and/or real-world situations according to topics of the course. To demonstrate the possibilities of this educational scenario, two case studies were conducted. One focuses on Design Patterns contents in a computer science course, and the other spotlights computer graphics topics in an information technology course. The results gained in these processes demonstrate the students' involvement in the proposed activities

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and the capacity to apply the lessons learned in diverse situations.

INTRODUCTION

The acquisition of skills related to creativity and abstraction, indispensable to any computer science and information technology curriculum, constitutes unquestionably a didactical challenge. From the educational point of view, the use of games in this process is a motivational element that could help to make the knowledge-building process more personalized. It is also possible to take into account students' learning styles, thus establishing an adaptive and flexible environment where any skill, subject, or even concept can be effectively learned (Prensky, 2007; Gee, 2003; Bransford, Brown, & Cocking, 2000).

Another aspect that must be considered is that actual undergraduate students belong to the so-called "Net generation" (Tapscott, 1998). According to Tapscott, "N-Geners" could be characterized by having autonomy sense, intellectual openness, technology inclusion (or the facility to use technological elements even though never having any previous contact with them), freedom of expression, curiosity, immediacy, and mainly trust. This scenario perfectly fits into a game universe-based andragogic proposal, because nowadays it is necessary to institute mechanisms that take advantage of technological culture over where they are steeped and transform it into learning resources. The same author also points out the need for an interactive learning posture where focus is learner centered and related to interaction with hypermedia-based systems in order to promote a lifelong learning from a customized—and mainly fun—point of view.

In this situation, professors could be, in a metaphorical way, considered analogous to game masters that guide and encourage players (the students) into a game (the educational process

itself) to play the game, face the challenges, and go through the next level (in other words, succeed in academic life). By exceeding curriculum demands, students could be able to enjoy a lifelong, meaningful learning experience (Ausubel, 1962).

In the role of gamer characters or game development, learners have the opportunity to compare, analyze, and experience situations similar to the real ones. When a student plays in this controlled environment or constructs them, it is possible to present fully inspiring situations where actions only occur in the virtual world, which contributes, among other factors, to reduce cognitive load.

Another consideration in this proposal is based on Shaffer's (2007) works, which focus real problem solving by role-playing a professional character that uses new digital technologies to assume his or her own learning process and institutes attitudinal changing by implementing epistemic games.

Nonetheless, teachers and students barely consider games as something detached from entertainment. The sole tentative of introducing "serious," non-entertaining games into a curriculum often causes the inverse effect, since these sorts of games tend to be tedious as they do not prime for the entertainment-related aspects that are responsible for retaining students' attention.

It must be remembered, although obvious, that the act of learning does not have to be a boring, unexciting situation that students are exposed for a significant part of their lives (Johnson, 2005). Instead, it must be a stimulating and—why not?—funny, entertaining activity to be performed by students. Thus, recovering the ludic side of learning is primordial to motivate students to learn the issues curricula tell them they have to.

Specifically in computer science and information technology areas, students often are already gamers; thus, they are completely aware of game strategies, terminology, and play. The introduction of game-related situations in their curricula has been a well-accepted operation, since games belong

to their cognitive comfort zone. Thus, given such familiarity with the pedagogical instrument—the game—even uncomfortable, hard-to-be-taught syllabi could make use of games in order to approximate curriculum subjects to students' social context (Sweedyk & Keller, 2005; Squire, 2002).

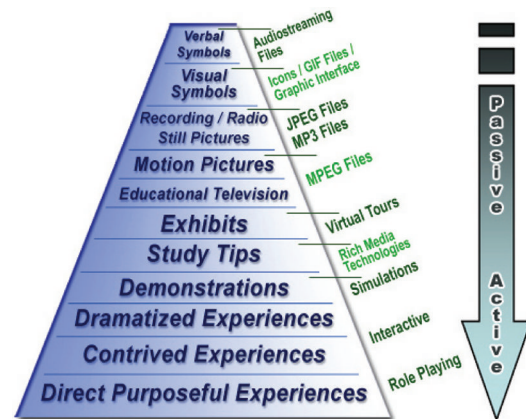
According to the elements previously presented, this chapter's main objective is to show how ludic aspects of electronic gaming could be used as motivation for advances studies in computer science and information technology undergraduate courses. This involves three aspects: the theoretical aspects of game playing as a contributing factor for constituting more autonomous, self-critical and inquirer students; how game-driven activities could be inserted in traditional curricula of such courses; and the demonstration of theory reviewed and discussed through analysis of two case studies about applying games in syllabi.

THE USE OF GAMES IN EDUCATIONAL PROPOSALS

An educational proposal based on games requires a different instructional design approach. In this special case, it is necessary to consider not only learning objectives, learning styles, contents, procedures, and other elements related to structure, such as methodology, evaluation, outcomes, and feedback (Mustaro, Silveira, Omar, & Stump, 2007; Reigluth, 1999). Games for education also demand the use of narratology—screen written and creativity components to develop a result that could be motivating, challenging, and enjoyable—being able to engage learners in a process where learn and play are combined into one.

This architecture can be established through the use of a learner-centered educational approach with adaptive systems that could take advantage of interactive media. The type of media or resource used in educational proposal influences learners' activity levels during the learning process (Dale,

Figure 1. Adapted Dale's Cone of Experience (Mustaro et al., 2007)



1969). According to this idea, it is possible to adapt Dale's scheme to the contemporary scenario (see Figure 1).

From the elements presented in the adaptation of Dale's Cone of Experience, games could be classified as activities with high levels of participation, which also amplifies information retention, making them more significant to students. This occurs because, through video games, learners can "interact with real rules while imagining a fictional world" (Juul, 2005, p. 1). Furthermore, game playing could be considered "an activity of improving skills in order to overcome...challenges, and playing a game is therefore fundamentally a learning experience" (Juul, 2005, p. 5).

According to Juul (2005) games present essentially two forms of providing challenges for players. The first is based on a combination/variation of a small set of rules (called *emergence*); the second is related to the level-based structure and sequence of events (denominated *progression*). Besides, the game universe developed for educational purposes also needs to consider knowledge and background abilities of students to present challenges that match the contextualization requirements, and they must also take into account Vygoysky's (1978) theory

about the Zone of Proximal Development (ZPD). This combination requires exploration of serious games' characteristics.

Bergeron (2006) pointed out that a serious game is mainly an interactive computer application that presents challenging goals, fun elements of engaging, and some score concepts, as well as provides knowledge, skill, or even attitudes that could be used in real-world situations. These concepts could be complemented with the following sentence: "To play a game is to improve... repertoire of skills, and the challenge of game design is to work with the skill set of the player through the game" (Juul, 2005, p. 5).

However, not only providing games to students could be effective, but it is also relevant to motivate them to develop their own games if possible, especially in computer science (CS) and information technology (IT) undergraduate courses. This approach can merge the Real Problem Solving approach proposed by Shaffer (2007) with Problem-Based Learning (PBL) developed by Barrows and Tamblyn (1980), thus exploring constructivist elements when considering previous knowledge and concepts of each student through the whole process of learning construction (Halverson et al., 2006).

In this situation, it is possible to retrieve concepts and knowledge, or even pieces of information to establish a relationship with new content. In a complementary way, it also allows one to experience solving problems that are similar or even equal to those that students usually find in their professional lives. According to Norman and Schmidt (2000), the use of PBL in curricula could improve knowledge retention, students' motivation, and self-learning capacity, and presents the capacity to transfer learned concepts to new scenarios. Because of that, the present research combines PBL with games to increase intrinsic motivation of students, thus instituting a significant learning scenario.

METHODOLOGY

Both case studies were taken in the context of undergraduate courses at a private university in Brazil, namely Mackenzie Presbyterian University. The first case study was carried out from 2005 to 2006 with three different groups of students from the fourth year of a CS undergraduate course, involving approximately 120 students. The second case study included nine different groups of IT undergraduate students during the same year, involving around 550 students.

The approach presented here is mainly based on Problem-Based Learning (Barrows & Tamblyn, 1980; Barr & Tagg, 1995; Wilkerson & Gijsselaers, 1996), which is an instructional theory that motivates students to work in a collaborative way to propose solutions to real-world problems. In both cases, students were faced with different sorts of game-related problems.

In the first case, the students had to have a software engineering vision about games, having to propose different solutions for the problem of modeling games in an object-oriented way, using extensively Responsibility Assignment Patterns (Larman, 2004) and Design Patterns (Gamma, Helm, Johnson, & Vlissides, 1995). According to the learner's evolution, the modeling evolved together.

Nowadays, a growing demand for some updates and changes in the curricula of software engineering-related courses is being noticed in CS and IT undergraduate courses, in order to include modern software development techniques. In this sense, inclusion of Design Patterns in such curricula is being considered as an urgent necessity. However, the Design Patterns' learning process demands students to have a high level of abstract reasoning, in addition to a certain degree of maturity on software engineering issues, which makes this task a non-trivial effort to be performed.

The main purpose behind Design Patterns (Gamma et al., 1995) is to provide to software

development community a set of problem-solution pairs so they are generic enough to serve as guidelines to solve recurrent problems in different application domains. Together with such a set, a common high-level vocabulary also arises, which makes integration easier among development teams, leading to a software development process with higher abstraction levels.

Using Design Patterns is an extremely good practice in the sense that it improves one's skills about object-oriented system design, and since it allows the evolution from a low-level reasoning, dealing with isolated classes and their object, to a more abstract way of thinking, where software is usually planned in a macro-structured way, and patterns can be applied in a plug-and-play manner.

In the second case, students were meant to face the problems related to computer graphics issues when creating a game scenario. Such modeling was supposed to evolve while students were presented new computer graphics techniques.

Modeling and rendering are major issues in a computer graphics course. However, IT undergraduate courses have some specific characteristics that often make the teaching of computer graphics topics a hard task, since many students consider the matter as uncoupled, isolated from the rest of curricula. Besides, computer graphics learning frequently requires from students a very good basis in Math, as well as dealing with a family of non-trivial algorithms for both modeling and rendering.

Games were used in this case study in order to improve students' sense of motivation, as long they were learning and applying sophisticated techniques to create a game scenario (Rucker, 2003). Simple board games were chosen, since they usually rely on a family of accomplishable challenges for undergraduate IT students, regarding their simple, but comprehensive modeling process of pieces and the board itself, as well as the fact that they open a wide range of possibilities for studying rendering techniques.

Case Study #1: Design Patterns and Software Metrics

This section will show some experiences from the years 2005 and 2006 in which games were used to teach patterns to CS students. These experiences will be divided in two phases: the first one, introductory, shows how games could be used in order to stimulate students in their first contact with basic software patterns, specifically Responsibility Assignment Patterns—some of them supported by object-oriented metrics—and Architectural Patterns. The second phase deals with the same students being taught GoF Design Patterns (Gamma et al., 1995), a more sophisticated subject of study. Games were also used in this second phase.

To explore this scenario, it is relevant to consider some elements. The increasing of processing power of computers, the spreading of mobile devices, and all the Internet phenomena are factors that contribute to the demand each time for more complex and sophisticated software. Since software is becoming increasingly complex, it is expected that its design follows the same path. Thus, professionals are required to act in a market with increasing demands for sophisticated designs (Cayley, 1999).

In this scenario, an average student of a regular CS course would not be completely able to ingress in such a software engineering market. With few exceptions, these students lack expertise in more realistic situations involving software development. The fact of not knowing Design Patterns could lead such students to propose simplistic, naïve solutions for problems that otherwise would require complex solutions. Such a gap in students' formations could be partially explained by the low level of abstraction that is commonly used in regular software engineering courses. In spite of it being very useful to teach basic principles about object orientation paradigm, such strategies

are shown to be inefficient when applied to larger, more complex systems.

A wide range of didactical aspects must be considered when dealing with such a category of subject, often considered too abstract and high level for undergraduate students, who must be motivated in some manner to build the knowledge related to these topics. Motivation, as stated by Gagné, Briggs, and Wager (1992), is a key factor to learning, and it can be achieved through a variety of strategies. For instance, a recent book about Design Patterns (Freeman, Freeman, Sierra, & Bates, 2004) tries to promote motivation through the usage of a metacognition-based approach, while an earlier publication (Duell, 1997) already tried to present Design Patterns' main concepts by associating them to non-software real-world examples. In the context of the experience, games are used as motivational factors, acting as triggers to the learning process.

The complexity of the subject is easily perceived, if confronted with—barely not naïve—approaches first-year students usually apply when modeling object-oriented systems. To depict this, a first case study was carried out in 2005 with a class of fourth-year students. Students were confronted with a simple but not trivial challenge: given a software already completed and how to analyze it, extract its main characteristics and, through a reverse engineering-based process, infer which would be a good object-oriented design for this software, particularly dealing with UML Class Diagrams. In order to improve students' motivation, a game was proposed as the subject software for this study (Berguin, Reilly, & Traynor, 2005; Björk & Holopainen, 2005; Nguyen & Wong, 2002). The targeted game is known as *Extreme Farm Simulator*,¹ a very simple game done in Adobe Flash®. It is a third-person shooting game, with a solely—and funny—goal: a farmer, controlled by the player, must shoot a flying saucer that tries to abduct his cows. Although simple, it is a multi-phased game, in which new levels add

new flying saucers, requiring simply players' quicker reactions.

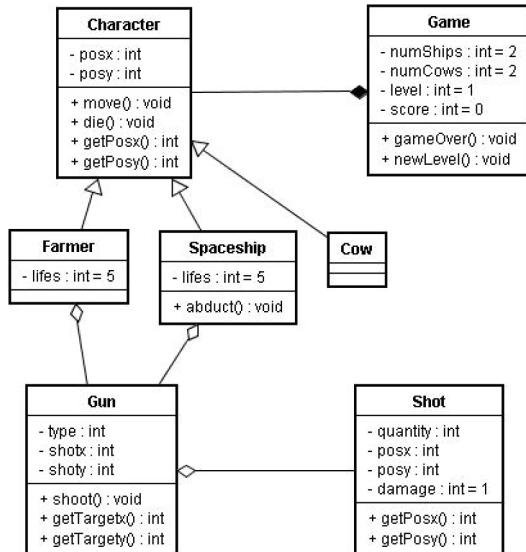
Students' first attempts to propose a class diagram for this game, based on their previous knowledge about object orientation, resulted often in simplified models, whose cores dealt only with that which is known as resource tier in a five-layered architecture. Some of these attempts can be seen in Figures 2 and 3, which depict two different diagrams for the same subject. Since they are made by Brazilian students, all projects were originally written in Portuguese. For the sake of readability, all class diagrams in this chapter show translated versions of the originals.

Both cases show how students cope with the concept of classes in the Object Orientation paradigm: they are merely representations of visually perceived “real” objects that are present in the application domain. Even though this is a conceptually correct first concept, to reach higher levels of abstraction, students would have to be able to recognize classes that are not necessarily direct representations of “physical” elements. Thus, invariantly, at this time students are able to present diagrams that would better fit as data-tier elements in a multi-tiered approach.

Some interesting questions arose from a first analysis of these diagrams made in the classroom. For instance, which class would be responsible for controlling the game? Which would be responsible for creation of other objects (the student that authored Figure 3's diagram tried to solve it using a “self-creating” class-like level)? Since students, at that point, were not yet presented to GRASP Patterns (Larman, 2004), they were unable to apply patterns like Pure Fabrication, Controller, or Creator to solve these problems, which remained unsolved until the next step forward.

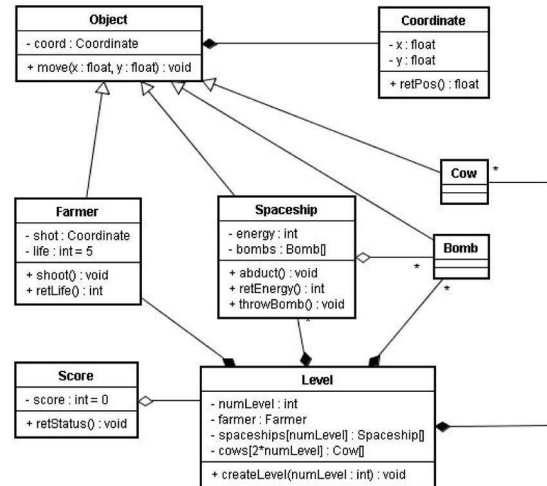
Starting from this point, students were invited to present and discuss their diagrams with colleagues. Such discussion took place at two different times: first in the classroom, where students were stimulated to have a critical approach to

Figure 2. Simple class diagram for the game (example #1)



colleagues' proposals, and afterwards through a virtual environment-based forum (Moodle² was used in this case). The discussion allowed students to be presented to a high-level Architectural Pattern, namely Three-Tiered Architecture, based on the MVC (Model-View-Controller) Pattern

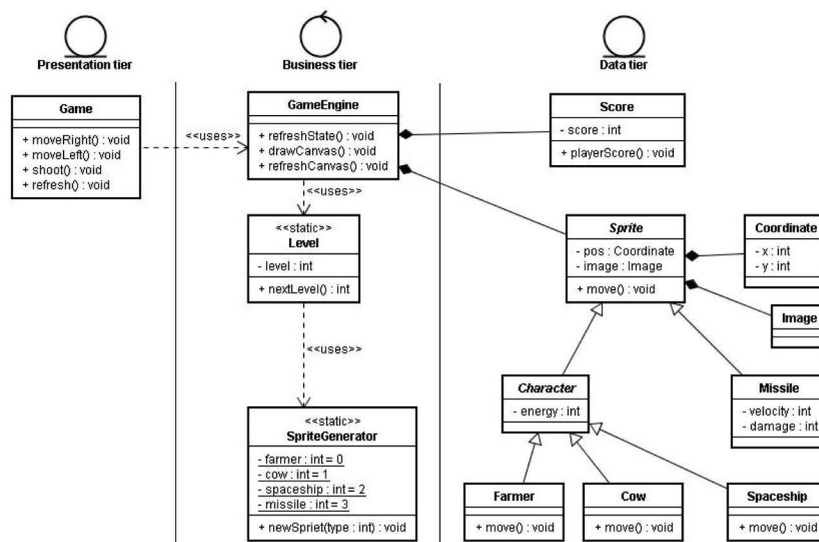
Figure 3. Simple class diagram for the game (example #2)



(Adams, 1988). Students were invited to rethink their designs after having contact with this pattern. One of the results can be seen in Figure 4.

It must be noted that Figure 4 represents an overall improvement from those depicted in Figures 2 and 3: by having made contact with the concepts around tiered architectures, students now go beyond the simple representation of a data/

Figure 4. A more elaborated class diagram, applying the Three-Tiered Architectural Pattern



resource tier by thinking in specific classes for encapsulating business rules. However, interface issues are not yet well addressed in these phases.

More than just modeling, in this educational approach, students were also invited to criticize colleagues' works. Again, the fact of using popular games as subjects of modeling was decisive, as their domains are widely well known by everyone. Below is an intervention (translated from Portuguese) of a student about the design proposed by a colleague in the semester before. In this case, students were faced with various diagrams, from which they had to choose the best one according to their own criteria. Using a virtual environment, they were asked to expose the reasons of their choices.

I think the diagram of students X and Y is the one that better represents the game, since it has the best class definition, keeping clear the idea about how game is structured. On the other hand, Z's diagram is without methods and attributes, making vague the idea about how the game works.

In the Game class I could not understand why there are methods like shoot(), moveRight(), or moveLeft(), since they are already defined in the following classes: Flying Saucer, Cow, and Farmer.

Where are the methods related to cow's abduction??? And those one related to flying saucers'shoots?

It was good to have tried to divide in tiers, although I'm not sure if it is correct.

After having contact with some basic concepts regarding architectural patterns, the next set of patterns studied was Larman's (2004) GRASP (General Responsibility Assignment Software Patterns), which is a set of nine general-purpose patterns. Such patterns serve as guidelines for software development, as well as being the foundations for Gamma's Design Patterns.

In order to motivate the use of GRASP concepts, it was proposed that the students choose a game and build a class diagram to represent it, with posterior applying of two object-oriented metrics—LCOM and CBO—from the well-known set of metrics proposed by the classical work of Chidamber and Kemerer (1994). These metrics were chosen since they support the application of two GRASP patterns, respectively High Cohesion and Low Coupling (Larman, 2004).

One of the students choose *Tetris* (from Russian Тетрис), a well-known game whose pieces are composed of four square blocks, called *tetraminoes* (Figure 5), that fall down on the playing field.

The basic mechanics of the game are to manipulate these tetraminoes, by moving each one sideways and rotating it by 90-degree units, with the aim of creating a horizontal line of blocks without gaps. When such a line is created, it disappears and the blocks above (if any) fall. As the game progresses, the tetraminoes fall faster, and the game ends when the player “tops out”—that is, when the stack of tetraminoes reaches the top

Figure 5. Possible configurations for Tetri's tetraminoes

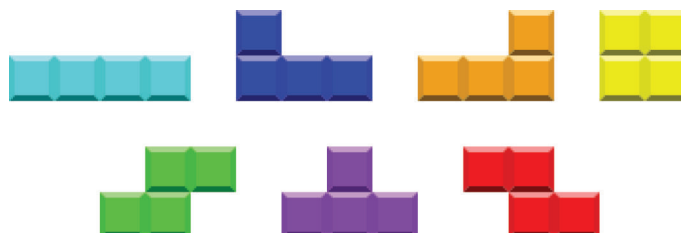
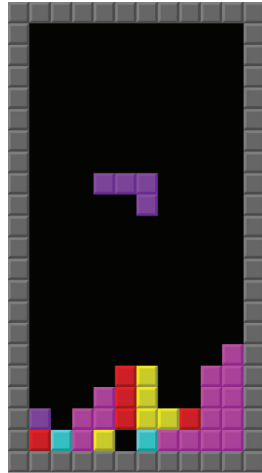


Figure 6. An intermediate Tetris configuration during a game session



of the playing field and no new tetrominoes are able to enter.

A non-end configuration of a *Tetris* session is depicted in Figure 6.

To contextualize object-oriented metrics, the following section revises LCOM and CBO metrics.

The Lack of Cohesion Metric (LCOM) is an object-oriented metric and states the dissimilarity of methods in a class by instance variable or attributes. Lack of cohesion or low cohesion increases complexity, thereby increasing the likelihood of errors during the development process. Classes with low cohesion could probably be subdivided into two or more subclasses with increased cohesion. A highly cohesive module should stand alone, and high cohesion indicates good class subdivision. High cohesion implies simplicity and high reusability, and indicates good class subdivision. LCOM measurement is not a trivial problem, since it requires classes' methods to be already well defined in an algorithmic way. Besides, there are currently different methods to perform it, leading to different interpretations of this metric. A comprehensive analysis of these different methods can be found in Lakshminarayana and Newman (1999).

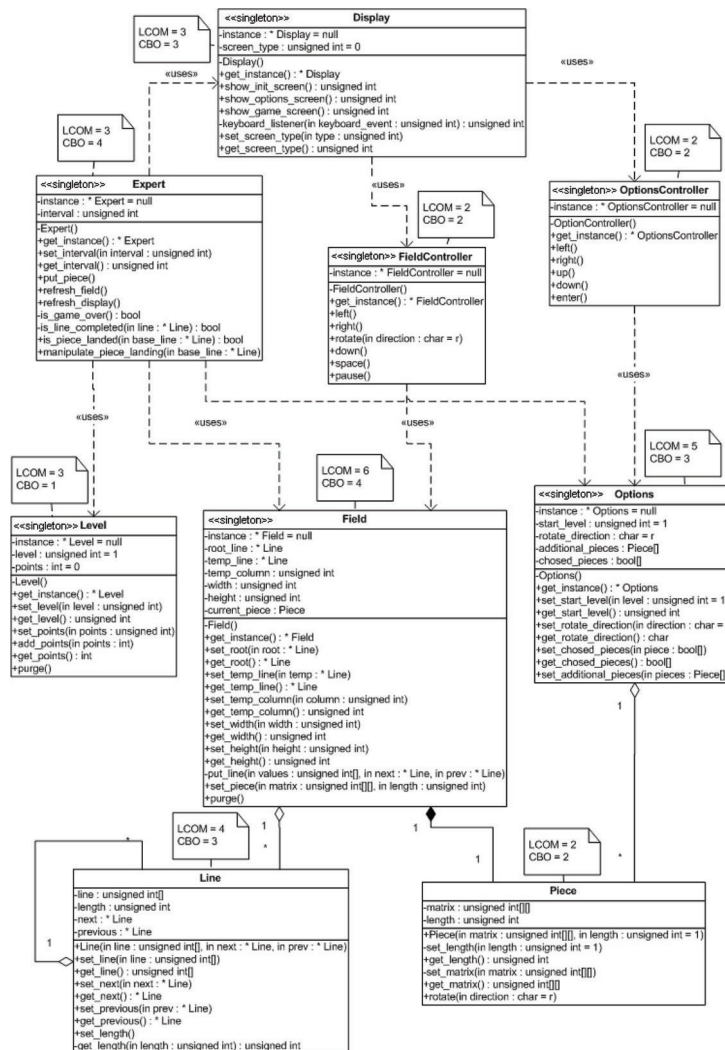
The Coupling Between Object (CBO) is a count of the number of other classes to which a class is coupled. It is measured by counting the number of distinct non-inheritance-related class hierarchies on which a class depends. Excessive coupling is detrimental to modular design and prevents reuse. The more independent a class is, the easier it is to reuse it in another application. The larger the number of couples, the higher the sensitivity to changes in other parts of the design, and therefore maintenance is more difficult. Strong coupling complicates a system since a class is harder to understand, change, or correct by itself if it is interrelated with other classes. Complexity can be reduced by designing systems with the weakest possible coupling between classes. This improves modularity and promotes encapsulation. Computation of CBO is often done through the class diagram being represented as a directed graph, where edges represent dependencies among classes. An individual node's CBO is its outer degree. One result devised from the proposed experiment is depicted in Figure 7.

The proper application of GRASP could lead students to a satisfactory project for the games they have chosen. By means of PBL and Collaborative Learning, students themselves could build these solutions and, through criticism, supported by LCOM and CBO metrics, they were able to decide if they had made the correct choices during design phases.

This first attempt to bring a higher level of maturity to students concerning object-orientation issues owes a considerable part of its success to the fact of using well-known games as subjects of modeling. Such a decision allowed students to be motivated by dealing with a ludic, stimulating problem, which was also a chance for them to model a "complete" system, due to its simplicity.

After this first approach, students were able to deal with more sophisticated concepts, like Design Patterns. Recently, the use of patterns, as defined by Gamma et al. (1995) and Alur, Crupi,

Figure 7. A class diagram with applied Design Patterns and corresponding object-oriented metrics



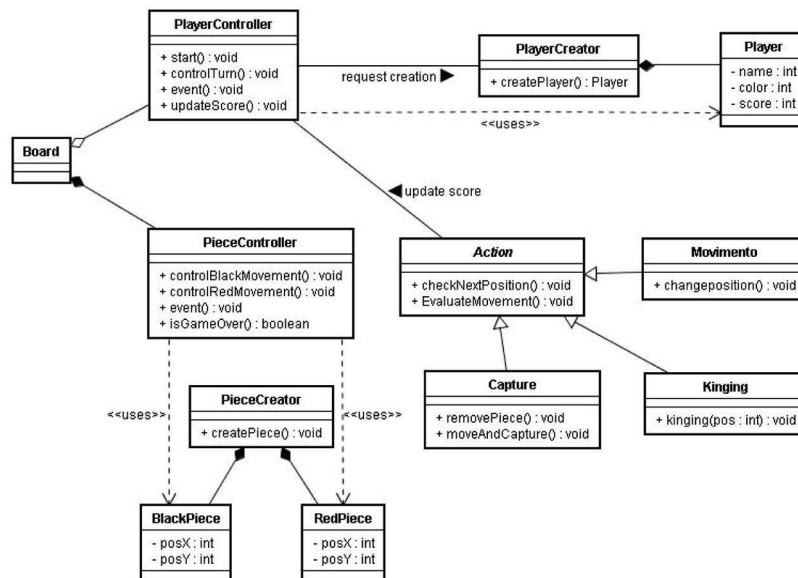
and Malks (2003), among others, is increasing in the software industry. In some countries, the study of patterns, especially Design Patterns, is to be considered as standard in the core of undergraduate courses (Astrachan, Mitchener, Berry, & Cox, 1998; Wick, 2005). In other countries, such initiatives are in their early stages. In Brazil, for instance, the official Curricular Guidelines barely mention Design Patterns (Menezes et al., 2001).

To satisfactorily understand and apply Design Patterns, a set of previous skills is required of students. Many of them were developed in a

previous phase—for instance, the awareness of cohesion and coupling issues, and the separation of concerns, among others. Nonetheless, the results produced by students are not yet satisfactory if compared with professional expectancies of complex software. An example of this, shown in Figure 9, is presented by two students to model the classic Checkers game.

It can be noted that, in spite of being conceptually correct, this diagram primes for simplicity. It presents a proper three-tiered organization—business rules are dealt by CTR—Controller

Figure 8. Modeling Checkers with GRASP



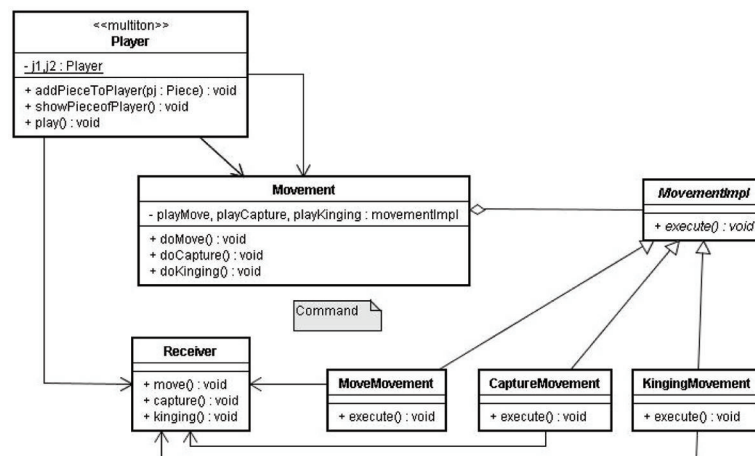
classes (Larman, 2004), objects creators are well-defined, and so on—although its implementation, if carried through up-to-date frameworks or APIs, would present a considerable gap between conceptual design and implementation project.

Based on this, games were used again to move a step forward in direction to a more sophisticated set of patterns, namely GoF Design Patterns (Gamma et al., 1995). Using students' criticisms

and some punctual interventions of professors, students were able to absorb the main concepts involving such patterns. The text below shows one of these interventions, and Figure 9 shows the final version of the diagram from Figure 8 after some months studying GoF Design Patterns.

This new version for the diagram is better than previously presented in classroom. However, there are still some issues to be addressed:

Figure 9. Discovering the Command Pattern in a game of Checkers



- What's the need of having a class for black pieces and another one for reds?
- There is no relationship among Player, Action, and Piece?
- Coupling of CTR_Piece is over the diagram's average.

By means of the triad of *criticism, intervention, and auto-criticism*, students were able to discover by themselves, in the application domain of the game, some of the patterns taught. For instance, Figure 9 shows part of the diagram made by the same students that authored the previous diagram (Figure 8). Figure 9 shows how students were able to properly identify and apply the GoF Command Pattern (Gamma et al., 1995).

Case Study #2: Computer Graphics

Teaching computer graphics in the context of an IT undergraduate course has been the topic for discussion. Now we ask, how do we teach highly algorithmic content to students that are not really motivated to it? IT courses educational purposes, different from CS courses, are usually more driven to the application of technology than the behind-the-scenes content CS courses are used to having.

In the 1970s the issue was already being discussed, and a large range of APIs and frameworks appeared in order to make computer graphics learning easier in different contexts (Knowlton, 1972; Towle & DeFanti, 1978). More recent works proposed alternatives to the omnipresent OpenGL through the use of widespread languages that give support to 2D-3D basic modeling tools, such as Java (Mukundan, 1999) and Java plus Java3D API (Zhang & Liang, 2005; Tori, Bernardes, & Nakamura, 2006), or even languages that were not as widespread like Ada (Brown, 2004). Other tests focused on modeling software like Maya and Blender (van Gumster, 2003; Zhu & Owen, 2004). The present case study was carried out using Blender.

Groups from a fourth-year IT course had been submitted to one experiment: modeling and rendering of a board game. Initially, the groups had chosen which game they wanted to work on, and, using concepts of modeling and rendering, had produced a final project of a game in two phases.

In the first phase, the objective was to apply extensively concepts of polygonal modeling, NURBS, and generative curves, in such a way to show the difficulties and applications of each of these types of modeling.

Some concepts involving modeling are sometimes extremely abstract to students in general, specifically to IT undergraduate students, which are meant to face computer graphics issues not as full developers of algorithms and techniques, but instead as having a comprehensive knowledge about techniques and methods.

A relevant unit on this course is about modeling. On this topic, students were meant to be presented to a range of modeling techniques, which vary from direct polygonal mesh modeling to procedural techniques (Foley, van Dam, Feiner, & Huges, 1995; Watt, 1999). One of these techniques is CSG (Constructive Solid Geometry), which is based on combining pre-built solid primitives according to a set of Boolean operators. A solid is thus described by its scene graph, in which leaves are the primitives and internal nodes are the operators.

CSG is a very easy technique to learn. However, the more formal specification through scene graphs is not always an easy topic for IT students, since it requires basic knowledge about trees, besides basic algebra and set theory.

This topic was addressed over three semesters by proposing to students the modeling of some board games' pieces using CSG. According to the game chosen, some pieces were extremely easy to create—checkers, for instance. Ludo, dominoes, or some chess pieces, for instance, require a little more modeling effort, being a proper issue to be addressed with CSG techniques. To achieve this goal, a modeling tool was used.

Tools instead of direct programming with APIs like OpenGL have been used in an effective manner to improve student's learning of hard topics in computer graphics. The works of Abdullah, Suyoto, and Ahmad (1997) and Song, Ou, and Shiau (2000) show experiences that used tools to teach computer graphics concepts to undergraduate students.

More than just using tools, the experience in these classes was meant to stimulate students to use such tools. It is well known that complex modeling tools have inherently also complex, user-unfriendly interfaces, besides being, most of the time, machine-consuming, proprietary, and expensive. The solution found to some of these problems was using Blender,³ an open source, cross-platform suite of tools for 3D modeling and rendering.

Figure 10 shows some students' results applying CSG modeling techniques in some pieces of a domino game. Typically, these pieces are the result of applying an intersection among a box and a sphere (to generate a rounded-corner piece basis); holes are built by applying a difference between such basis and a hemisphere, which is built by again using the difference operator between a sphere and a cube; a box is used as separator. Linear transformations and the union operator are applied afterwards.

Some other topics that require a deeper knowledge of math are specially considered as difficult matters, with no practical application. For instance,

NURBS (Non-Uniform, Rational B-Splines, see Piegel & Tiller, 1997) is a non-trivial topic when teaching computer graphics, since it is a kind of curve that require students to have some knowledge about the concept of continuity (positional, tangencial, and curvature). Besides, they are expected to cope with a curve's weighted control points and its knot vector. More than this, NURBS surfaces require an extra degree of complexity.

NURBS curves are extremely useful in some modeling techniques, such as sweeping through revolution. Students were stimulated to model some chess pieces using such technique. Again, once the goal was well established, students were able to understand and apply some intricate concepts related to such curves in the chosen tool. Figure 11 shows a chess piece created using a mixed approach, combining sweeping and CSG.

Having some pieces modeled, students were assigned the task of modeling an entire board game, with all pieces. Such a game was supposed to be located over a surface, like a table. Some results obtained by students in this phase are shown in Figure 12.

The variety of proposals was sufficiently great, and the motivation with the use of a game as the subject was very well accepted.

Figure 10. Domino pieces modeled with CSG

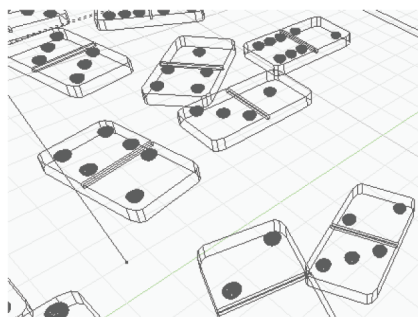


Figure 11. Chess horse modeled with NURBS-based sweeping and CSG

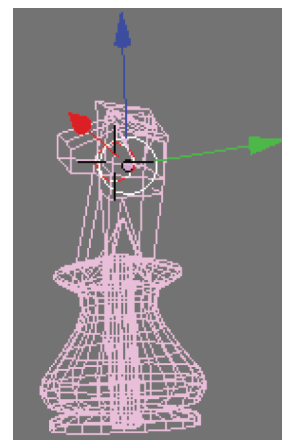
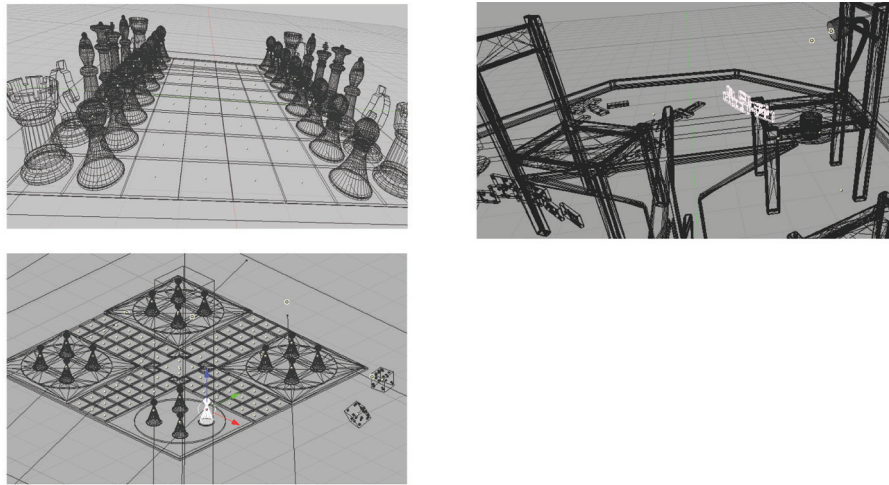


Figure 12. Some of the best results in the modeling phase



After that, in the second phase, the challenge was to add realistic effect (illumination effects) to the models generated in the previous phase. Our current program of computer graphics includes two basic illumination models: Lambert and Phong. Although they represent the most basic models of illumination in computer graphics, they demand certain mathematical maturity to understand them.

The Phong Reflection Model is an illumination and shading model, which allows the assignment of shades to points on a 3D model. It represents a simplification of the more general rendering equation, whose computation is a hard computational task. Essentially, the Phong illumination model comprises three components—ambient, diffuse, and specular—as depicted in Figure 13.

The Lambert illumination model is a more simplified model and includes only the diffuse component. Both equations for these models are obtained by the formula in Figure 14.

In this equation, the terms (k_a, k_d, k_s, α) represent the material to be bound to the 3D model and quantify the amount of reflected light i_a, i_d, i_s (ambient, diffuse, specular). The required maturity to understand these models includes methods from vector calculus and analytic geometry, which, not always, are remembered when we are initiating the topic of illumination models. For example, in order to calculate the normal vector (N), an important step for both Lambert and Phong Models, we need to evaluate partial derivatives over polygonal surfaces (Foley et al., 1995; Watt, 1999).

Figure 13. The components of the Phong Illumination Model

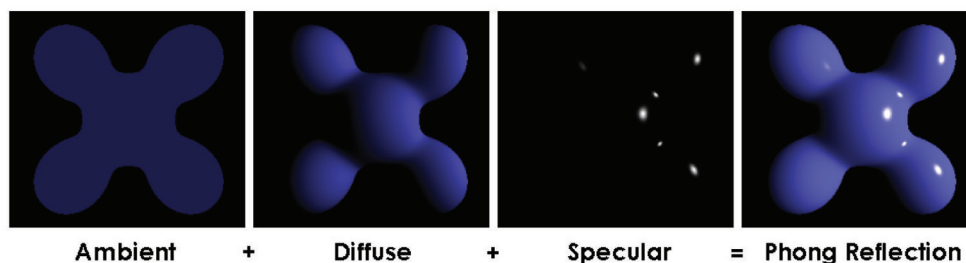


Figure 14.

$$I_p = k_a i_a + \sum_{\text{lights}} (k_d (L \cdot N) i_d + k_s (R \cdot V)^\alpha i_s).$$

This direct approach often shifts the focus of the discipline for a purely mathematical scenario, which often decreases the motivation of students to learn more complex illumination models.

As the model of illumination of Phong is empirical, we also follow the same empirical strategy to teach the model to our students. As a strategy, initially, groups had been motivated to test several lighting conditions in order to gain mathematical and perceptual skills related to photo-realistic parameters. Using these skills, they had tried some models to get realistic qualities for wood and plastic, among other materials that could appear in the scenes of the games. The results obtained from these experiments are shown in Figure 15.

Using the common approach of the Phong model, the students extrapolated the results to include models of texturing, using the qualitative equation *material* = *lighting model* + *texture*. The textures were generated by procedural models involving complex models, such as Perlin's noise (Watt, 1999), for wood and marble.

The results were very interesting, mainly because the students had faced the mathematical barriers of the model and had been able to transform them into sufficiently convincing products of the point of view of realism.

IMPLICATIONS AND FUTURE TRENDS

These case studies demonstrate the effective use of instructional design elements to elaborate a proposal of applying games exclusive in undergraduate courses such as computer science and information technology. In these types of

courses, students use and explore computers and technological tools constantly. It is necessary to implement the methodology developed in other areas as social sciences, philosophy, biology, and so on to compare the results and analyze the specialties of these experiences.

Another element that can be pointed out is to research the possibilities of amplifying the collaborative approach combined with massive multiplayer games to investigate how students work and structure an autopoietic system to examine and solve problems in a game universe.

But not all of these proposals can be developed without a change in the posture of teachers, which includes increasing the value of ludic (playful) in education and verifying, by use of instructional design analysis, how different contents can be combined in a game universe to contextualize and offer a meaningful experience to students. This proposal requires an interdisciplinary approach and new curricula structures that also consider different learning styles and the use of group dynamics to provide an environment where ZPD can emerge.

CONCLUSION

This chapter showed two case studies carried out by the authors at a university in Brazil in which games were effectively used to teach two different subjects: Design Patterns for a computer science course and Computer Graphics for an information technology course. To implement this proposal, we used an instructional design approach that pointed out a learner-centered methodology and constant analysis of games contexts, contents, and

scenarios development during the course periods in a blended solution that amplifies the laboratory classroom when implementing a virtual environment to discuss students projects.

These elements enhanced the proposal because students were challenged to study, in a detailed way, Design Patterns and Computer Graphics content so to have the opportunity to create their games architectures and interact with other colleagues to find solutions to real projects, not in a hypothetical or theoretical manner.

The use of games as a motivation factor for the presented concepts showed importance not only for the ludic aspect, but for the wealth of exploration elements as well. In both cases, the exploration factor represents a relevant aspect for attainment of clear and cheap solutions for software, as well as three-dimensional realism in models.

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KEY TERMS AND DEFINITIONS

Design Pattern: A proven solution for a recurring problem. Some authors provide a catalog with 23 Design Patterns (Gamma et al., 1995).

Instructional Design: Constitutes a systematic framework that involves educational theories, instructional strategies, and other elements to support learning experiences, and permits one to acquire competences based on educative goals.

Learning Styles: Involves individual preferences of perceiving and processing information in response to educational stimuli.

Ludic: The Latin word *ludus* (meaning “game”) originated the concept of ludic, which represents a human behavior characteristic that synthesizes social and educational principles, and establishes a vehicle of imaginary expression and action through knowledge and rules appropriations in a pleasant way. Curiously, *ludus* also refers to a “school” for roman gladiators: they used to be

taught to fight and use weapons—daggers, swords, tridents, and so on—in *ludi* (plural form of *ludus*), by “teachers” (in fact, gladiators’ trainers and often owners) called *lanistae* (plural form of *lanista*). The “game” gladiators were meant to “play” was also called *ludus*.

Modeling: In computer graphics, modeling is related to the process of representations of n-dimensional elements in a well-defined language or data structure. There are many techniques for modeling, many of them more suitable to some kinds of objects to be modeled.

Rendering: In computer graphics, rendering is the process of generating a still image from a scene, taking in account information about the geometries present in the scene, as well as viewpoint, lighting, shading, and texture information.

Software Metrics: Metrics are a set of parameters used to perform assessment of a product or process meant to be measured. Software metrics are commonly applied to the software engineering

process or the artifacts derived from them. The object-oriented metrics targeted in this chapter are part of a set of metrics proposed by Chidamber and Kemerer (1994), which are meant to give some quantitative values over a class diagram.

Zone of Proximal Development (ZPD): Determined by distance existing between real capacity to solve problems in an autonomous way and potential capacity to solve problems with the help of a partner (another person as teacher, colleague, or even a group).

ENDNOTES

- ¹ <http://extreme-farm-simulator.freeonlinegames.com/>
- ² <http://www.moodle.org>; university’s distribution is available at <http://ead.mackenzie.com.br/moodle>
- ³ <http://www.blender.org>

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Chapter 1.15

Using Video Games to Improve Literacy Levels of Males

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ABSTRACT

This chapter examines the differences in the educational needs of males, the origins of video games, and the issue of the decline in literacy achievement levels of male students worldwide. It promotes the idea that a new literacy which includes computer technology and visual literacy has changed the scope of literacy and that males have succeeded at developing the new literacy skills. The chapter is intended to inform educators of the literacy skills involved in video games, make connections with video game literacy and traditional literacy, and to encourage teachers to integrate video games into their curriculum.

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INTRODUCTION

According to the 2005 National Assessment of Educational Progress (NAEP) females scored thirteen (13) points higher on average in reading than male students (National Center for Educational Statistics, 2005). Gurian (2001) also cites statistics indicating that boys:

- Earn seventy percent (70%) of D's and F's and fewer than half of the A's,
- Account for two-thirds of learning disability diagnoses,
- Represent ninety percent (90%) of discipline referrals,

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- Dominate such brain-related learning disorders as ADD/ADHD, with millions now medicated in schools,
- Make up eighty percent (80%) of the high school dropouts, and
- Make up fewer than forty percent (40%) of college students.

The current educational system around the world is failing to meet the educational needs of males. In the United States, Black males are three (3) times more likely than white students to be labeled as mentally disturbed (www.BET.com, 2005). Males are more often classified as being mentally retarded, having learning disabilities, and having attention deficit disorders.

Girls performed better than boys academically in the thirty-five (35) countries who participated in a three (3) year study of knowledge and skills of males and females. The Organization for Economic Co-operation and Development (OECD) studied males and females in industrialized countries including the United States, Canada, European countries, Australia, and Japan. The results show that reading and writing skills brought the male scores down the most. (Gurian & Stevens, 2004) The dismal educational achievement of males continues in the high school dropout rates and graduation rates of males.

The difference in graduation rates for males and females widen within minority groups. There is an eleven percent (11%) difference in graduation rates of African-American males and females, nine percent (9%) fewer Hispanic males graduate than Hispanic females, five percent (5%) fewer white males graduate as compared with white females, and three percent (3%) fewer Asian males graduate from high school than Asian females (Greene & Winters, 2006). During the past decade, the graduation rate for Black women improved while the rate for Black males slipped. Fifty-six percent (56%) of Black women graduate from high school compared with forty-three percent (43%) of Black

males (NAEP, 2005). The differences in high school graduation rates of males and females lead to differences in college attendance rates. Women earn an average of fifty-seven percent (57%) of all BA's and fifty-eight percent of master's degrees in the United States (Conlin, 2005). The United States Department of Education predicts that if the current trend continues that by 2020, there will be 156 women for every 100 men earning college degrees. The college attendance rates for African-American males are even lower with only thirty-seven percent (37%) of Black males being enrolled in college (NAEP, 2005). The college graduation rate of Black males is lower than any other group.

The research clearly shows that males are getting lost in the educational system. One of the problems could be that the current curriculum is designed for all students to learn the same things at the same time in the same ways. It does not examine the cultural expectations of or for the males and does not consider the differences in the males' brains, learning styles, or developmental levels. With the use of the current curriculum, the unrealistic expectations of teachers for males in the classroom, inappropriate teaching and presentation styles, and the restrictions on student movement in the classrooms, it becomes easy to understand why males appear to be angry, aggressive, and frustrated.

In order to relieve the frustrations of males and to reverse the current educational trends of males, it is important for educators to consider all types of instruction. All students should be taught utilizing the knowledge of cultural gender differences as well as gender differences in brains and interests. Cultural expectations and gender differences are difficult to quantitatively study but have been extensively researched by literary and developmental experts such as Leonie Rowan (2002), Elaine Millard (1997), and many others. Research on the brain has vastly expanded with new medical technologies available to scan and

learn more about the brain. Neurologists are finding that there are major differences in the characteristics of males' brains and females' brains. Evidence supporting brain differences in males and females is referenced by Michael Gurian and Kathy Stevens (2004) showing that:

- “boys brains have more cortical areas dedicated to spatial- mechanical functioning, males use, on average, half the brain space that females use for verbal-emotive functioning. The cortical trend toward special-mechanical functioning makes many boys want to move objects through space, like balls, model airplanes, or just their arms and legs. Most boys, although not all of them, will experience words and feels differently than girls do. (Blum, 1997; Moir & Jessel, 1989).
- boys have less serotonin than girls have, but they also have less oxytocin, the primary human bonding chemical. This makes it more likely that they will be physically impulsive and less likely that they neurally impulsiveness to sit still and empathetically chat with a friend (Moir & Jessel; 1989, Taylor, 2002).
- boys lateralize brain activity. Their brains not only operate with less blood flow than girls' brains, but they are also structured to compartmentalize learning. Thus, girls tend to multitask better than boys do, with fewer attention span problems and greater ability to make quick transitions between lessons (Havers, 1995).
- The male brain is set to renew, recharge, and reorient itself by entering what neurologists call a rest state. The boy in the back of the classroom whose eyes are drifting toward sleep has entered a neural rest state. It is predominantly boys who drift off without completing assignments, who stop taking notes and fall asleep during a lec-

ture, or who tap pencils or otherwise fidget in hopes of keeping themselves awake and learning. Females tend to recharge and reorient neural focus without rest states. Thus, a girl can be bored with a lesson, but she will nonetheless keep her eyes open, take notes, and perform relatively well. This is especially true when the teacher uses more words to teach a lesson instead of being spatial and diagrammatic. The more words a teacher uses, the more likely boys are to “zone out”, or go into rest state. The male brain is better suited for symbols, abstractions, diagrams, pictures, and objects moving through space than for the monotony of words (Gurian, 2001).”

The schools are failing to recognize and respond to the current educational gender specific needs of males. In today's world, computers and video games play a major role in a student's life. Whether the student is completing work on the computer or using it for video games, a major portion of a student's day is spent using a computer of some type. The education system has embraced the use of computers to complete assignments and conduct research for class projects. The disconnect between the educational system and technology occurs with the lack of a complete integration of the use of technology including video games for instructional purposes.

HISTORY OF USING VIDEO GAMES FOR INSTRUCTIONAL PURPOSES

In examining the history of educational games (video games), it is important to define the term educational video games. In this chapter, the definition of the term educational video games is written by Sara de Freitas (2006) in a report to the JISC e-Learning Programme in London. She defines educational games as “applications

using the characteristics of video and computer games to create engaging and immersive learning experiences for delivering specific learning goals, outcomes, and experiences” (de Freitas, 2006, 10). With this definition in mind, a review of the history of video games for educational purposes will be focused on the use of electronic games to enhance learning. *Spacewar* was the first computer game to be developed. In 1961, Steve Russell used a PDP-11 at the Massachusetts Institute of technology to develop the game that was collaborative and exhibited learning capabilities (Herz, 2001). The first games used to support learning and training were simulations. These games were war games and led to the fighting and shooting games of today (de Freitas, 2006). In the 1980’s, Brøderbund and the Learning Company are two of the first companies created who developed educational software. Reader Rabbit, developed in 1989 by the Learning Company, is one of the first software programs designed to teach children basic reading and spelling skills (http://en.wikipedia.org/wiki/Educational_software, 2007). The personal computer promoted the development of software that could be used to help students learn concepts, provide practice, and engage students in a fun activity. Peter Catalanotto first coined the word edutainment in the late 1990s as he traveled around the country edutaining school children about writing and illustrating. Edutainment is defined as “a form of entertainment designed to educate as well as to amuse” (<http://en.wikipedia.org/wiki/Edutainment>, 2007). Edutainment typically seeks to instruct or socialize its audience by embedding lessons in some familiar form of entertainment (<http://en.wikipedia.org/wiki/Edutainment>, 2007). Today, there are millions of video games that are considered as edutainment. Parents and children can use a search engine (google) using the key words “reading video games” and one hundred twenty-nine million (129,000,000) sites can be accessed.

CURRENT USE OF INSTRUCTIONAL TECHNOLOGY

Since the invention of the teaching machine in the 1920’s by Sidney Pressey, an educational psychology professor at Ohio State University, and the problem cylinder by M. E. LaZerte, Director of the School of Education at the University of Alberta, the use of technology in the classroom has been expanding and developing. In 1960, Programmed Logic for Automated Teaching Operations (PLATO) created the first computer assisted courses at the University of Illinois at Urbana-Champaign. From there, distance education classes were developed where students did not have to actually sit in classrooms to learn the concepts. Students could use the computer to assist them in mastering objectives and completing coursework at their convenience. In the 1970’s computers were first used in elementary classrooms in Canada. In 1976, the first virtual college was founded in the United States. In the 1980’s, PLATO introduced a cartridge to be used at home with the ATARI home computer escalating the use of home systems for instruction. The 1990’s saw an increase in the use of computers in schools with the establishment of computer labs in most schools. Teachers were able to individualize instruction with the software programs that were available. Educational software companies exploded with some school districts forming their own software libraries for teachers to check out programs for use in the computer labs. As computers became less expensive and more attainable for schools, computers began to appear in classrooms. Teachers began to develop PowerPoint presentations with the introduction of computer to television connections and LCD projectors. Learning games became less prevalent as teachers struggled to integrate technology into their daily lesson plans.

Sandford, Ulicsak, Facer, and Rudd (2006) conducted a MORI poll of teachers in the United Kingdom and found that thirty-one and five tenths

percent (31.5%) of teachers have used games designed for entertainment in their lessons and fifty-nine percent (59%) of the teachers reported a possibility of considering them in the future. The study also found that sixty-three percent (63%) of the teachers believed that students using games actually learned specific content knowledge.

In a Eutopia survey conducted by Sara Bernard, five hundred one teachers responded to the question, “Are computer and video games effective teaching tools?” (Bernard, [Http://www.edutopia.org/are-computer-and-video-games-effective-teaching-tools](http://www.edutopia.org/are-computer-and-video-games-effective-teaching-tools)). Seventy-eight percent (78%) of the responders voted yes that “computer games engage, motivate, and inspire students and educational researchers and game designers are collaborating to create their ideal niche in the classroom” (Bernard, [Http://www.edutopia.org/are-computer-and-video-games-effective-teaching-tools](http://www.edutopia.org/are-computer-and-video-games-effective-teaching-tools)). Many teachers agree with the theory of the benefits of video games without actually integrating them into their curricula. This is where there is a disconnect between the approval and actual application of video games into classroom instruction.

Video games are definitely part of students’ lives, especially the males. The interests of students need to be considered in creating an active, engaging learning environment. The integration of video games into instructional practices may help to connect males back to learning experiences.

VIDEO GAMES AND MALES

Males can find the action they seek from using video games. They enjoy fighters, shooters, action adventure games, and strategy games. More and more, males find the adventure and action they seek not from books but from video games. In an American study, one thousand four hundred ninety-one (1,491) children aged ten (10) to nineteen (19) comprised a representative sample of adolescents. It was found that thirty-six percent of

the sample population played video games. Eighty percent (80%) of the males and twenty percent (20%) of the females played video games for approximately one hour on weekdays and ninety (90) minutes on weekends. On the average, students who spent time playing video games spent thirty percent (30%) less time reading and thirty-four percent (34%) less time doing homework (Cummings; Vandewater, 2007). The study also found that for every hour males played video games during the week, they spent two (2) minutes less time reading. Educators and researchers need to understand what draws students, especially males, to sit for long periods of time and focus on video games. The studies have shown that there is a sharp difference in the percentage of males and females who play video games as well as differences in their video game preferences and amount of time spent playing video games. Male video game players tend to like person shooters and sports games. These games increase the chances that the player will be completely absorbed in playing the game. Game promoters believe that people play video games to escape from everyday life and to a world of adventure without risk. Adults who play video games report that video games are mentally stimulating and that hand-eye coordination is improved by playing (Dawson, 2007)

MALES AND READING

Reading assessments throughout the world are substantiating the fact that males are scoring lower than their female counterparts in reading. The National Center for Educational Statistics has been reporting reading and mathematics assessment results from 1971 to 2005 for the United States. Its report, the National Assessment of Educational Progress, documents that from 1971 to 2004 that males have consistently scored below females. Average scale score differences range from 12.7 (1971) to 5.3 in 2004 (<http://nces.ed.gov/nation-sreportcard/litnde/viewresults.asp>). In 2006, the

Canadian Human Resources and Social Development concluded from their assessments that “females have much superior reading achievement than males” (<http://www.hrsdc.gc.ca/en/cs/sp/hrsdclp/publications/2006-002833/page06.shtml>) In the Canadian study, sixty-one percent (61%) of the students in the high achievement reading category (75th percentile) were females leaving males with only thirty-nine percent (39%) scoring in the seventy-fifth (75th) percentile. Males also had seventy-three percent (73%) scoring in the low achieving category which is below the twenty-fifth (25th) percentile. Michael Sullivan, the director of the Weeks Public Library in Greenland cited research done by Lanning Taliaferro from the Journal News stating that “By the time boys are in the eleventh (11th) grade, they can be three (3) years behind girls in their reading levels” (Cicco, 2005)

In 2002, Smith and Wilhelm summarized their literacy and gender research in their book *Reading Don't Fix No Chevys: Literacy in the Lives of Young Men*. The conclusions include that:

- Males spend less time reading for pleasure than females.
- Males do not report reading as an enjoyable experience as often as females.
- Males are not as confident in their reading abilities as females.
- Males take longer to learn how to read than females.
- Males talk about what they are reading less often than females.
- Males like to physically respond to the reading by acting out responses or by making something.

Males do report that they enjoy stories and information that they can relate to through their own personal experiences (<http://www.liberating-boys.com/books.html>). Magazines, internet text, and even video games capture males' attention as being reading that they can relate to. Elizabeth

Haydon, an author of adolescent books, writes that “Themes that are appreciated by boys this age [preteen] are action, the more detailed the better, some sort of struggle, threat or fighting, particularly of the heroic sort – whether it is epic or in the schoolyard – suspense, puzzles, horror and humor, often of the crass kind.” (Brown, 2007)

VIDEO GAMES AND LEARNING AND LITERACY CONNECTIONS

Learning occurs when a person “gains knowledge or understanding of a skill by study, instruction, or experience” (Webster's New World Dictionary, 353). James Paul Gee, a University of Wisconsin-Madison curriculum and instruction professor, has studied the connection between video games, learning, and literacy. He found that learning principles and knowledge about human learning is incorporated into video games (Gee, 2003). Video games captivate players by giving them complex problems to solve in real world settings that get progressively more difficult with each level mastered. The players' problem solving skills are tested at each level with the game giving positive reinforcements for each accomplishment. That description of a video game could be the description of a learning centered environment producing successful students. “Playing video games evokes a potentially powerful, active learning environment that includes demonstration, rehearsal, and reinforcement” (Funk et al, 2006). Thinking and learning skills can be developed by playing some video games. Reading skills, logical thinking skills, observation skills, vocabulary development, problem solving skills, and strategy planning can all be improved through the use of some of the available video games. Most of the video games require reading. The problem occurs because the reading required in video games is not the traditional form of literacy thought to develop reading skills. Video games are creating new forms of literacy. In today's world, print

media and literacy of print media is not enough to be successful. Playing video games offers the opportunity to learn a different type of literacy. Computer games, the internet, instant messages, and phone texts have shaped the way people, especially males, interact with texts. Males use a sub-standard form of English to communicate with others quickly while playing games. The language used is to help them reach the goals of the game. The literacy of the games is action oriented. Paul Gee (2003) writes that visual literacy is an important part of communication that is often ignored in typical classrooms. The viewing and understanding of symbols, graphs, charts, and visuals is necessary to obtain an adequate level of literacy in today's world. "Visual literacy is just as important an element as that of reading the written word in gaining a more complete understanding of society and culture" (Madill and Sanford, 2006). Active learning can occur and generate a greater understanding by interacting visually with something rather than simply reading about it.

"Experiencing the world in new ways, forming new affiliations, and preparation for future learning" are the three (3) components of active learning identified by Gee (2003). Video games offer the student a visual image that invites the student to become completely involved in the experience. As the students interpret and become immersed in their imaginative play, the meaning of the experience is more tangible (Robertson, 2005). "They're learning to take up different pieces of information all at the same time. This is not just about entertainment. The skills that they are learning will transfer to the world of work" (Madill and Sanford, 2006). The skills obtained from playing video games may be more intricate than those required by simply reading a text.

Researchers (Schmidt, 2006) at the University of Victoria found that males exhibited high literacy levels in video game technology. The study concluded that the "unique richness" of the literacy of males in regards to video games

is not recognized as being meaningful or useful in today's educational system (Schmidt, 2006). Males enjoy reading the magazines and web sites that give directions, tips, and clues on how to progress further in the level of the games. Students actively seek information on the new game systems and video games that will be available in stores. Males interact with one another with a different heightened sense of excitement when discussing the video game, its characters, and action scenes. The interaction about and excitement regarding video games are the same behaviors that teachers seek in students required to read books and stories. The video game has led males to become a different type of reader requiring him to develop a literacy of the world of computers and online resources. Gee (2003) states that "video games are not replacing books, they are simply an art form that will interact with them, and change them and their role in society in various ways".

Teachers do not recognize that video games are a form of literacy or art. "It's very sophisticated, but a lot of adults aren't reading this kind of text, so we don't recognize it as high functioning because it doesn't look like traditional literacy", Leanna Madill said at the Canadian Society for the Study of Education in Toronto (2006). The video game players take for granted their knowledge of the video game terminology and computer literacy not recognizing the actual level of difficulty. Males are not becoming less literate; they are becoming more literate in a less traditional form of literacy. The new literacy is difficult for teachers to relate to and is one of the most pressing challenges for an educator in today's world.

CHALLENGES OF USING VIDEO GAMES TO IMPROVE LITERACY

One of the challenges facing educators is assessment of the new literacy. In order to measure improvement of literacy, there must be some form of assessment. Currently, the forms of avail-

able literacy assessment are the read the passage and answer questions type. This type of literacy assessment does not measure the new literacy that males have acquired. The use of games in instruction may promote different, more flexible types of assessments. It becomes the teacher's responsibility to become technologically literate to be able to develop and incorporate the new forms of assessment. Most teacher preparation programs have basic integration of technology classes in their programs but do not have the advanced level technology courses required for teachers to become adequately prepared to fully utilize and assess various forms of technology and technological literacy. Basically, we have PK-12th grade students entering classrooms with better developed technological skills than the teachers. The rush of new technology into the world has created a technological blockade in the educational system. Students have the abilities and skills to use technology and video games to learn, but teachers do not have the computer skills and video game knowledge to integrate video games into their learning curriculum.

Educators know that it is extremely important to motivate student learning through the use of the students' interests. Teachers also know that males are extremely interested in video games. To promote traditional literacy development, teachers must match students' interests with the right book. The same pedagogy holds true for using video games for instruction. Not all students like to play video games. Not all students like the same types of video games, and not all students are good at playing video games. Many students, including males, find video games to be frustrating. Providing a wide range of types of video games is important to match the interests and meet the needs of all male students.

Providing a wide variety of video games for instruction poses an additional problem. The expense of the hardware and software along with the lack of funding for such endeavors poses a threat to the development of a program that

utilizes video games to improve literacy. In the report, "Learning in Immersive Worlds: A Review of Game Based Learning", Sara de Freitas (2006) reported that "The main barrier to using games in school...is a lack of access to equipment and availability of up-to-date graphics/video cards-making it difficult for teachers to run games on their own PC's – a problem also faced in higher and further education". De Freitas (2006) listed the seven (7) major barriers to the integration of video games in learning practice including:

- "access to the correct hardware including PC's with high end graphics video cards;
- effective technical support or access to suitable technical support;
- familiarity with games-based software;
- community of practice within which to seek guidance and support;
- enough time to prepare effective games-based learning;
- learner groups who would like to learn using effective games-based approaches;
- cost of educational games software or licenses" (16)

Although barriers do exist for the integration of video games into the instructional process, there are ways to overcome the barriers.

POSSIBLE SOLUTIONS

Examining the barriers to the integration of video games into classroom curriculums can result in a more flexible instructional curriculum and assessment process. To ease the process of including video games to improve literacy of males in the regular school curriculum, the following initiatives need to be explored:

- Increase and improve video game training in teacher preparation programs;

- Create and adopt video game guidelines for teachers;
- Develop video game curriculum based on skills used in novels;
- Seek expanded funding for schools to purchase hardware and software;
- Analyze data to determine that video games do improve literacy in males.

Schools and colleges of education have begun to include instructional technology classes for all future teachers. These courses need to include methods of including video games into the curriculum as well as computer programming languages so that they will be able to develop video games that meet the curriculum requirements of individual classrooms. New master degree programs in instructional technology have appeared which may allow for more support in the schools for the teachers implementing game technology. Professional development classes in video game instruction for current teachers will also enhance the initiative. Having the teachers play the video games with the students will also serve as learning experiences for both the students and the teachers. The teachers can help instruct the concepts to be learned through playing the games; while the students teach the technology skills and literacy to be successful in the game.

For video games to be a successful tool in the classroom, teachers will need to have guidelines to follow and have video game learning outcomes aligned with the content standards. Typical guidelines for using video games to improve literacy of males include:

- Define and establish clear learning outcomes;
- Select the video game that supports the learning outcomes and that can be appropriately assessed;
- Sequence the learning activities so that the game fits and flows within the instruction,

practice, and assessment of the learning outcomes;

- Structure the game playing session with pre-play connections to the desired learning outcomes and post-play reflection on the actual concepts and skills learned;
- Assess the learning outcome of the video game including computer literacy skills;
- Evaluate the effectiveness of the game for reinforcing and teaching the desired skills and outcomes; and
- Make changes as needed based on the assessment data and feedback from students (de Freitas, 2006).

With the aforementioned guidelines serving as a framework and structure for teachers to follow, development of curricula integrating video games into literacy instruction will utilize best practices in teaching with video games.

In promoting literacy, best practices have typically revolved around the use of novels. Fiction and non-fiction books were used to teach classic literature skills. In today's educational arena, this approach is not working for all students, especially males (Conlin, 2003; Greene and Winters, 2006; Gurian, Henley, and Trueman, 2001). The skills that are usually taught with novels can be taught through the use of video games. These skills would be the easiest connection to video games. The specific skills/learning outcomes to be taught by the novel should be identified and sequenced. Then a video game which teaches the same skills should be identified/developed. The video game can then be placed in the correct sequence of instructional activities to insure that the proper outcomes occur. Assessments would determine the mastery of the outcomes/skills as well as the effectiveness of the game to teach and reinforce the desired outcomes and skills. Currently this type of literature curricula is not commercially available and would have to be created by the teachers. Curriculum development of this type is

time consuming and may require additional funding for teacher training and software development.

Funding for new initiatives in technology is essential to have the training, technical support, software support, and hardware to ensure success. Software designers need to consider the needs of teachers in developing new games. Teachers need to be proactive in demanding funding for development of curriculum that uses video games. Software designers and teachers need to come together to align literacy skills and standards with the current available video games to facilitate the development of the video game/literacy curriculum.

RECOMMENDATIONS FOR USING VIDEO GAMES TO IMPROVE LITERACY LEVELS OF MALES

To quicken the process of using video games to improve literacy levels in males, it is important to explore the current technology available. Millions of video games are available in stores all over the country. Although their educational qualities have not been their selling points, most video games can be used to teach certain literacy skills. For example, reading skills can be enhanced for males through video games by requiring the game player to read the directions for play first, then allowing the student to play the game, and finally having the student research the tips and hints to reach higher levels of play. Through this structure, teachers are requiring males to read. The more the males read, the better they get at it. Males do not resist reading about the video games that they love. Additional traditional literacy skills can be taught through video games including symbolism, genre, comprehension, literary merit, vocabulary development, logical thinking, critical thinking, and problem solving skills to list just a few. By using the current software available, traditional literacy connections can be made to the video games.

Male students can already list video games that match concepts being taught in history classes. Civilization builder games are historically based and allow the player to better understand geography of different areas and the effect of choices on the success or failure of the civilization. Video games create new paths and different outcomes that encourage the student to consider how the choices not made in real history could have changed historical events (Whelchel, 2007). By changing the choices made, students can actually create better civilizations and determine the causes of civilization failures through trial and error processes.

For learning with video games to be effective, connections need to be made between what is learned in the game and how it is applied to practice in other literary genres. This follows most theories and best practices of teaching and learning. Follow-up reflection of the learning outcomes by the game player and connections to the literary applications in different genres are essential (de Freitas, 2006). Wilhelm (1997) found that males have to responsively interact with the reading before critical analysis could take place. Games promote the responsive interaction required to think critically. Bonk and Dennen (2005) conducted empirical studies concerning skills supported by game-based learning approaches and found that “...another way to build conceptual knowledge is to engage in dialogue with peers or experts about the game during game play” (29). The hands-on learning experiences offered by video games promote the types of discussions between students that all teachers encourage. Male game players are more likely to excitedly explain their moves in a step-by-step sequence to another game player and analyze their moves and decisions altering the outcomes of the game.

In the new literacy studies conducted by Gee (2006), results supported the concept that reading and writing are not only mental achievements but are also social and cultural practices. Video games allow the players to simulate characters

and to share the characters' experiences and social relationships. Critical thinking skills are gained through interacting with the game, taking on new identities, solving problems through trial and error, and gaining expertise or literacy within the game (Craft, 2004). The analyzing skills gained through video game play are of the highest level of reading comprehension. If appropriately assessed, the literacy levels of the males would increase.

Through the vivid graphic images, character analysis, and challenges that video games present, students interact with the game acquiring mastery of skills that literacy teachers would recognize as essential for traditional literacy. Although students do not recognize the learning aspects of the game, they quickly become immersed in playing the game. In a presentation on "Teaching Generation X", Christopher Clark (2005) presented facts about learning including that video games and teachers have 30 seconds to "hook the player or the player is gone for good". He challenged educators to establish methods (including video games) to get students emotionally connected with the content as quickly as possible (Clark, 2005). Video games can "hook" males into obtaining high levels of literacy without even knowing that they are learning. Males may be able to show their literacy skills better through video games than through the traditional literacy assessments.

With males consistently scoring lower on literacy assessments than females, teachers need to know that:

- There is a real difference in literacy levels of males and females;
- Text selection and curriculum development should be based on the knowledge of males and their interests;
- Teacher assigned reading should be enhanced with self-selected reading;
- Males should be guided in making connections with texts through a wide variety of activities to support their reading comprehension and analysis skills (Bowen, 1997).

Knowing how males learn literacy skills best and what motivates them to read and learn is essential in closing the gap on literacy achievement.

As the keynote speaker at the University of Newcastle's 4th Biennial Working with Boys Building Fine Men's conference Dr. Martine F. Delfos, a Netherlands researcher said, "Boys learning can be enhanced by taking into their account evolutionary deeply embedded preference behavior. Teaching strategies should encompass boys' preference for competitive behavior; a cognitive style orientated more towards discovery and rote memory; and a need for strong peer connections. Boys have a tendency to action, and need action in class" (<http://www.newcastle.edu.au/news/2005/04/teachingboys.html>). In Michael Pollock's book entitled *Real Boys: Rescuing Our Sons from the Myths of Boyhood* (1998) states that boys have superior spatial abilities and see things in three dimension easily. He advocates using activities with intense movements and make believe violence. He contends that by allowing these types of activities, boys would learn how to harness the energy. Video games can create the active learning environment that males need through demonstration, demonstration, rehearsal, and reinforcement (Funk et al, 2006).

SUMMARY

The researchers (Craft; Cummings; Dawson, de Freitas; Funk et al) studying the use of video games in promoting learning agree that video games offer the hands-on types of experience that males need to efficiently learn. Males learn differently from females and require a more interactive, physical type of activity. Video games offer the vivid images, flashy display of text, action, and challenges that engage males in participating and learning. The current generation of male students enters classrooms with technology skills that far

exceed that of the teachers. Many teachers do not recognize the technology skills as literacy skills, although the literacy outcomes of a male playing a video game may be very similar to the outcomes expected in traditional literacy activities. Research on the use of video games in classrooms is expansive with more positive impacts noted than negative. Research on the use of video games to improve literacy skills of males is limited, however. James Gee is the leading researcher in the area of video games, learning, and literacy. He strongly promotes the use of video games to improve literacy skills. He explains that the literacy skills of the males currently in school are not lower than they have been in the past. They are just different. He contends that the literacy skills taught by the use of video games reflect the skills necessary to be successful in today's world. In the Review of Game Based Learning, de Freitas (2006) explains the possibilities that game based learning holds for the future educational system.

For game based learning to progress in the educational arena, more funding needs to be offered to schools to improve their levels of technological support and provide up-to-date equipment and software. Teacher preparation programs need to include more indepth computer classes including computer programming as well as instructional technology integration. Teachers need to be trained in the structure and guidelines for integrating video games into their curriculum. Teachers and video game developers need to work together to align content standards and games. Game developers need to consider the educational possibilities of creating games that go along with traditional reading materials. Video games can expand the understanding of the written texts, especially of males.

If the goal of learning is to "gain knowledge or understanding of a skill by study, instruction, or experience" (Webster's New World Dictionary, 353), video games may be the best learning tool for males. It offers the opportunities for males to

study their choices/moves, analyze the outcomes of those choices/moves, reflect on the changes to be made to improve their level of play, and experience a wide variety of situations that simulate real world issues and problems. The active nature of video games match the learning requirements of males and better engage them in the learning activity. Video games have an addictive nature to them resulting in video games being an excellent tool for creating lifelong learners. The entertaining aspect of the video game combined with the educational components create an potentially exciting and invigorating classroom learning tool which may improve the literacy levels of males. More research on the literacy level gains with the use of video games needs to be conducted to best determine how to meet the twenty-first century literacy needs of all students.

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KEY TERMS AND DEFINITIONS

Brain Differences: The variations found in the male and female brains.

Computer Assisted Courses: Software programs designed to provide extra instruction and practice on educational concepts. For example: extra computer based drill on multiplication facts.

Cultural Gender Differences: Ways in which males and females are expected to act and are treated in different cultures.

Educational Video Games: Software programs designed to provide instruction, practice, and feedback of educational concepts.

Edutainment: Entertaining ways to teach educational concepts typically through games.

Instructional Technology: The use of any type of computer software programs or computer components such as LCD projector and SMART Boards to teach students educational concepts.

New Literacy: The increased requirements of literacy, not only requiring understanding of the written word, but understanding of computer images, languages, software, and hardware.

Reading Assessments: Diagnostic tests to determine levels of reading.

Traditional Literacy: The ability to read the written word to gain understanding and meaning.

Visual Literacy: The ability to look at charts, graphs, pictures, and other visual images to grasp an intended message.

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Section II

Development and Design Methodologies

This section provides exhaustive coverage of conceptual architecture frameworks to endow with the reader a broad understanding of the promising technological developments within the field of instructional design. Research fundamentals imperative to the understanding of developmental processes within instructional design are offered. From broad surveys to specific discussions and case studies on electronic tools, the research found within this section spans the discipline while offering detailed, specific discussions. From basic designs to abstract development, these chapters serve to expand the reaches of development and design technologies within the instructional design community.

Chapter 2.1

Planning for Technology Integration

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ABSTRACT

Three models structure the planning for technology integration into instruction. Institutional needs are assessed for three dimensions suggested in Gilbert's, "Model of Human Competence." The areas needing addressing are typically within instruction; therefore, the process steps of a generic instructional design model are used. Within designing for instruction, Bransford's, "variables affecting learning," are the focal points organizational planners need to consider in planning instruction. Instruction is framed as "faculty-as-learner centered instruction." The variables are also a significant aspect of the content of instruction for faculty because faculty will use them in planning their own instruction integrated with technology.

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INTRODUCTION

The work of integrating technology into instruction at an institution may be daunting, particularly in the absence of a plan. To support technology integration, a plan is described with the goal of competence in the area of teaching. The plan calls for assessing the co-requisite conditions of an institution and their influences on the goal. The underlying model is Thomas Gilbert's model of human competence (Chevalier, 2003; Gilbert, 1978). The institutional needs assessment is combined with the general process of an instructional design model. The latter is used because a typical institutional condition needing intervention is the need for instruction among personnel. In practice, the entire process is best organized as a series of questions. The discussion is outlined according to that logic. The process flow will be familiar to instructional technologists and organizational

planners and it will appeal to their sense of a systemic approach to problem solution.

In the first part of the plan, technology is identified, and needs are assessed. The next two steps are instructional planning based on three reasons. First, most work in technology integration has a training need—personnel need to understand institutional information, or how, why, and when to use the target technology. Second, instructional planning models may be fairly wide-ranging and are flexible enough to apply to organizational systems—they work well for that purpose. Third, it is useful to consider faculty as the benefactors of learner-centered instruction, it may be considered as, “faculty-as-learner centered instruction.”

There are several strategies for the integration process that are based on research in the adoption of instructional technology. They are meeting subjective norms, which is akin to peer pressure, and the management of institutional expectations. The dimension for deciding the use of either strategy is the relative novelty or newness of a technology to an institution.

In summary, the process is workable, practical, and effective; that is, if followed it does help one to achieve technology integration at an institution. This ought to offer a strong measure of reassurance to those professionals undertaking the task. The challenge, as often happens, is in the actual implementation.

THE PLAN

Which technology is needed?

This is a wide-ranging question with conceptual as well as practical answers. For the purposes of institutional planning, the latter are more important; there are several notions of what technology is and which technology is wanted. Begin by considering the materials, tools, and processes that are useful for instruction. The technology used in instruction typically refers to computers or the software applications for computers.

The kinds of technology most institutional planners deal with include communication systems such as e-mail or messaging, and software applications for administrative use including student auditing systems. They also include instructional technologies that encompass software and hardware to facilitate learning. These include online learning management systems, individual audio devices, and online virtual worlds.

The purpose of identifying technology is to focus your work and to select that with which you will work. The result of this process is an answer to the question of which technology you want faculty to use in instruction. You know what is needed in general. Specify what is needed and set that as a standard expectation.

Part A: Assess the Institution Conceptual Model

1. Define Competence

A standard expectation has been established that faculty will use the given technology. (The working example in this chapter will be that faculty will use a learning management system (LMS) in instruction.) Express the expectation into operational terms—faculty will be competent in integrating an LMS in instruction. There may be other expectations, but for whichever expectation is decided, the criterion for it is competence. Identifying the expectation thus allows for using Thomas Gilbert’s model of human competence to structure this phase of the overall process (Chevalier, 2003; Gilbert, 1978).

The model suggests three co-requisite dimensions addressed from two areas of the institution. The dimensions are information, instrumentation, and motivation. The two areas are the external and the internal. The external refers to the institution. Typically, it includes the administration and its members who support and provide the conditions for the success of an individual faculty member. Because it does not include faculty, it is external to

Table 1. Gilbert's model of human competence

<i>Environmental Supports (Institution)</i> <i>Repertory of Behavior (Faculty Member)</i>	Information	Instrumentation	Incentives
	Knowledge	Capacity	Motives

the individual faculty member. The internal refers to individual faculty members. The emphases for the dimensions vary as appropriate for each area and are depicted in the matrix shown in Table 1.

For the external area—Information:

Information refers to the expectations of the institution expressed as vision, mission, and goal statements and includes institutional philosophy. It is the body of information about the institution that must be communicated to employees generally and specifically. It is likely that some parts will differ by institutional organization. There may be different expectations for faculty than there are for residential life staff, for example. The role of the external area including all levels of administration and support is to communicate the expectations for competence towards the faculty. This means that the provost as well as a librarian or a student activities staff member know that faculty are expected to use an LMS in instruction.

For the internal area—Knowledge:

To achieve competence in using an LMS for instruction, a faculty member must be aware of the information from the institution. A faculty member must also know, understand, and especially, accept the expectations for competence. The three dimensions are co-requisite meaning that all of them must be successful in order to achieve the goal of competence for individuals. It is obvious how if a faculty member does not accept the expectation, meeting competence is thwarted.

For the external area—Instrumentation:

Instrumentation refers to the tools and resources necessary to complete the competent behavior. For LMS use it includes computers, connection to a network, LMS software, support software, etc. The responsibilities of the institution are to ensure that the necessary resources are available and functioning at the expected level of quality, the availability is communicated, and use of the resources is possible. The institution is also responsible for providing education and training to learn how to use the technological resources.

For the internal area—Capacity:

Instrumentation for a faculty member refers to the ability or capacity, the interest or inclination towards, the scheduling allowing, or the selection of personnel for using LMS technology. Levels of individual instrumentation vary and the degrees of variation determine the quantity and quality of instruction or other remediation. Faculty may understand how to use LMS technology but do not have a preference for it, or vice versa.

For the external area—Motivation—Incentive:

The provision of incentives properly states the contributing role that an institution has towards a faculty member in regards to motivation. It is the responsibility of the institution to provide incentives for achieving competence by integrating LMS technology into instruction. There are a variety of incentives including salary, awards or other recognition such as the recognition for the

use of technology in instruction towards tenure and promotion. Motivation does not occur if the intended recipient does not accept the incentive. It is the responsibility of the institution to provide the appropriate incentives for faculty.

For the internal area—Motivation—Motives:

Faculty need to communicate their expectations for incentives. It is not accurately stated as a responsibility of faculty but rather as a natural consequence that if the appropriate incentives are made available, faculty will be motivated to achieve competence. For the purposes of this process, Gilbert's model is a useful structure. It is not entirely all-encompassing as an example, for much of faculty competence in using an LMS may be prompted by internal incentives such as personal or professional satisfaction. A knowledgeable institution will be aware of that, understand it, and foster it among faculty by making the conditions necessary for internal incentives to occur.

2. Assess Whether all Conditions are Met for Competence

Consider the three dimensions of the model of human competence. Use the model of competence to structure the assessment of an institution to determine which parts of the institution are providing the conditions necessary for competence to occur. Recall that the premise is that the competence is being sought. Specifically, competence in the integration of technology in instruction is being sought. The working example is the integration of Learning Management Systems (LMS) in instruction.

Here is what to do: External Information

Assess the institution's information. Recall that the external area refers to those parts of the institution that contribute to the work conditions of the target employee, which is in this case an

individual faculty member. Following are samples of assessment questions germane to the target of competence.

Message Communicated

- What is the institution's vision?
- Does it refer to the integration of technology? To what level of specificity?
- What is the institution's philosophy?
- Does it refer to the integration of technology? To what level of specificity?
- What are the goals of the institution?
- Do they refer to the integration of technology? To what level of specificity?
- Assess the layers of administration for the above questions beginning with the entire institution to the next level which may be a college, school or department, etc.

Communication Process

- How is the message communicated? It could be in an annual presidential or other executive address. It could also be in the institutional catalogue or other prominent publication.
- To whom is the message communicated? Is it for the general public? Is there an expectation that the message be received? How is that expectation operationalized? Is there an executive order directing all managers to announce the messages? Is it expected to be received by virtue of the fact that it is part of the primary point of contact for the institution, such as a Web site may be?
- Is there an expectation that the messages be accepted as well as being received and understood? How is that expectation operationalized? Is there an order from the executive or other level of administration directing the

Planning for Technology Integration

faculty to acknowledge and accept the messages?

- In summary, it needs to be established
 - Whether relevant communications are being made
 - Whether relevant communications are being made via appropriate channels
 - Whether the institution expects faculty to receive, understand, and accept the messages.

Internal Information

Assess faculty members' responses to the institution's information about competent behavior in the integration of technology in instruction—the use of an LMS.

Following are samples of assessment questions:

- Do the faculty know that the institution at some level of administration has a target of competence in the use of an LMS?
- Do the faculty know that competence in the use of an LMS is expected?
- Do the faculty understand the institutional target? Do they know what an LMS is? Do they know which is being used by the institution? Do they know what the implementation plans for such a system are?
- Do the faculty understand the institution's intentions?
- Do the faculty understand the institution's expectations?
- Do the faculty accept the institution's intentions?
- Do the faculty accept the institution's expectations?
- Will the faculty act on the institution's intentions and expectations?
- In summary, it needs to be established
 - Whether relevant communications about the expectations of competence are being received

- Whether relevant communications are being understood, and
- Whether relevant communications are being accepted by faculty.

External Instrumentation: Resources

Assess the institution's resources. In the discussion above about the conceptual model, an assumption was made that it was the responsibility of the institution—the area external to the target of competent behavior, the faculty member—to provide the necessary resources in all its connotations. These include hardware, software, and spaces for the instrumentation to be used such as laboratories, classrooms, or offices. The connotations include reasonable availability to the instrumentation in its various locations. Reasonable accessibility needs to be provided, also. Importantly, either instruction in the use of the instrumentation needs to be provided or means for the instruction need to be provided. The institution may conduct faculty development programming or faculty may participate in such instruction externally.

Following are samples of assessment questions:

- Is the appropriate kind of hardware provided?
- Is the appropriate kind of software provided?
- Is there enough instrumentation or are there enough opportunities to use it?
- Is the instrumentation functional, current, reliable, and in good working order?
- To what degree of accommodation must faculty submit in order to use the instrumentation? Is it within proximity? Is the schedule for the use of it reasonable?
- Is instruction for the competent behavior, using an LMS, provided?
- Is the necessary instrumentation accessible? (Can it be readily accessed?)

- Is instruction relevant to the needs of the students, that is, the faculty?
 - Is instruction scheduled to meet the widely heterogeneous schedules of faculty?
 - In summary, it needs to be established
 - Whether there is appropriate instrumentation
 - Whether the instrumentation is available, there is enough of it
 - Whether the instrumentation is operational
 - Whether the instrumentation is accessible, the distance to it is reasonable and the schedule for access is reasonable
 - Whether there is appropriate training.
- Internal Instrumentation: Capacity

Assess faculty members' responses to the instrumentation. Following are samples of assessment questions:

- Do the faculty know which resources are needed?
- Do the faculty know when the resources are available?
- Do the faculty know where the resources are available?
- Do the faculty know how to get access to the resources, that is, locations, log in, passwords, etc.?
- Do the faculty schedules allow for accessing the resources?
- Do the faculty know how to use the resources?
- Do the faculty know how to access instruction for the use of the resources?
- Do the faculty learn from the instruction?
- In summary, it needs to be established
 - Whether the faculty know what resources are needed
 - Whether the faculty know how the resources are available

- Whether the faculty know how to access the resources
- Whether the faculty can accommodate the expected use of the resources per their schedule
- Whether the faculty know that training is available
- Whether the faculty make use of available training
- Whether the faculty learn from the training.

External Motivation: Incentives

Assess the institution's use of incentives for faculty to reward competence in the use of an LMS. Recall that the institution's contribution to motivation is in the provision of incentives. Following are samples of assessment questions:

- Are there incentives for the use of an LMS?
- Which incentives are there for the use of an LMS?
- Do the incentives match the needs and expectations of faculty?
- Are the incentives material, such as salary or other compensation?
- Are the incentives symbolic, such as awards?
- Do the incentives acknowledge the professionalism of the faculty?
- Does competence in LMS use contribute to faculty promotion and tenure?
- Are conditions made available that promote faculty members' internal motivation for the pursuit of competence?
- In summary, it needs to be established
 - Whether incentives are available to faculty for LMS use
 - Whether the incentives are appropriate.

Internal Motivation

Assess the faculty members' responses to incentives rewarding competence in the use of an LMS. Recall that it is characteristic of human nature that an appropriate incentive be given in order for a person to accept it.

Following are samples of assessment questions:

- Are the incentives appropriate, that is, do they motivate the faculty to pursue competence in using the LMS?
- Is internal motivation encouraged?

In summary, it needs to be established

- Whether faculty respond to the incentives.

3. Repair the Areas of Deficiency

Communication Deficiency

The model suggests the most important dimensions that contribute to competence. Once they have been defined and identified in an organization, the next step is to determine the status of whether the dimensions are meeting the expectations for competence. If, for instance, the institution has formulated a statement about the use of an LMS but demonstrates limited communication of it as evidenced by the absence of principal communication media for the campus such as its Web site, internal e-mail or print publication, communication through the chain of command, etc. and if a survey of employees, particularly the faculty, reveals that there is a little awareness of the institutional view, then there is a deficit of some sort. From this deficit it can be inferred that there may not be enough communication, or that the media are ineffective, or that the intended audience, the faculty, does not respond to the media. It is impossible to expect that there would be action taken or understanding of a communication if attention is not paid to it. The action of identifying deficits in expectations and then correcting them is the essential process for enabling the conditions necessary for competence in the use of an LMS.

Instrumentation Deficiency

The institutional assessment may reveal that there is an LMS license, but few of the faculty have been exposed to it or have been instructed in its use. Deficiencies in this case are the lack of familiarity with and knowledge and skill in the use of the LMS for instruction. The need to be addressed would be the understanding and the skill sets of the faculty.

Motivation Deficiency

The institutional assessment may reveal that there are not any incentives provided to encourage and maintain the use of the LMS. The faculty members who have integrated it into instruction are largely early adopters who respond to their own personal incentives who would attempt to use the LMS regardless of an institutional common plan.

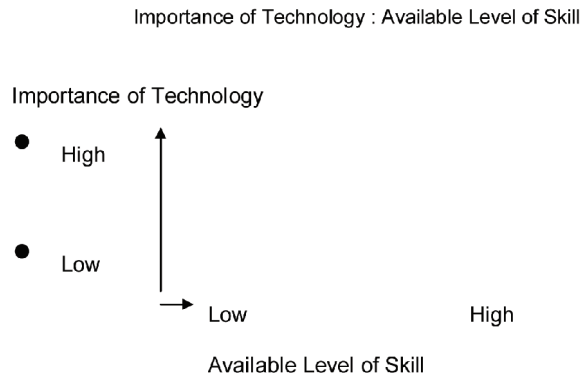
The examples of deficits are generalized and there will be nuanced versions of them in the organizational assessment. Predictable deficiencies are in the areas of faculty capacity and knowledge and in institutional incentives in respect of the integration of technology. Because these two areas of deficiency are the most likely to occur, strategies for addressing them are suggested.

Part B: Professional Development—Provide Instruction

When your organizational assessment reveals that the area of deficiency is capacity, it may be that training for professional development is appropriate. Consider the technology that you are targeting, LMS in a matrix of two dimensions: degree of importance and level of skill among faculty.

See Figure 1. The quadrant of interest is the intersection of high importance and low skills. This may be evidence for the need for instruction. If there were high importance and high related skills, then it is unlikely that instruction would satisfy the deficit determined by the organizational assessment.

Figure 1. A need for training indicated



The deficiency between the importance of the skills needed and the actual skills available illustrates a situation predicted by Rossett's (1987) initiators of training needs assessments—the use of an LMS may be a “new system or technology” for those faculty with low skills in the integration of the highly important use of LMS. When there is a need for instruction, follow an instructional design model even though the learners are faculty members. In this case, you can develop “faculty-as-learner centered instruction.”

An Instructional Design Model

Consider preparation for teaching faculty as planning for instruction—follow an instructional design model to guide your instructional planning. ADDIE is a model with most of the elements which are found in other instructional design models as well as in research and planning models. The acronym stands for Assessment, Design, Develop, Implement, and Evaluate (Molenda, 2003; Schrock, 1991)

Assessment

How do you know instruction is needed?

The organizational assessment that was done within the parameters of the model of human competence resulted in the identification of de-

ficiencies such as the need for instruction among faculty. The assessment should also have revealed the level of instruction needed.

Design Instruction

What do the faculty need to learn? What are your expected outcomes for the instruction?

Understand your students and their needs and plan to meet them. Plan “faculty-as-learner centered” instruction: What do you need to know about your faculty-students?

To guide your design process focus on the factors affecting learning suggested by Bransford (1979). These factors will be used twice in your planning; once for planning the instruction of your students. The second time will be as the content of the instruction your faculty-students will learn. The factors are the learners’ characteristics; the media of instruction, the method of instruction, and assessment of learning.

Learner Characteristics

Who are faculty?

What are their needs?

How do they respond to technology?

Some characteristics of academic faculty include the love of and the pursuit of learning and recognition for one’s intellect. Find other traits

that would be relevant to your instruction of them. Faculty response to the use of technology may not be the same as the general public because faculty members are increasingly confronted with technology in their work. As a result, they would have more opportunities and direct experience to form opinions about technology.

Media

Which media are appropriate?

Because one of the subjects being taught would be the use of an LMS, the system itself ought to be used directly in instruction. Faculty as highly intelligent, adult learners ought to respond well to the medium of instruction being the same as the subject of instruction. There is a double lesson in this instruction in that if the media are used well to demonstrate how technology can facilitate media, then the point needs to be made that that is the eventual goal.

Method

What will the learners need to do during instruction?

In the basis for Bransford's original work, the term used was orienting task. This refers to the activity that the learner performed in order to learn the point of the instruction. This could be a method. Would the presentation and practice of information be orchestrated for the learners' discovery or would it be provided by the instructor or other source of information? For this group of adult learners, experience has shown that non-embarrassing actual or "hands on" practice in very small groups is appreciated.

Assessment

How will you and the students know they are learning?

Are your faculty-students learning what you and they expected? Is your instruction successful? A much used and useful assessment of your instruction is the Small Group Instructional Diagnosis (Clark & Redmond, 1982).

There are three questions:

1. What did you like about the instruction?
 2. What should have been excluded from the instruction?
 3. What should have been included in the instruction?
- Content
What will they learn?

The subject of the instruction for the faculty is the knowledge and skills necessary for using the LMS. In order to achieve integration of the LMS, the faculty-students also need to learn about the factors affecting learning to help plan their instruction. Just as the planner for technology integration follows an instructional design model and the factors affecting learning, faculty need to know about the factors affecting learning for their students. They need to know the characteristics of their students, the ones that will cause them to modify or target their instruction such as students' reading ability. There may be needs to keep in mind such as the familiarity with the native language of instruction.

The faculty-students need to know which media work well with the subjects they are teaching and with the needs of their students. They need to know which methods work well with their students and with the media they use. They also need to know which assessments are informative and instructive.

Part C: Motivation: Select a Strategy

It is necessary to create the conditions for which technology can be integrated. To select your strategy, determine the relative novelty for technol-

ogy use at the institution. The assessment of the institution using the competence model ought to reveal the relative novelty of the technology being integrated. Is the use of an LMS something new and unfamiliar or is it common knowledge and there is much experience in the use of it? There are two principal organizational strategies to employ based on the relative novelty. At an institution where the use of technology is novel, motivate with the goal that there is much awareness, much interest, much familiarity: use subjective norms, create dependencies, and create infrastructure. Where technology use is typical and not novel, manage use per institutional needs. Identify expectations, plan staffing and curricula accordingly. At such institutions, technology is integrated and the strategic goal is to maintain the integration through management of it.

Technology Integration as Novel

For an institution where technology is new, the goals are widespread awareness building and motivation. The strategies are to use subjective norms, create dependencies, and create infrastructure.

Subjective Norms

A series of studies (Marcinkiewicz, 1996, 1995/1995, 1995, 1993/1994) revealed that the most predictive personological variable of teachers' use of instructional computing was subjective norms. Subjective norms refers to the perception that teachers use technology because they believe that significant constituents expect them to use technology. They use technology because they believe that students, administrators, learned societies, and their colleagues expect them to. It is similar to "peer pressure" in that the incentive is meeting the perceived expectations of others. Subjective norms are operationalized by communicating the expectations to faculty. The research has shown that faculty will use technology if they

believe that the constituent groups expect it of them. It supports the need for excellent communication. They need to know that students expect LMS in instruction. Students can be surveyed to know their minds on the matter. Faculty need to know that administration expects them to use LMS. This coincides with the prediction of the model of human competence discussed above. Faculty need to know that their colleagues and learned societies expect them to use LMS. These groups are the support system of faculty; they are the peers and colleagues with whom faculty identify.

Create Dependencies and Infrastructure

One knows that one is responding to a dependency for technology when a task cannot be accomplished without it, or the completion of a task would be done differently than typically expected. An example of this is the cessation of departmental memos on paper; memos will only be posted online via e-mail or perhaps via an LMS. New course offerings will be availed if they are conducted as hybrids with some percentage of them requiring online LMS instruction; otherwise, the courses are not run. Many occurrences exist in professional and personal life including the upgrading of technical services, price changes for needed services, etc. The creation of dependencies is not a goal, but rather a strategy that provides the incentive of completion of a necessary task. The tasks to be performed ought to be a part of the infrastructure of an institution. An example of the complete use of an LMS as a part of the infrastructure of an institution is an LMS for an online degree. In this instance, completion of the degree is made possible or required by the use of an LMS because it is a fundamental part of the infrastructure of the institution offering the degree. Make the use of the technology necessary for the performance of activities that are parts of the infrastructure.

Technology Integration as Mature

An institution that can post employment announcements for faculty requiring knowledge and experience in the use of LMS demonstrates maturity in the integration of technology for instruction. Under such conditions, an institution has defined technology and its expectations for its use; faculty, staff, students, and administration accept and expect the use of the technology. There is sufficient instrumentation available and accessible and there are continuous opportunities for professional development. There are also incentives for the successful use of the technology and faculty are motivated by the incentives. This level of technology integration is the ideal goal state for institutions. In this state the strategy for the integration is management of expectations. This is accomplished by hiring appropriately and providing professional development opportunities. Furthermore, there is continual planning for technology integration.

SUMMARY

The purpose of this set of processes is to guide organizational planners for the integration of technology into instruction. A model for human competence is used to specify the deficient areas, those not supporting competence in the integration of technology. Typically, the deficiencies are the lack of knowledge or skills. An organizational strategy for the introduction of new technology is to begin to create dependencies on it for the completion of necessary tasks. Another strategy is to communicate the expectation that the faculty are expected to use technology by their peers, students, learned societies, and administration. For organizations where technology integration is mature or not novel, integration can be managed by the administration as by institutionalizing job descriptions that require integration.

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KEY TERMS AND DEFINITIONS

Dependency: The need for using technology in order to complete one's work.

Integration: The condition in which technology is used in instruction so that without it instruction would not be possible as intended.

Learning Management System (LMS): A set of online processes focused on instruction that function together.

Subjective Norms: The personal belief that others have expectations that one should behave in a certain way. The belief influences one to behave that way.

Technology: The materials, processes, or tools used to solve problems.

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Chapter 2.2

Bringing Reality into the Classroom

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ABSTRACT

Researchers and practitioners have been advocating that the nature of learning is contextually situated, and that this should be reflected in the development of learning experiences designed to acquire knowledge. However, learning experiences are still being developed as mere one-dimensional processes aimed to move, from the teacher into the student, pure autonomous pieces of content that are stripped from all their contextual and cultural information. The purpose of this manuscript is to propose a methodology to allow instructional designers and teachers to encompass the complexities of reality so that they can bring it pedagogically into their classrooms to build meaningful authentic learning experiences. This methodology permits students to first engage

in problem solving activities and then present their solutions using a computer application as a cognitive tool. The chapter discusses literature related with the development of situated learning environments, proposes a methodology for facilitating context-dependent knowledge building, and describes a case where the methodology was used and evaluated.

INTRODUCTION

For more than a decade, researchers and practitioners have been advocating that the nature of learning is contextually situated, and that this should be reflected in the development of learning experiences designed to acquire knowledge. However, in spite of all the evidence gathered so far about the importance of understanding the process of human learning as intrinsically linked to context

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and culture (Brown, Collins, & Duguid, 1989) and indistinct from acting (Maturana & Varela, 1998), learning experiences are still being developed as mere one-dimensional processes aimed to move, from the teacher into the student, pure autonomous pieces of content that are stripped from all their contextual and cultural information.

According to the constructivist perspective, this linear, cause-and-effect understanding of the learning process is used because knowledge, the product of learning, is wrongly conceptualized as an object that can be transferred from some form of repository to a human mind. Thus, knowledge is confounded with information and content. Moreover, information and content are also incorrectly understood as being independent of the contexts and cultures in which they were developed and used. Consequently, human knowing and learning are equated with the basic acts of being exposed to, and storing, independent entities of information and content.

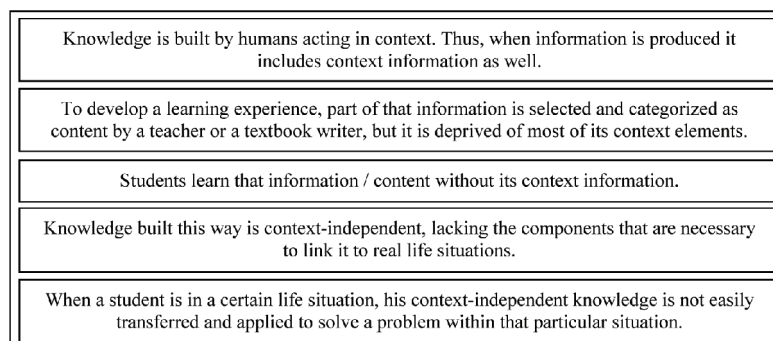
The consequence of educating students this way is that they end up with rather big amounts of inert decontextualized knowledge, which they do not know what to do with, besides using it to move forward in the school system that has given them this kind of knowledge. During their school years, basic education learners memorize content as if they did not have to do anything with it besides answering a test. They, more or less, accept as an act of faith their teachers' promise about the

possible future transfer of that knowledge to their "real life." Nevertheless, in higher education, students that are finishing their degrees always worry about not having cleared the relationship between what they learned and the practical nature of their upcoming jobs. In general, it can be said that students do not relate what they learn to the contexts and cultures where they are supposed to use that knowledge because it is context-independent and lacks the components that are necessary to link it to real life situations (See Figure 1); they only relate what they are learning to the very school's traditional didactic culture (Brown et al., 1989). In a few words, students receive, memorize, repeat, move to the next grade, and forget.

Some causes that could explain why educational institutions remain in the didactic teaching and learning paradigm are:

1. Accepting the constructivist notion that knowledge, learning, and content do not exist in a vacuum and that they are always context related entails profound changes to the school as a whole because, in essence, this posture represents a new paradigm. In consequence, it "...requires more of a paradigm shift in educational practice than most institutions are ready to accommodate." (Jonassen & Carr, 2000, p. 166). It is not just a matter of using a new group of teaching strategies, it means innovating in several of the schools'

Figure 1. Knowledge is built as context-independent



basic educational processes such as curriculum design, teachers training, learning assessment, relationships with parents, and most importantly, classroom environment. The basic teaching and learning process has to change profoundly because, as Miettinen (1999) states, to incorporate content context into the classroom the didactic model of teaching needs to be broken.

2. Even when some schools are opened to this new view of learning, they do not take action because they still do not know how to manage the different educational processes that emerge under this new paradigm. That is, under the traditional paradigm, administrators clearly understand the orderly cause and effect model of pre-stating objectives, identifying instructional strategies to teach them, and assessing if, what was stated in the objectives, was or not achieved. A linear model like this facilitates the control and supervision of what is going on inside the classroom and allows to account for its results. We could say that, at the organizational level, there is not a situated learning model for administering an educational institution.
3. There are few instructional design models for creating learning activities under this different paradigm, and the ones that have been developed have not been sufficiently tried and researched to be proven practical.

The purpose of this manuscript is to further explore and add to the solution of the third identified cause. That is, based on several years of applying constructivist theory on my teaching and research projects, I will propose a methodology to allow instructional designers and teachers to encompass the complexities of reality so that they can bring it pedagogically into their classrooms to build meaningful authentic learning experiences. The aim is to describe how to contextualize content so that students can actively build and negotiate meanings and link them to environments where

they can potentially apply those meanings. In other words, I will try to describe a methodology to, on the one hand, “bring reality into the classroom,” and, on the other, facilitate for students the process of transferring the newly constructed knowledge back to “reality.”

On this subject, some important questions that have been addressed by researchers are:

1. How can we analyze and comprehend the complex real-life situations, where human knowledge is created, together with their contexts of activities and cultures? (See Leontev’s studies, for example Leontev, 1978; Engeström, Miettinen, & Punamäki, 1999; Brown & Duguid, 2000; and the special section of volume 45, number 2, 2005 of the *Educational Technology Magazine*, which was dedicated to cultural studies in instructional design).
2. How can we bring those complex real-life situations into the classroom so that our students can live meaningful authentic learning experiences? (See the literature around the design of learning environments, for example: Cognition & Technology Group at Vanderbilt, 1993; Campbell & Monson, 1994; Jonassen, 1999; Jonassen & Rohrer-Murphy, 1999; Wilson, 1996).
3. How can this type of knowledge construction be evaluated, that is, how can we assess how knowledge is being actually constructed inside the students’ heads? About this particular aspect, although most of the authors cited in the previous questions also address evaluation issues, assessing this type of learning becomes complicated because it requires a qualitative orientation. In this line, as part of the proposed methodology, this article will discuss an innovative way to assess student’s learning.

The first two questions have been well addressed by Leontev’s activity theory and Jonas-

sen's model for constructive learning environments design. However, to further explore how we can bring complex real-life situations into the classroom and to address the evaluation issue, this article will suggest a methodology, which can be used by teachers and/or instructional designers when they are developing a problem-based learning environment. This methodology permits students to first engage in problem solving activities and then present their solutions using a computer application as a cognitive tool. The software used during this study was developed by the local software company *Jacarandas Software* (www.jacarandas.com), which specializes in educational software. The software is commercially registered as *HiperVideo Studio®*, and it basically allows students to display a produced video and stops it at selected points where they believe that more information should be given to further explain their ideas (see Figure 2). The idea is that by indexing the context depicted in a video, students bring out their mental representations of the learned content.

The rest of this article is organized in three sections. The first discusses literature related to the constructivism paradigm and its implications for the development of situated learning environments. The second section takes into account the ideas of section one and proposes a methodology for facilitating context-dependent knowledge building. Finally, the third section will present a case where the methodology was used and evaluated.

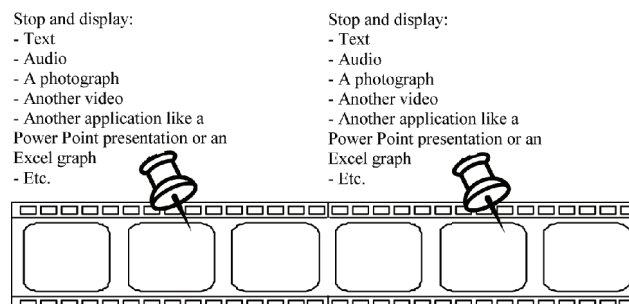
BACKGROUND

Situated Cognition

The idea that knowledge, learning, and content are contextually situated can be traced to several theoretical endeavors, for example Bednar, Cunningham, Duffy, and Perry, 1992; Brown et al., 1989, 2000; Greeno, 1998; Lave and Wenger, 1991; and Wenger, 1998. In their seminal situated cognition model, Brown et al. (1989) stated that knowledge that is being built in the present moment is in part a product of the interdependency of the actual activity, the information and tools used, and their context and cultural underpinnings. Thus, students not only learn about concepts and the use of tools, but also about the context and cultures where those concepts and tools were developed and used. Furthermore, the authors state that "All knowledge is, we believe, like language. Its constituent parts index the world..." (Brown et al., 1989, p. 22). That is, the constituent parts of the knowledge that is built during a learning experience are linked to both the context where it is learned and to the context where the information that is being learned was developed by other human beings.

Therefore, a learning experience designed to facilitate the construction of context-dependent knowledge by students must also include contextual elements from the context where the information was originally produced. This way, students

Figure 2. A film analogy to what students can do with the *HiperVideo Studio®* software



establish explicit links or indexes between their constructed knowledge and the content's context; which, in turn, facilitates transferring back knowledge to the students' everyday problematic situations (see Figure 3).

These ideas are important for the purpose of this article because based on the notion that our built knowledge, like language, indexes, or points to certain elements of our life situations, the proposed methodology will ask students to index a video produced by them depicting a certain situation by sticking pins, metaphorically speaking, with their ideas attached to them. These ideas can be presented in several formats (i.e., as text, as images, or as audio using other software applications like a PowerPoint slide presentation, an Excel graph, or a Web page (see Figure 2)). These indexes are context-dependent because they are directly related to a certain time and place as shown in the video. Students decide at which point to stick a pin and how to further explain their ideas, that is, they can show an image, a graph, or a piece of text. In this way, they are explaining to the world their inner understanding of certain content.

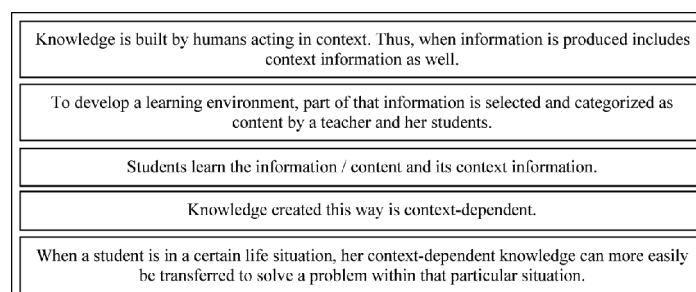
USING ACTIVITY THEORY AS A FRAMEWORK

As discussed so far, situated learning theories propose that knowledge is context-dependent and that learning experiences must be multi-dimensional

to include context information. This perspective understands teaching and learning systemically; that is, not as a systematic linear cause-and-effect process. Thus, if one wants to include contextual information in a learning environment, it is better to have a holistic conception of the learning process to encompass all relationships and interconnections (Carr, 1996) that naturally happen in a complex human learning activity. Once a teacher has selected a subset of information as content (not all information is content, but all content is information), he or she needs to develop a contextual type of learning and to deeply understand the context where that information was produced. Generally speaking, information is produced by a group of people acting as a community with a common interest and purpose. These groups can interact informally, like a stamp collecting club or very formally like a group of professionals interacting together to build the bodies of knowledge that define a certain discipline.

Consequently, to include contextual information related to the group of persons that developed the content to be learned as part of the whole learning experience, a teacher needs to analyze that group's complex real-life situations and settings. Above all, the teacher must analyze their systems of activities because that is where their knowledge is created. To this end, although useful methods for cultural and contextual analysis are still a concern for research (Quek & Shah, 2004), several investigators are proposing, in tune with the socio-constructivist epistemology, to use activity

Figure 3. Knowledge is context-dependent



theory as an appropriate socio-cultural framework for analyzing human community systems (Engeström et al., 1999; Jonassen, 1999; Jonassen et al., 1999; Johri, 2005; Quek et al., 2004; Wilson, 2005). The strength of activity theory lies in the fact that it offers a systemic perspective to analyze complex human systems of activities.

Activity theory was developed by Russian psychologists Leontev, Luria, and Vygotsky. It is based on the principles of dialectical and historical materialism, which Vygotsky used to analyze the historical development of social activity and how it shapes and is shaped by changes in human consciousness (Vygotsky, 1982). Jonassen et al. (1999) state that activity theory “is a powerful socio-cultural and socio-historical lens through which we can analyze most forms of human activity.” (p. 62).

Traditionally, linear cause-and-effect propositions are established to understand actions, for example, if teachers teach then students learn. Alternatively, activity theory proposes triangular relationships, a model that is more powerful to encompass all the relational complexities of a human system. This structural model of an activity system portrays the dynamic relationship between a subject, the object of his activity and the mediating tools employed during the activity, such as symbol systems, methods, and instruments (see Figure 4). It is in this Vygotskian idea of mediation that the context information is included because different cultures choose different tools

to perform their specific actions, which, in turn, “shape the way people act and think.” (Jonassen et al., 1999).

To encompass community actions and to see the process more as a collective activity system, Engeström et al. (1999, 2002) depicts these triangular relationships graphically as shown in Figure 5. The dynamics in this basic model states that through the recursive activity of a subject, or a team of subjects, who belong to a community whose activities are mediated through rules of relationship and division of labor, the object is transformed and projected into a broader final outcome. In addition, the subjects’ activities are organized hierarchically, according to Leontev (1978), in actions and operations.

Thus, in order for teachers to apply activity theory to understand the activities that characterize the everyday actions of a particular group of professionals, they can apply several data collection methods like observations, interviews, questionnaires, analysis of documents, etc. For example, to understand the context of social researchers, a teacher can observe the everyday actions of those professionals and interview them. Some of the tasks are identifying the professional goals that this group of professionals is traditionally pursuing, clarifying the inner motives that drive these individuals to perform as members of that profession, and identifying the types of products that this group of professionals obtains as the result of doing their activities.

Figure 4. Activity system

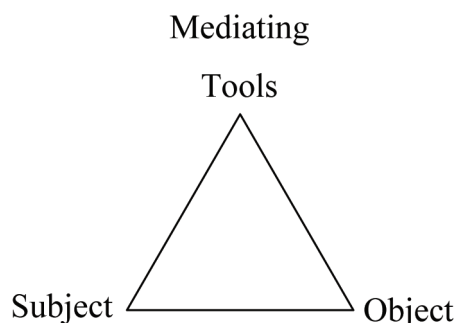
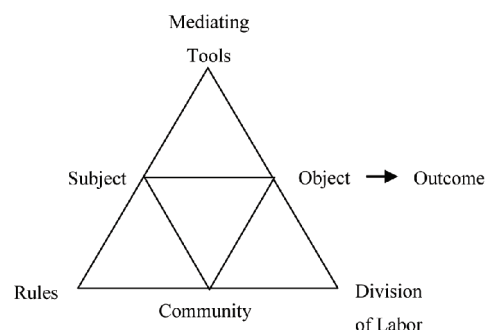


Figure 5. Collective activity system



Jonassen et al. (1999) present and discuss six steps to use activity theory as a flexible framework for analyzing a certain system of human activities. The data can then be used to design the components that a constructive learning environment should have. The first step explains the purpose, motives, and goals of the activity system; the second clarifies the components of the activity system; that is, the subject, object, community, rules, and division of labor; the third step analyzes the structure of all the activities that are done by subjects; the fourth analyzes all the tools and mediators used by the activity system; the fifth analyzes the context within which activities take place; and the sixth links the outcomes of the previous steps to clarify the activity system dynamics.

THE CONCEPT OF COGNITIVE TOOL

The concept of tool is substantial in socio-constructivist notions. To further understand it, it is important to bring into consideration Vygotsky's theory of mediated activity, an essential part of activity theory, which argues that "all purposeful human activity is accomplished through the use of physical and/or psychological tools...by the subject in order to achieve the object" (Quek et al., 2004). In this sense, tools are not just conceptualized as mere physical extensions of the subject to increase his or her physical strength like a hammer or a screwdriver; they are understood as cognitive tools that mediate the subjects' activities by supporting, guiding, and extending their thinking processes (Derry, 1990, discussed by Jonassen et al., 2000). Jonassen (1996) calls this type of tools *mindtools* (i.e., knowledge construction tools that students learn *with*, not *from* or *about*). He defines them as "computer-based tools and learning environments that have been adapted or developed to function as intellectual partners with the learner in order to engage and facilitate critical thinking and higher-order learning" (p. 9). Also, Jonassen et al. (2000) refer to

mindtools as computer software applications that "...enable learners to think in ways that they otherwise would not and could not" (p. 167) and that "...scaffold different kinds of thinking and knowledge representation" (p. 167).

This concept of cognitive tool is relevant to the methodology proposed in this article because students, going through the problem-solving process inside the learning environment developed by the teacher, are asked to produce a program using the HiperVideo Studio software to argue in support of their selected problem solution by explaining and justifying their selection.

The HiperVideo Studio software is considered a cognitive tool because it enables learners to capture in video a piece of a real life situation and relate it to their inner process of meaning construction. Learners engage in higher-order thinking by deciding in which parts of the video to put indexes to further explain how they understand the learning environment content. When they present their produced programs to the rest of the class, they engage in metacognitive thinking by identifying their own knowledge production process.

The set of indexes placed in the video by the students are context-dependent because they are related to the context shown in the video. The set constitutes in itself a network or a map that shows what is in the student's head and explains how he or she sees the world in relation to his or her (the knower's) understanding of the content.

THE PROPOSED METHODOLOGY

Based on the ideas discussed in the previous section, in this one, the instructional methodology for bringing reality into the classroom is presented and discussed in more detail. For the purposes of this article, a methodology is conceptualized as an organized body of pedagogical strategies. According to the socio-constructivist base of this methodology, the pedagogical strategies discussed in this section are not only related to the teaching

aspects of the process, but they also incorporate collaborative actions, including thinking done by instructional designers, teachers, and students.

The pedagogical strategies are categorized (see Figure 6) into three different kinds of strategies: (1) Learning environment development strategies, where the instructional designer and/or teacher develops problem-based learning environments that replicate a system of activities done by a particular group of professionals; (2) Problem solving engagement strategies, where the teacher and the students collaborate in the knowledge construction process and engage in complex problem-based learning; and (3) Knowledge representation strategies, where learners engage in further reflection by constructing a product to represent what they are learning and show it to the rest of the learning teams. This product is also used by the teacher to assess how students understand the learning environment content.

THREE PEDAGOGICAL STRATEGIES

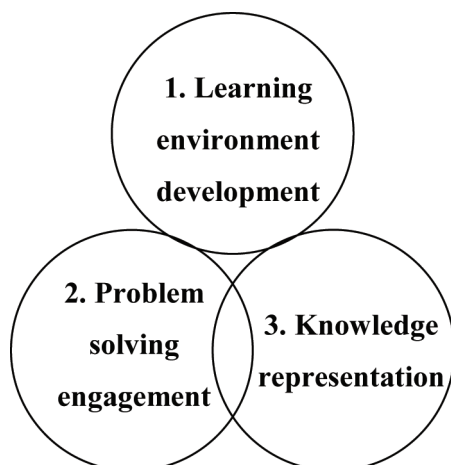
1. **Learning environment development strategies:** These strategies develop a learning environment based on the system of activities

that characterize the everyday actions of a particular group of professionals.

As stated earlier, information and content are intrinsically related to the contexts and cultures in which they were developed and used. For the regular school classroom, this means that most of the content domains to be learned are actually linked to the different activities of a group of professionals. For instance, Cobb, Perlwitz, and Underwood-Gregg (1998, p. 73) state that “students who engage in mathematical practices involving conventions, models, and symbolisms must necessarily be constructing the taken-as-shared concepts of the mathematics community.” That is, in the learning of mathematics, students not only learn the subject matter but also live a process of acculturation on what it means to be a mathematician or any other profession, which makes a wide use of the mathematical language such as physicist or engineer. Also, if we consider that most of what experts do in their professional contexts is solving problems and not answering exams, as Jonassen (2004) states in the introduction of one of his books on problem solving, then a mathematics learning environment must include conventions, models, and symbolisms used by mathematicians, physicists or engineers, and allow students to engage in solving the traditional problems that these professionals face every day.

Accordingly, to initiate the methodology proposed in this section and use activity theory, the instructional designer and/or the teacher (it is very common in schools that the instructional designer and the teacher are the same person) must develop a constructivist learning environment based on the system of activities that characterize the everyday actions of a particular group of professionals. For example, a learning environment can be based on the traditional activities of the community of historians that gather information about a certain event and inductively analyze it to identify the

Figure 6. Pedagogical strategies



possible causes that originated it. Another learning environment could be built around the set of activities that a social researcher performs to phenomenologically understand a certain social context, such as the complex human dynamics of a school classroom. Another example would be a learning environment based on the everyday actions that an electronic engineer does when working at a steel producing company, like designing a device to control temperature.

Once the activity system of a particular group of professionals has been identified using activity theory (See Table 1 as an example), the methodology recommended in this section suggests that the

teacher develops a learning environment based on the data gathered from that group. The type of learning environment suggested here has two characteristics: (1) according to the traditional definition of a learning environment, students should live meaningful, authentic learning activities making use of tools and resources to develop the skills to solve problems (Wilson, 1996); and (2) in order to facilitate the process of acculturation, the environment should also simulate the type of problem solving activities that a community of professionals face everyday. Both characteristics are suggested because knowledge construction is both understood as “a person’s meanings con-

Table 1. Components of the community of social researchers’ activity system

Community:	Educational researchers working in social sciences (scholars, academics, social workers) Purpose of their activity: Develop research projects towards the building of theory frameworks to better understand the social phenomena
Subjects:	Educational researchers working under the qualitative paradigm Purpose of their activity: apply qualitative research methodology to understand, from the participants’ perspective, relationships among different people, meanings, events and contexts related to education
Tools:	Theoretical models and concepts, research methodologies, terminology, communication systems, computers, software, video, and audio equipment, etc.
Rules:	Research is done according to the norms accepted by the international community of researchers. Research must be done with scientific rigor. Research is done based on postulates of a research paradigm. Qualitative research is based on the postulates of the phenomenological posture. Research questions should match the used methodology. Research is done based in a theoretical frame of reference. Always cite ideas taken from other researchers.
Division of labor:	Directors of the whole research project General advisors Designers of research instruments like interview and observant guides. Producers of research materials Field workers
Object:	Research projects
Outcome:	New educational theory The research project implemented, presented in a report, conference, and publication
Actions:	Read cutting edge literature in their field of education Identify problems and solutions in education and argument to convince others Select research methodologies Design and implement research studies to better understand the educational phenomena and to create theory Writing academic papers to disseminate findings in scientific journals and conferences Teach younger researchers
Operations:	Filling out research proposals for funding Design research instruments Do field work, gather data Analyze data to find patterns Write research reports

structed by interaction with one's environment" and as "enculturation or adoption of a group's ways of seeing and acting" (Wilson, 1996, p. 4).

Perkins (1992) proposes that a learning environment should have five facets: Information banks, symbol pads, construction kits, phenomenaria, and task managers. Information banks are warehouses of information resources from which both teacher and students select the learning environment's content. These can be textbooks, electronic encyclopedias, the Internet, etc. Symbol pads are tools that students use to register and manipulate symbols and language; examples include notebooks (paper and electronic), video cameras, software to create concept maps, drawing, and graphing software, etc. Construction kits allow students to build artifacts from prefabricated parts, a classic example is Legos; however, a more sophisticated example is the MIT Media Lab's technology called The Tower (<http://gig.media.mit.edu/projects/tower/>), which is an inexpensive modular development system for designing and prototyping electronic devices. Other examples of construction kits include different types of software that allow students to create computational programs to control de-

vices using a computer. Phenomenaria is an area that a learning environment should have where students can go to explore and test their hypotheses. Examples include laboratory equipment, complex computational simulators, microworlds, etc. Finally, task managers are components of a learning environment that set the tasks that should be accomplished by the students, and provide feedback and guidance. The obvious example of a task manager is the teacher, and also textbooks and different computational programs.

As can be seen from the literature discussed so far, the development of a constructivist learning environment is a rather complex process; however, the methodology described here represents an effort to simplify it, probably by sacrificing some of its pedagogical strengths. The intention is to make things easier for teachers who do not have profound instructional design knowledge (Figure 7 and 8).

2. Problem solving engagement strategies:

According to these kinds of strategies, students solve problems presented in the learning environment. Once the teacher gathered information regarding a group of profes-

Figure 7. The HiperVideo Studio® software editor

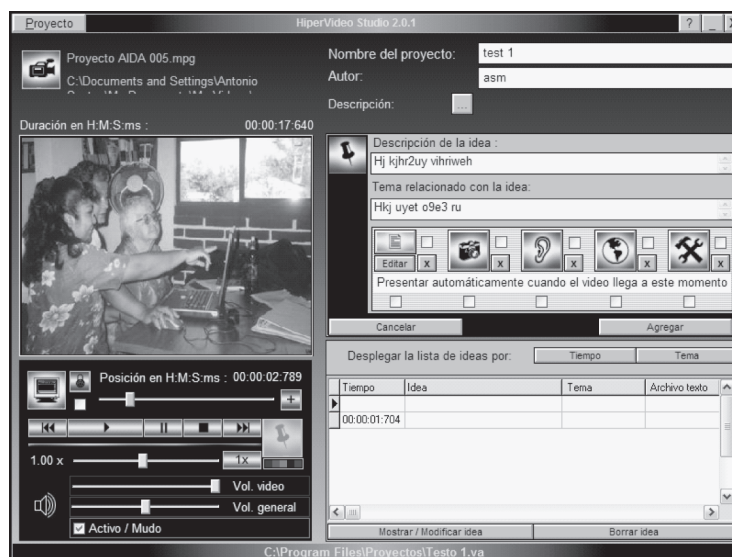
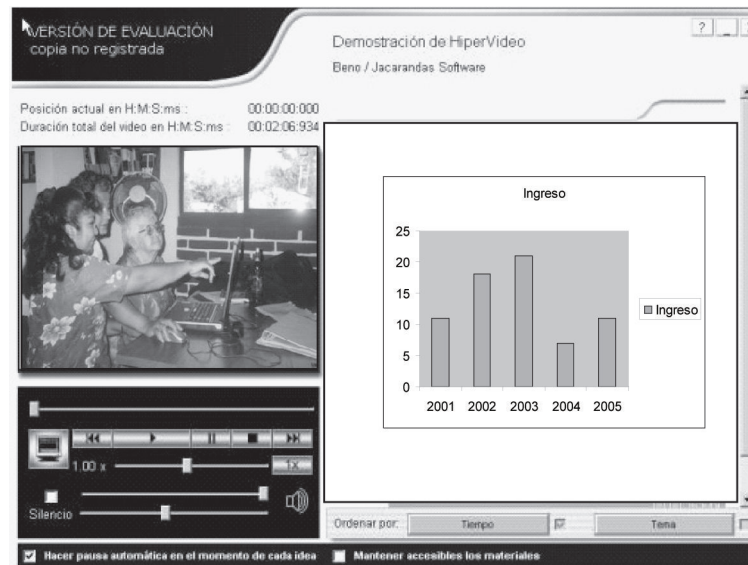


Figure 8. The HiperVideo Studio® software Presenter



- sionals and used it to develop a learning environment, he or she lets the students freely interact inside the learning environment so that they can build their own meanings about the environment subject matter.
3. **Knowledge representation strategies:** Students here develop a program with Hyper Video Studio software to crystallize their knowledge construction. As part of the activities suggested by the learning environment, learners are asked to collaboratively or individually produce a program using the Hyper Video Studio software. To do it students:
- Shoot a video that they decide is related with the solution they selected to the learning environment's central problem. Students decide what to shoot and what not to; through this action, they are already showing part of their inner understanding of the content.
 - The video is incorporated into the software so that it can be indexed. To do it the students use the editor part of the software (see Figure 7).
 - Students then insert pins at certain points in the video to stop it while they are showing it so they can present more information about particular ideas at those points. This is done by using the tools available on the right side of the screen (see Figure 7).
 - Finally, each team of students presents their products to the rest of the class. To do this, learners use the presenter part of the software (see Figure 8). As can be seen, the left part of the screen shows the video running. Then the video stops at certain points, during which the right side presents the extra information that students developed to further explain their ideas.
- This part of the suggested methodology has two objectives: (1) to evaluate how students built their inner conceptual map (to this end a rubric can be used to assess students' products, which can then be compared to evaluate how different teams of learners understood the subject matter); and (2) to allow students to engage in metacognitive thinking processes (i.e., when they make a

presentation for the rest of the class and justify their solution by arguing (providing evidences and explanations) in support of their ideas, they are also overtly reflecting about their learning process, which increases their learning).

All the time that students are building their programs with the use of the HiperVideo software, they are engaged in both cognitive and metacognitive thinking. In fact, when indexing they are going through a deep process of reflective analysis, and when they present their programs and explain them loudly to the rest of the group, they engage in another level of reflection. Thus, although this experience allows them to concretize what they learned interacting in the learning environment, it should be considered as an integral part of the whole learning environment. In fact, this is a clear example where learning and evaluation are merged into the same practice, according to the constructivist concept of evaluation.

TWO CASES DESCRIPTION

The methodology described in this article is still a prototype. Research projects to further examine it are on their way. Here, two cases will be presented mostly to clarify more the methodology to the reader. The results discussed in this section represent part of the groundwork needed to develop more complex research projects.

Case 1

The methodology was applied in a group of 12 students that were participating in an undergraduate course about qualitative research methodology; the course belongs to an education program offered by a private university in the area of Puebla, Mexico. Participants were all women with a rather high degree of technology literacy.

Learning Environment Development

According to the three discussed pedagogical strategies and to the course objectives, the components of the system of activity were identified in the first place. These components included typical actions and operations of the community of researchers working in social sciences (see Table 1).

With the data gathered about the system of activities of the researchers' community, a learning environment was developed around one of their professional activities: doing fieldwork using participant observation. The environment central problem and its context were created around an imaginary school. Its main learning goal was that students comprehended the philosophical underpinnings of the qualitative data gathering method called participant observation.

The learning environment was built using as its context problem an imaginary high school called *Escuela Benito Juárez*. Students could relate to the school downloading a couple of text files from the course's Web page, which thoroughly described the school and the problem that students were supposed to solve; the problem stated that the school's mathematical scores were among the lowest in the nation, according to a national standardized test.

Problem Solving Engagement and Knowledge Representation

The learning experience consisted of three weekly face-to-face periods of two and a half hours each and of the tasks that students did as homework. The first class began with an explanation of the learning goal. Then the school was described and the problem was explained. Students were divided in three teams. They were told that they should imagine that they were doing educational practices in the school. The teacher told them that one day, when they were at the school, the school's principal informed them about the problem related

to the low mathematical scores and how he did not know what to do about it. They were also told that they had advised the principal about using qualitative methodology to better understand what was going on inside the classrooms and that the principal had answered that he did not really believe in the qualitative paradigm, but that he was willing to attend a presentation where they could explain it to him.

The objective for this first class period was that students identified from the start of the learning process that they were being asked to solve the problem and produce a program using the HiperVideo to present their solutions. It was also explained to them that to complete both tasks, they could read about participant observation in the materials selected for them by the teacher.

Subsequently, a general and basic explanation of the HiperVideo Studio software was given to the students and each working team installed the software in their laptops so that they could practice and ask questions about how to use it. The first two and a half hour period was dedicated to explaining the problems and letting students become familiar with the software.

During all this process, a research assistant was present taking notes in a field diary for further qualitative analysis, describing how each team collaboratively learned to use the software. Students were given a two-week period to finish the task and were told that they should make a presentation for the rest of the class and the teacher acting as the principal.

Students were also told that they should send an e-mail after each class period with a diary explaining how they were learning. These diaries were also analyzed as part of the evaluation strategy. To evaluate the student's presentations, the teacher and the research assistant took notes of the whole process. Originally, it was intended to use a rubric, but it was not ready by the time of the study.

Results

Judging from the learners' diaries and from the type of advice that they asked for during the first week, it was clear that the time was dedicated to solve the technical difficulties that they encountered learning to use the software, for example, how to shoot and edit the video in digital format and how to insert it into the HiperVideo environment. During this first week, it was not explicit if the teams were also reading about participant observation. For the second week, students had solved most of the technicalities about the use of the software; however, it was clear that the videos they were producing were not clearly related with the subject matter. To correct this situation, the teacher explained to the group how to do a video storyboard on paper. This helped students to pre-visualize their videos and to realize the need to make them more content related. Also, the teacher strongly emphasized the need to read the observant participation materials. All the teams answered that they were already reading them.

In the third week, the teams finally presented their programs. The teacher and the assistant registered the process in the field diary. Later, using the constant comparison method of data analysis, some interesting results were found.

Most teams produced videos depicting real classroom activities and one team made an enactment of an actual classroom showing a teacher with his students. As expected, students showed classroom contexts with the video, but when they inserted an index to stop the video, most of the times they explained why they did it using text in the right part of the software screen. Even when they used audio files at the pinpoints, they were their own recorded voices. The team that performed the classroom enactment used most of its indexes in the video to show text balloons explaining the characters' thoughts.

It can be concluded that students participating in this small study accepted to use the video

images for analogical communication, but used the indexes to explain their ideas using digital communication. This is an interesting result because although they could explain their ideas analogically using images or even another video, most of the times they preferred to explain their ideas digitally. This, according to Watzlawick, Bavelas, and Jackson's (1967) model of human communication, could be explained because, in general, we use analogical communication (non-verbal) to explain relationships and digital (verbal) for the message's content.

A similar result was found in the few cases where students used analogical communication to explain their indexes. That is, in one case, one of the teams decided to use a small video showing a child doing homework at an index, but it was not self-explanatory; they had to explain orally in great detail what the video meant. In another case, a team showed another video at an index showing one of them explaining orally something regarding observant participation. In conclusion, students relied too much in their oral explanations and less in what was actually shown.

Regarding their comprehension level of the content (i.e., observant participation), it can be said that they were able to understand its main purpose as a qualitative method. For example, one team said that by shooting a video in a classroom, they were actually doing participant observation. Another expressed that participant observation allows us to be closer to a certain context. When one of the teams was asked by a classmate after their presentation why they shot that particular video to explain observant participation, they answered that they did it to explain how students and their teacher in that classroom were behaving.

However, it was not possible to identify any type of pattern in the set of indexes used by each team (i.e., the places where teams actually inserted their indexes did not give any relevant information regarding the students' understanding of the subject matter). This result was probably due to

the fact that this was the first time that the students were using the HiperVideo software; it can be hypothesized that after several experiences, they will become experts in knowing where and why to index a video at a certain point. Also, better evaluation instruments are needed to relate the indexes network to the subject matter.

Case 2

The methodology was again applied to a different group of the same university as Case 1 to further understand how it can increase the quality of learning of students of different educational levels. The group consisted of 2 men and 10 women enrolled in an educational technology graduate course. In this case, all of the participants had a bigger level of technology literacy, as compared with the group in Case 1, and had much more experience in developing educational projects because all of them had teaching experience.

In this second case, to obtain more feedback from the participating students, right after they finished the HiperVideo projects, each team filled out a questionnaire where they were asked to explain in detail how they had developed the project. The main purpose of the questionnaire was to analyze the process that each team followed to produce the main video and to decide when and what type of information they would insert in each pin.

Learning Environment Development

For this Case 2, Table 2 shows the components of the system of activities of the community of instructional designers working at educational institutions.

Based on the instructional designers' activity system, a learning environment was developed for the graduate course on educational technology and loaded to the Web page of the course. Within the environment, students acting as in-

Table 2. Components of the community of instructional designers' activity system

Community:	Instructional designers working at educational institutions Purpose of their activity: Develop and apply instructional theories for instructional planning
Subjects:	Instructional designers working as media experts in the public school system Purpose of their activity: Apply instructional theories for instructional planning to develop information and communication technology-supported learning environments
Tools:	Theoretical models and concepts, research methodologies, project development methodologies, terminology, communication systems, computers, software, video, and audio equipment, etc.
Rules:	Instructional design is done according to the norms accepted by the community of instructional designers. Instructional design is done applying accepted instructional design models. Instructional design is done based on expert knowledge and creativity. Media experts select information and communication technologies (ICT) considering: Learning objectives, characteristics of the learners and the context The main purpose of a learning environment is not to use ICT, but to increase learning. Always pilot test the produced products
Division of labor:	Instructional designers Content experts Media producers Technicians. Designers of evaluation instruments.
Object:	Instructional plans.
Outcome:	Instructional theory Instructional design models Learning environments
Actions:	Read cutting edge literature in their field of education Identify learning needs and problems Manage the process to develop an information and communication technology-supported learning environment Disseminate results in the institution and in the public school system Writing academic papers to disseminate findings in scientific journals and conferences
Operations:	Receive and discuss learning needs and problems Apply needs assessment models Select an instructional design model for planning instruction Develop instruction Evaluate results: Interview teachers and students, do participant observation, apply questionnaires, etc. Design evaluation instruments Tell every body in the design team what to do.

structional designers and media experts working in a public school were asked to solve a problem presented to them by the school's administrator. He explained that the school had just received federal funding to increase the quality of learning using computers in its classrooms. Students received reading materials explaining the educational concepts related to using media in schools because the main objective of the learning environment was that students learned to use media as cognitive tools.

Problem Solving Engagement and Knowledge Representation

For Case 2, the learning experience was developed during a two and a half week period. During this time, students and teacher interacted face-to-face for a total of 15 hours. Moreover, students, learning in teams, worked on the project for at least another 25 hours on their own.

Again, as in Case 1, students were told that they should solve the learning problem presented to them and that they should base their solutions in the reading materials. They were also told

that they should use the HiperVideo software to explain their solutions to the school's administrator. Next, the teacher explained the basics of the HiperVideo software and from then on, he acted as a facilitator asking and answering questions, supervising, and giving feedback when needed.

To assess the student's learning process and presentations, the same methods were used as in Case 1. However, in this second case, a questionnaire was added; it was designed and applied to obtain more feedback from the students regarding their learning experience. We wanted to better understand the students' thinking processes when they were developing their presentations in HiperVideo. The questionnaire asked students to (1) explain in great detail how and why they took all the decisions related with the production of the video; (2) explain why they decided to stop the video at a certain point and insert a pin; and (3) explain, also in great detail, what type of information they decided to insert in each pin and why they chose to use video, text, graphics, audio, etc. to display it.

Results

As happened in Case 1, three of the four teams dedicated their first week to understanding how to use the HiperVideo software and the video equipment. However, one team realized that using the software and equipment was rather easy and started right away to solve the instructional technology problem that was posed to them. In general, the whole group showed higher technology literacy than the undergraduate students. This fact allowed them to dedicate much more time to solve the instructional design problem and thus were more able to reach the educational objective that we were looking for.

According to the data gathered in the questionnaire regarding the production of the video that was going to be the core of their HiperVideo presentations, it can be said that all of the teams went to their familiar contexts to do their shooting.

All students are or were working at educational institutions, thus they either videotaped classrooms in the institution where they are students or at the institutions where they work. Their intention was to shoot real examples of the use of media inside a classroom and then use them at their presentations so that the audience could compare the traditional uses of media as opposed to using them as cognitive tools. It is interesting to realize that because they could not find real examples of actual teachers using media as cognitive tools they decided to enact their own, however, they decided to act as teachers using media as cognitive tools in a real classroom with authentic students. One of the teams decided to produce a piece of animation, something that was unexpected and unwanted by the researchers. However, it was considered that this team also appealed to their familiar context because the characters in the animation represented real people known by all. These results support the methodology proposed in this manuscript because students, by shooting the video in real contexts, linked the content to people's activity systems interacting in those contexts; in this case, actual classrooms including their teaching and learning situations.

Inductively analyzing the explanations that the students gave in the questionnaire regarding why they decided to place a pin at a certain place in the video, we can say that students first produced the main video and then decided where and with what purpose to stop the video. In general, students reported that they did it to further explain, enrich, reinforce, complement, or to make a more careful study of what was being shown in the images of the video. For example, one team was showing a video of a classroom where a group of students was using a certain type of technology, they stopped it and presented in the right part of the interface an Internet link to a page that explains in detail that particular technology.

As expected, and similarly to what was found in Case 1, in many occasions students used text to present information, some students reported that

they decided to use text because: (1) they wanted to explain key concepts that were analogically presented in the video portion of the interface. As already discussed in Case 1, this further supports the Watzlawick et al.'s (1967) model of human communication, which states that we use analogical communication (non-verbal) to explain relationships and digital (verbal) for the message's content. In this line, one team said that "we used text because written information allows students to read it as many times as they need to understand it; also, because when we want to understand a concept it is more significative to read it than to hear it."; (2) they wanted to ask the audience to perform a certain task; and (3) they wanted to elicit reflection processes in the audience by presenting questions to them. This is a rather interesting result, which can be explained by the fact that the students were also teachers used to apply instructional strategies to explain content.

Audio was also used in the insertion pins; however, it was almost always used redundantly just to repeat what was written in text. Nevertheless, in a couple of instances, one team presented a photograph with an audio clip explaining what it meant; and another presented a video with background music. Students reported that they used audio because: (1) they felt that it is more attractive for students to hear the information and read it; and (2) they wanted to underscore some key aspect of the video by linking a piece of music to what they are seeing in the video.

Analyzing these results, we can conclude that, in this second case, the whole learning experience allowed them to build context-dependent knowledge, even though the content they read was in general context-independent.

Also, the diaries sent by students to the teacher after the learning experience showed that all the students were very highly motivated during the whole task. In the diaries, they wrote very positive comments regarding the learning experience, for example: "It was very hard, but I enjoyed it very much" or "I am so tired, but, at the same time,

very satisfied." Also, this high motivation was shown by the fact that they stayed rather long hours working collaboratively, even meeting during weekends to work in their projects.

CONCLUSION

Most of the critiques made to the constructivist pedagogy state that it has not been able to modify deeply the teaching and learning processes; in spite of the fact that it has been recognized as a new paradigm in Education. It has been said that different educational changes move back and forth, while researchers and academia widely discuss them in journals around the world without making any important impact in the classroom. With this in mind, the main purpose of this article was to suggest a way to ground one of the most relevant ideas of the socio-constructivist paradigm, that is, that human learning is contextually situated. To this end, a methodology was proposed consisting in several pedagogical strategies including the use of software as a cognitive tool. The methodology proposed in this article can be considered design theory because it can be used as a guide to help students develop their higher order learning abilities (Reigeluth, 1999). Accordingly, it can become the subject for a larger, formative research project as suggested by Reigeluth and Frick (1999).

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Chapter 2.3

Model–Facilitated Learning Environments: The Pedagogy of the Design

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ABSTRACT

The purpose of this chapter is to discuss how instruction, technology, and models converge to create online model-facilitated learning environments. These instructional environments are designed in such a manner that the interaction with the model on the computer network is essential to the learning experience. The idea is to use these models to maximize the pedagogical power that helps students construct conceptual mental representations that lead to a greater degree of retention and overall recall of information. How students will act and learn in a particular environment depends on how the instructional designer creates the environment that maximizes their learning

potential, considering the interrelationships between the learning experience, the technology, cognition, and other related issues of the learner.

CHAPTER OBJECTIVES

The reader will be able to:

- Discuss models
- Describe online model-facilitated learning
- Find evidence that supports decisions to design online model-facilitated learning experiences
- Define complex systems and their association with online model-facilitated learning
- Understand the role of collaboration in the design of online model-facilitated learning

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- Consider specific issues and challenges in designing online model-facilitated learning experiences

INTRODUCTION

You are, once again, preparing your lesson plans for a fall semester online science class. For the past two years, your students have expressed problems learning certain scientific principles, and their opinions have been substantiated in their overall test scores. You are trying to decide how to revise your instruction to teach some of the more complex scientific concepts. To your credit, you are aware of the challenge and are willing to consider alternative instructional methods. You become curious about *model-facilitated learning* after reading Hestenes (1987, 2006) describe a decade of successes using modeling in physics, chemistry, and physical science classrooms. In addition, today's powerful computers allow you to go beyond traditional methods of instruction by breaking down the limitations and constraints of conventional methods of teaching and assessment. They give you the capability to use electronic applications and processes to deliver the content, and situate learners in a domain of information and a set of circumstances that maximize the cognitive potential of learners. By creating these online learning environments, you can give the students the opportunity to use computer-based models and simulations to explore, and better comprehend and communicate complex ideas (Maier & Größler, 2000). In an extensive review of the literature to examine computer-mediated communication in educational applications, Luppici (2006) reported that learners in online courses did just as well as face-to-face courses, therefore, it seemed a favorable alternative.

Online model-facilitated learning has its roots in the learning sciences, an interdisciplinary field of study that focuses on building innovative learning environments that incorporate multimedia

and computer-based technology. Therefore, we define online model-facilitated learning as an instructional experience whereby the instructional materials and resources are managed and run on a computer system. The system is connected by a network of devices that are used and manipulated by the students to support and enhance their participation in the learning experience. Students are placed in experiences that allow them to learn with and from other students in a system that uses a model. The model is the artifact structurally designed and created to represent or to demonstrate a theoretical construct of a system or some chosen phenomenon. The instruction is designed in such a manner that the interaction with the model on the computer network is essential to the learning experience. The instructors and students may or may not be geographically separated.

The intent of this chapter is to discuss how instruction, technology, and models converge to create online model-facilitated learning environments, and discuss the pedagogical structures within which they operate. More specific objectives for the chapter are:

- a. Define models and their function in online model-facilitated learning
- b. Develop a theoretical platform and related principles as these apply to online model-facilitated learning
- c. Apply pedagogical principles to teaching and assessment in online model-facilitated learning

MODELS

Models are instructional tools that teachers can use to enhance the human cognitive power (Kozma, 1987) and enhance higher order thinking as they “function as intellectual partners with the learner” (Jonassen, 1996, p. 9). They are used to provide a learning situation that is more contextually bound than most conventional instructional approaches

because they situate the students in an experience that gives them the chance to experience and “play with” selected aspects in the domain of knowledge. As a *representation*, a model is the tangible depiction or portrayal of some original object or phenomenon. For example, a globe is a representative model of Earth that the learners can interact with to find different locations around the world; the interaction between the learners and their interaction with the model are most important. As a *demonstration*, a model becomes the means to demonstrate or show the learner how to do something without having to actually build a model. For example, a scale model of the solar system demonstrates the size of the planets in relation to each other. Regardless if it is a representation or a demonstration, a model is primarily a tangible communication device for conversing with self and others immediately and through time (Pea, 1994).

How Are Models Used In Instruction?

Instructors can employ models in different ways. They can create a model that the student can use or they can instruct the students to build their own model. Bliss (1994) refers to this as explorative modeling and expressive modeling respectively.

Using Models

Students can be instructed to use instructor-created dynamic models (computer simulations and games) or static models (illustrations and concept maps) to learn about a domain of content. These models are usually designed and created by instructors for learners to use within a specific sphere of interrelated knowledge. Löhner, van Joolingen, Savelsbergh, and van Hout-Wolters (2005) say, “Learners explore a given model representing someone else’s ideas by trying it out and perhaps modifying it” (p. 442).

The primary learning objective of using models is to acquire domain content at the application

level. For example, intuiting the effects of supply on demand or grasping the possible affects of global warming on hurricane strength are case in point.

Building Models

Students can be instructed to build models in order to construct their own new understanding of a domain content area or of the dynamics of a system. Students learning about the human cardiovascular system can build a concept map (e.g., a static model) of the content and then use their concept map to write an expository essay of the content. Or they can build a dynamic model of the same system using *Stella*^{®1} (a software modeling program for creating *dynamic systems*) and examine the structure and function of the heart. With both strategies, students build their own understanding of the content. If decision making is your instructional aim, there are software packages that students can use to build a model of a system that needs to be managed (e.g., SIMPROCESS[®] is a product that can be used to build models that support decision making²).

Model building typically seeks to answer questions of inquiry (Kolb, 1984). The knowledge gained allows the student to understand causal relationships and make predictions. The overarching learning objective is aimed at the students’ ability to gather information; to communicate knowledge; to transfer the knowledge; and to apply complex cognitive skills to other novel real-life encounters (van Merriënboer, Clark, & de Croock, 2002). Thus building models directs attention to higher-order, transferable cognitive skills and develops a domain-specific base of content knowledge.

Tasks Accomplished with Models

We propose that the tasks learners are asked to accomplish with models in online settings fall under one of two categories: *peremptory* and *dialectic*.

Peremptory Online Task

A peremptory online task invites either acceptance or rejection, it is “a-dialectic” and it brings along an underlying worldview. Working alone on a computer-based simulation or game is a peremptory task. A learner who has become proficient in *Simcity* has acquired important concepts and principles regarding city planning that reflect the theory that undergirds this simulation, including a positive bias (but perhaps misplaced trust) towards public transportation. Said differently, the learner ‘wins’ when their intuitive planning actions and interactions with the simulation most agree with the hidden theory and the learner *appropriates the theory usually without reflection* (rather like brain washing). This assumption is derived from the research on implicit learning.

Reber (1967) refers to implicit learning as a process by which knowledge is acquired independently of conscious and deliberate attempts to do so. What is implicitly (unconsciously) learned about the domain through simulations and games can probably be evaluated only within the simulation or game. This is an important issue that is overlooked. Further, learners will internalize the “grammar” of the technology tool that they are using; for example, thinking in terms of stocks and flows when using *Stella*, or in terms of variable control when programming. At a minimum, given enough model-facilitated exposure, students will begin to think about everything as a system, and this represents a substantial mental shift that may not be measured by traditional tests.

Dialectic Online Task

In contrast to the peremptory online task, a dialectic online task invites argument or participation. The learner must ‘fill-in-the-blanks.’ If the instructor posts a detailed concept map of a topic and requires students to study it for a test, this approach is highly peremptory. However, if the students are given the same concept map and are

told to work individually to find the errors and correct it, then it becomes less peremptory. If the students complete this same concept map task in a collaborative group with appropriate ground rules, then this becomes a dialectic experience.

In summary, the model is a contextual representation whose primary function is to provide the basis of an experience where the students can experience and investigate the fundamental attributes and properties of what is to be learned. If the instructional intent in online model-facilitated learning is to promote a conceptual change, according to Windschitl (1996), allowing students to interact with the dynamics of a modeling system can create unique ways to help students conceptualize the information. Common to both uses of models is simulating a situation, specifically designed to situate learners in experiences that serve to stimulate their process of inquiry and understanding (Kolb, 1984).

A THEORETICAL PERSPECTIVE

Learning, as we know it, is an active cognitive process whereby knowledge is built on existing knowledge as the learner seeks to understand the information and experience as it is presented (Duffy & Cunningham, 1996; Winn & Snyder, 1996). In online model-facilitated learning environments, regardless whether the learner builds or uses the model, he/she takes the information from the model and adopts mental representations of the system to help organize the information in a *personally* coherent and meaningful way. The degree of learning rests in how well the learner can connect the existing facts, concepts and principles with the new information that is given or discovered in the modeling experience.

How this information is stored in memory and how it is linked in this complex, abstract and interconnected network of memory structures is the schema (Bruning, Schraw, & Ronning, 1999; Driscoll, 2000; Rumelhart, 1980; Schunk,

2000; Winn & Snyder, 1996). If you think of the brain as a neural file cabinet, these schemas are neural memory files that hold information about specific concepts. Over time, we make associations between and among them, and this intricate network of neural files become highly elaborate, interconnected, and cross-referenced. Online model-facilitated learning environments provide a powerful way for learners to develop these conceptual arrangements and manage the interrelationships and integration of these complex systems. In online model-facilitated learning, Papert (1993) argues that constructing and manipulating “quasi-concrete” representations of knowledge on computers leads to more robust internal knowledge structures.

Online model-facilitated learning is a generative learning approach that uses strategies to encourage learners to actively create and consider the relationships among various elements of information, between lesson information, and personal knowledge, and find personal meaning (Jonassen, 1988; Jonassen & Wang, 1993; Wittrock, 1992). Following the theory of generative learning, it is the process of generating relationships between and among the information and integrating that with memory, whereby “meaningful understanding and comprehension are predicted outcomes” (Grabowski, 1996, p. 898). Generative strategies, such as asking the learner to formulate new questions, form direct inferences, and demonstrate and represent how the concepts connect, typically require learners to consider *multiple information elements at the same time*, thus encouraging the development of the organizational and structural relationships between the information elements (Grabowski, 1996; Ritchie & Volkl, 2000). The focus is to generate new conceptual understandings, not just transform what is already known (Grabowski, 1996).

The view that students actively participate to construct their own knowledge through direct participation in the modeling experience (whether using or building the model) is from the philo-

sophical point of view called constructivism—a doctrine of beliefs that knowledge is constructed by the learner through experiences and direct participation with the environment (Duffy & Cunningham, 1996). Based on what we know of online model-facilitated learning environments, Cobb’s (1994) interpretation of the complementary nature of the two perspectives of constructivism and socioculturalism apply. According to Cobb (1994), the cognitive constructivist perspective explains the unique configuration of knowledge constructed by the learner and the quality of the individual interpretation of the experience in constructing that knowledge, while the sociocultural constructivist perspective emphasizes the construction of knowledge when individuals engage in discussion and activity about shared problems and experiences in a community of learning. Accordingly, *social interaction is necessary for the construction of knowledge*, and meaning will differ among the learners because meaningfulness is an individual interpretation based on past experiences. These interactions are uniquely understood by the learner through personal reflection and dialogue with others as they gain a shared understanding of the complexity of the concept being explored (Gasparini, 2004).

In the online model-facilitated learning environment, the student is situated in the learning experience in a manner that directly confronts the intellectual, practical, personal and social aspects the model brings to the experience. According to Collins’s (1988) definition of situated learning, knowledge, and skills are learned in contexts that reflect the way they will be used in real life (p. 2), and he goes on to cite benefits of situated learning that we feel are applicable to the design of online model-facilitated learning instruction:

- Students are placed in the conditions for applying knowledge
- Students are situated in conditions to apply information and problem solve

- Students learn the implications of knowledge as they work through the problem
- Students are supported in structuring knowledge in ways appropriate to later use by gaining and working with that knowledge in context

Brown, Collins and Duguid (1989) suggest that embedding information in the situation provides essential parts for its structure and meaning. The knowledge gained in the learning experience becomes coded in such a way that it is connected to that situation; therefore, context and authenticity become important considerations. In online model-facilitated instruction, the idea is to create models that simulate authentic practice.

We have continued to talk about the role of the experience in online model-facilitated instruction. We believe it is the hallmark and the distinguishing characteristic in your design. How you create the online modeling experience and then situate the learner in that experience will greatly influence the success of achieving the learning outcomes. Carl Rogers (1969) paved the way for student-centered, experiential education, and any instructional method that gives the student the opportunity to actively participate in the encounter with a goal of acquiring knowledge is considered experiential learning. The students directly experience the subject matter, either by using or building models.

PEDAGOGICAL CONSIDERATIONS AND ISSUES IN THE ONLINE MODEL-FACILITATED LEARNING EXPERIENCE

Among the pressing issues for instructors in designing online model-facilitated learning experiences lie in understanding of the complex systems taught with models, and appreciating the role of collaboration. Placing a student in the experience, knowing how information is cogni-

tively processed, and understanding the role of the social and collaborative aspects of learning about complex systems are important considerations in building a theoretical framework to support the pedagogical decision to use online models. These aspects are mutually connected and interrelated.

Complex Systems

Wilensky and Resnick (1999) describe complex systems as having multiple levels of simultaneous hierarchical interactions; the system under study may in fact be a sub-system of a larger system. An example of this would be the human body. When you consider the body as a functioning “whole” the interrelated, interdependent, and simultaneous interactions among the sub-systems, for example, oxygen transport system, the renal system, the cardiovascular system, the nervous system, and so forth, are essential for life. These complex systems are becoming increasingly important to understand in the 21st century as the relationships among the systems becomes more integrated (Lesh, 2006). But, learning about these systems is difficult because of the amount and complexity of subject matter within and across domains and disciplines (Hmelo-Silver & Azevedo, 2006).

These systems tend to be defined by the dynamic interactions and interrelationships among and between the multiple constituent parts and frequently cannot be explained by a set of linear, functional rules (Lesh, 2006). As stated by van Merriënboer et al. (2002), “In complex learning, the whole is clearly more than the sum of its parts because it also includes the ability to coordinate and integrate those parts” (p. 40). Therefore, approaching it from a traditional, behaviorist learning point of view will not suffice. The theories in behaviorism focus on forming associations between a stimulus and a response, and they do not account for the complicated and involved nature of systemic thinking in these complex online model-facilitated learning environments.

The memorization of facts limits knowledge to the constituent parts rather than fully comprehending how these parts fit together into one cohesive whole (Feltovich, Coulson, & Spiro, 2001). The instructor must break down the prevailing “silo” mentality so that the students can more easily find meaningful associations and see the patterns of relationships, and the control and influences among the parts. These relationships are not necessarily linear and the pattern of differentiation makes them complex. Specifically, Milrad, Spector, and Davidson (2002) suggest learners usually experience difficulty in the following:

- Comprehending nonlinear relationships
- Understanding and viewing the problem within the context of the system
- Considering the full range of connections, influences, and controls within a system
- Transferring what is learned in one context to find the solution to a problem in another

Kukla (1992) claimed that using models designed to represent various situations and complex systems will help develop cognitive systems that enable the learner to process information, solve problems by reasoning, infer consequences, form hypotheses about the world that’s external to the “microworld,” and make predictions about the future with reasonable accuracy.

The Association with Complex Systems

When learners are plunged into a system, they become more aware of the system’s dynamics in terms of the processes, relationships, and consequences of decisions. To illustrate this, we turn to work done by Colella (2000), who designed a microworld using miniature computers called *thinking tags* to explore viral transmission. Each learner in this “participatory simulation” wore a *thinking tag*³. To begin the session, only one *thinking tag* contained the virus. As the experience

unfolded the virus jumped from tag to tag infecting the other learners. Colella created this model of the dynamic system of viral transmission so the students could experience the transmission of a virus, understand the problem, develop hypotheses, explore the underlying rules (cause and effect) of the system, and learn the consequences if the rules were broken. Colella could have taught the students about viral transmission without giving them the chance to experience it; however, the power of using a model to explore this helped the students discover the knowledge of how a virus is transmitted, understand the social relationships in this community of learners, and feel the accompanying emotion when infected with the disease. According to Hmelo-Silver and Azevedo (2006), learning about these systems confronts our cognitive, meta-cognitive, and social resources.

Regardless if the students are instructed to use a model or build a model, the microworld becomes the place for the group to learn. The instructor creates these microworlds and models to simulate the real world so the topic of instruction can be taught in the safety of an instructional environment yet learned in a real-world context. Context and authenticity are important considerations in the design and creation of models because the model represents domain-specific situations and systems constrained within “microworlds” that are meant to activate the cognitive system in ways that traditional teaching by lectures often cannot accomplish (Colella, 2000; Kukla, 1992). According to Colella (2000, p. 474-475), “the flexibility of microworld environments opens up the range of possible experiences that can be created.” Thus a critical design issue in online model-facilitated instruction is determining the “level” of the microworld and the “size” of the model.

Role of Collaboration

Collaborative online projects are some of the most exciting ways to motivate students. Getting students involved with posting projects on the web,

emailing other students or experts, discussing issues on a threaded discussion, or chatting online is a great way to motivate students. Stahl (2004, p. 64) defines collaborative learning in terms of building “the gradual construction and accumulation of increasingly refined and complex cognitive and linguistic artifacts.” The students commit to a shared goal and work together in a mutual and joint effort to construct meaning, share learning tasks to build a knowledge base, clarify issues, explore a topic, and solve a problem (Hron & Friedrich, 2003; Nevgi, Virtanen & Niemi, 2006). In online model-facilitated learning environments, students gathered together in virtual groups not only learn from their own individual experiences as they solve a problem, but they learn from each other. The nature of the task, the context of the experience, the learner characteristics, and the group relations all affect the collaboration (Dillenbourg & Self, 1995).

Clark and Mayer (2003) make a distinction between two alternative collaborations: product-oriented and process-oriented. The product-oriented collaboration results in some tangible output. These types of assignments need sufficient instructional guidance and resources that guide the experience, yet allow enough openness for the student to explore, be creative and feel challenged. The process-oriented collaboration focuses on learning that is gained from structured group exchange rather than the production of a tangible finished product. The learning is stimulated by how the instructor designs interactions around the model. In either case, structuring the online model-facilitated learning environment to promote collaboration and maximize the power of the interactions is important and is critical for a successful outcome as suggested by Clark and Mayer (2003). During collaboration, all members *should* contribute equally to the model and begin to develop a sense of co-ownership of the model. In cooperative association, each member individually completes a discrete portion of the task in

detail, and then brings that portion or piece back to the group. A properly designed collaborative task engenders dialectic interactions as the group works together reaching consensus or compromise on every part of the project. Although the online model-facilitated learning itself may vary among different authors (Kanuka, Rourke, & Laflamme, 2006; Roberts, Andersen, Deal, Grant & Shaffer, 1983; van Merriënboer, 1997; van Merriënboer et al., 2002; Wolstenholme, 1990), the process generally moves through the following phases as described below:

1. **Problem orientation:** The problem is presented and the learner is oriented to the modeling task, which includes goal setting and engagement. These problems or scenarios are not only authentic and relevant but also have the correct level of complexity for the learners.
2. **Conceptualization:** The learner puts the problem into some context. Important components and causal relationships are recognized.
3. **Formulation:** The learner develops hypotheses and a method of collecting the data he/she needs to move forward with the problem.
4. **Rules and Principles:** The learner explores the cause and effect relationships.
5. **Testing:** The learner verifies in that their evolving mental model does not contradict data from the real-world system.
6. **Application:** The learner transfers the knowledge and applies the cognitive skills to authentic situations to solve problems (Perkins & Unger, 1999).

Collaboration in online learning, by its very nature, requires attention to the social interactions and communication strategies because this is very different than face-to-face collaborative learning experiences many students are familiar with.

PEDAGOGICAL CONSIDERATIONS

Instruction must be designed to teach students how to apply skills in a coordinated and integrated fashion (van Merriënboer et al., 2002). The instructor-created experience must be thoughtfully designed because it is paramount for learning. Rogers (1969) has provided us with essential guidelines to create an environment for learning. Although these guidelines were developed for face-to-face instruction, we believe they are so fundamental to learning that they are noteworthy considerations in creating online model-facilitated learning environments:

1. Setting the initial mood or climate of the group or class experience
2. Elicit and clarify the purpose of the individuals in the class as well as the more general purposes of the group
3. Make easily available the widest possible range of resources for learning
4. Take the initiative in sharing feelings with the group in ways which do not demand nor impose but represent a personal sharing

Just as important is the course design. Goldman, Williams, Sherwood, Hasselbring and the Cognition and Technology Group at Vanderbilt (1999) have provided us with these four principles for course design:

1. Organize it around the solution of meaningful problems
2. Provide scaffolds for achieving meaningful learning
3. Provide opportunities for practice with feedback, revision, and reflection
4. Promote collaboration, sharing of expertise and independent learning

Milrad (2002) concludes that the design of these environments should include multiple perspectives of the problem, support for learning and

cognitive development, opportunity to develop meaningful collaborative interactions among the learners, and concrete feedback to facilitate the learners' understanding. However, there are specific issues and challenges in designing these collaborative learning environments due to the unique characteristics of online instruction and online learning groups, most specifically in the areas of social context, the nature of the communication, cognitive load, and the emotional state of the learner (Hron & Friedrich, 2003). Suitable instructional supports must be considered in each area.

The social context of online model-facilitated learning experiences cannot be ignored because it differs from face-to-face experiences. There are no facial expressions, body gestures, voice inflections, or head nods to help the instructor or the students make judgments on interest, response, or participation. In addition, the "whose next" question can become an issue in deciding when and who takes the next turn to participate. How the instructor communicates the idea and how he/she draws all the participants into the model will determine the collaboration among the participants. The instructor must take the lead to establish clear ground rules and set the convention of etiquette for the communication at the onset of the experience so the students know what to expect and how to manage their role. It is the challenge of the instructors to ensure that the student interactions and discussions are engaging, productive, and meaningful in developing knowledge and understanding (Littleton & Whitelock, 2005). In a study conducted by Navarro and Shoemaker (2000), students enrolled in an online economics course were generally satisfied with the online student-to-instructor interactions, however, students were generally unsatisfied with their student-to-student interactions. Instructors, by providing appropriate supporting materials and resources, activities that support the learning, and feedback will enhance the quality of interaction between students and instructors.

Communication in online collaboration is an important consideration in terms of the technology and the quality of the message. Tolmie and Boyes (2000) have found that asynchronous communication not just facilitates discussions between students but “any disagreements which occur will promote growth and understanding (p. 121). The technology greatly expands the potential of the instruction, but it does not come without problems. Navarro and Shoemaker (2000) found that technical problems are pervasive in online learning environments. The system can go down, the students may have problems accessing some instructional materials, the software may not be compatible, the video and audio system might malfunction; indeed, a whole host of problems could occur. Technical support to students and instructors must be available, and instructors must match the course design to the technology that is available to the students. How the information is delivered to the students is very important because messages are more enduring and permanent in online collaboration (Hron & Friedrich, 2003). They can be accessed or sent at any time, and the sheer volume and the task of following them can seem unmanageable. Instructors must be concerned with the effect in how the message is interpreted, the value of the messages produced, and the manner in which the messages motivate the learners. In addition, it is the instructor’s responsibility to ensure that the students are not learning the “wrong” concepts that are transmitted in the messages. This is particularly important when the students are working and learning from each other. The instructor should intervene to bring the students back on track if this occurs.

Cognitive load can overwhelm the student (Hron & Friedrich, 2003). The complicated computer network, the complex subject matter, the sheer volume of information, and the different pattern of communication all contribute to this. It is important for the instructor to provide help for students to cope with the complexity. Technological support systems should be included

in the design of the instruction so that problems can be dealt with in a reasonable manner and without disruption to the learning. In designing online model-facilitated learning environments when multimedia is used, instructors must create experiences that maximize the opportunities for the learner to mentally organize the information in meaningful and coherent cognitive structures for meaningful learning to occur, while at the same time paying attention to the cognitive load associated with multimedia learning (Mayer & Moreno, 2003). This becomes particularly important when the model uses and presents visual and verbal representations of information. Mayer and Moreno (2003) highlight the potential for cognitive overload in multimedia learning environments due to the substantial cognitive processing that is necessary for meaningful learning to occur. They report that in their research on multimedia learning, they are “repeatedly faced with the challenge of cognitive load” (p. 43). In response, they explored nine ways to reduce cognitive load in processing information aimed at redistributing the demands of cognitive processing (Mayer & Moreno, 2003): off-load processing demands on the visual and verbal channels, segmenting, pre-training, eliminate extraneous information, provide signaling cues, minimize incidental cognitive load, eliminate redundancy, synchronize the presentation of material, build in ways for it to be individualized to the learner’s characteristics. In addition, other strategies to help manage this cognitive load might include breaking a larger problem into sub-problems, the inclusion of the heuristic aids, or the integration of metacognitive self-assessment tools (Malopinsky, Kirkley, Stein, & Duffy, 2000). Instructional supports in online model-facilitated learning experiences would include a plan to monitor the messages, coach the students, build in scaffolding strategies, and provide reflection and feedback mechanisms.

The emotional state of the learner cannot be ignored in online model-facilitated learning experiences. Interest and motivation are im-

portant learner attributes to the success of these experiences whether you use or build models. This is a concern, because low participation in discussions in online learning environments has been reported across the board (Tolmie & Boyle, 2000). Instructors must find ways to stimulate and motivate the learners to participate. They should include mechanisms to involve all students and not let a few dominate the discussions. Techniques used by experienced instructors include personal electronic workbooks as well as records of their contributions to the group projects; participating in instructor supported computer conferences; and having the students use critical reflection on both the content and the process. In a discussion on issues related to designing inquiry on the Web, Lim (2004) suggests using questions, student planning, careful sequencing of activities, and reflection to engage the students.

ASSESSMENT CONSIDERATIONS

Online model-facilitated instruction is aimed at teaching complex, higher-order thinking skills; therefore, online model-facilitated learning is defeated if the focus of the assessment is on declarative knowledge only, and using the traditional methods, such as paper and pencil tests. These methods are unlikely to measure the full range of knowledge, skills, and attitudes accumulated by the learner.

When developing an assessment plan in an online model-facilitated learning environment, the question is, “what should be assessed—the process (contribution and interaction), the product (the model), or both?” The assessment of process and product are equally important; yet, assume different types of assessment strategies and methods. In online model-facilitated instruction, the model represents the group’s understanding of a large amount of information from multiple disciplines due to the complexity of the modeling experience, and so assessing the model (the product) makes

sense. The evaluators(s) must assess the breadth and depth of information represented in the model as well as the students’ thinking and reasoning strategies. A process assessment would be used to measure the students’ contribution to the group structure, and participation in the discussion and information gathering.

Educational assessment plans should include two functional categories: formative or summative. *Formative assessment* supports the progression of learning by providing immediate, contextualized feedback and encourages self-reflection. Formative assessments should focus less on how closely student responses match a pre-determined model and more on the competency of the performance as a whole (Pellegrino, Chudowsky, & Glaser, 2001). In online model-facilitated learning, students work collaboratively to construct their own knowledge within the structure of the course objectives. Instructors must be diligent to guide the students “back on track” through either coaching or scaffolding or other pedagogical techniques if the students stray too far from the learning objectives. *Summative assessment* is done at the conclusion of a course or some larger instructional period to determine individual student success or to what extent the program/project/course has met its learning objectives. Because of the complex nature of online model-facilitated learning, we suggest that summative assessment must be designed to measure higher order thinking skills to learn how they reason through situations, how they transfer knowledge, how they make decisions, and how they critically think through problems. Reeves (2000) suggests three alternative assessment methods to use in an online environment:

- Cognitive assessment is the assessment of a wide range of abilities, including attention, memory, problem-solving, language skills and intellectual functioning. It is the process of determining a student’s cognitive strengths and weaknesses through observed behavior

- Performance assessment requires that a student carry out an extended, complex process or produce a product, such as a model
- Portfolio assessment can be either formative or summative. An example of a formative assessment portfolio is a “growth and learning portfolio,” which contains the student’s work that demonstrates their program toward a goal. A summative assessment portfolio is a “best works portfolio” which is representative of the student’s work that provides evidence that they have a specific learning target (Nitko, 2004).

Assessment must not be an afterthought to be effective, but strategically integrated into the instructional design plan from the very beginning, so it has the ability to assess the transfer and integration the conceptually-complex ideas, which are best measured through complex, authentic assessment methods (Erickson, 2001; Nitko, 2001).

CONCLUSION

This chapter provides a framework for online model-facilitated learning environments that offers pedagogical considerations not seen in traditional instruction. These models embedded in carefully constructed “microworlds” are artifacts within a specific sphere or domain of information that instructors create for learners to interact with and experience. The idea is to use these models to maximize the pedagogical power that helps students construct conceptual mental representations that lead to a greater degree of retention and overall recall of information.

Based on what we learned in this chapter, learning and most importantly, the comprehension of complex systems, are enhanced in online model-facilitated learning instructional environments because students can interact with the content and each other to apply it to real-world scenarios. The

overarching goal is to teach students a body of knowledge that may draw from the integration of many disciplines, and get this stored in long-term memory so it can be recalled and transferred to solve problems in different situations.

Perhaps the greatest value of online model-facilitated learning environments is in developing a student’s “thinking skills.” Reasoning and making judgments is a multi-layered, complex process of constructing evidence that is based on a social interaction with others and gathering evidence to support the claim. Learners must have the ability to organize large amounts of information through complex cognitive processes and mental associations to critically analyze many facets of a problem, reach an informed conclusion, develop a plan to solve the problem, and systematically justify their response by making a reflective judgment of their decision (Bruning et al., 1999; Winn & Snyder, 1996).

How students act and learn in a particular environment depends on how the instructional designer creates the environment that maximizes their learning potential, considering the interrelationships between the learning experience, the use of the technology, the cognitive conditions and other related issues of the learner. Pedagogical decisions depend on the interrelationships between the instructional goal, the instructor, the theory, and all the resources. The importance of considering these factors in the design of an online model-facilitated learning environment cannot be overstated. Surging ahead without this understanding will result in a situation that does not maximize the learning potential in online model-facilitated experiences.

FUTURE TRENDS AND RESEARCH

This area of online model-facilitated learning environments is relatively new and educators are at the fringe of gathering empirically valid and reliable data to support the pedagogical decisions.

As suggested by Hmelo-Silver and Pfeffer (2004) in talking about the complexity of the systems we are trying to teach, we are still at an early stage of understanding how this all fits together. For this reason, much more needs to be learned. The decision to choose model-facilitated instruction should not be solely driven by the available advances in technology, but by the principles grounded in empirical research findings. The major elements of model-facilitated instruction, learning and assessment, and the inherent relationships among them, provide important areas for investigation.

A pressing issue in online model-facilitated instruction lies in the complexity of the system being taught, and how the instructor integrates the breadth and depth of a vast amount of knowledge related to that system. These modeling systems cross disciplines and cross themes within a unit of study as they relate complex concepts and generalizations, yet are all linked to the common topic of interest (Erickson, 2001). Therefore, designing these learning environments takes a highly coordinated approach, sometimes involving experts from several disciplines because the instructional designer must be concerned with the integration of content (what essential topics to cover and which experts need to be involved in those decisions) and the integration of process (strategies to maximize learning and promote thinking). What we want from the design of on-line model-facilitated instruction is to integrate all the concepts associated with these complex systems in careful associations to the students to “integrate their thinking at a conceptual level (Erickson, 2001, p. 64), and commit this to long-term memory.

Complex dynamic systems surround us and it is critical that students are provided with the tools to understand these systems. We as instructional designers and educators have the tools and the knowledge to provide students with the learning environments to develop these skills. However, Stahl (2004, p. 9) argues that in spite of the wide

recognition of artifacts as “an embodiment of shared understanding,” only a few education scientists have focused on how new users learn to use them. To fully implement online model-facilitated instruction, we must learn how to use models to expand the capacity and capability to help students process the information, and construct conceptual models that lead to greater retention, and recall and application of knowledge to new and complex situations. Mayer, Dow, and Mayer (2003) focused on the pedagogic features of agent-based microworlds to begin to address how to promote deep learning in the next generation of highly interactive computer-based environments. How best we can facilitate learning in these complex environments and how our cognition changes to do this is an area to be explored.

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- ³ Thinking Tag technology was developed at the MIT Media Lab, 20 Ames Street, Cambridge, MA.

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Chapter 2.4

Developing Learning Communities: Improving Interactivity of an Online Class

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ABSTRACT

This study concerns the design and development of online instruction and specifically targets interaction and communication between online learners. Facilitating appropriate and meaningful interactions in designing instruction is a major goal for anyone developing an online class. The guiding question of the study was: how do the instructional design elements and discipline area impact the quantity of learner-learner interactions? The data for this study came from the online courses offered at one of the major Rocky Mountain University. The research subjects and courses were taken from the College of Education, College of Business, College of Arts and Sciences and College of Health Sciences. Forty graduate online classes, 10

from each college, were analyzed. The findings of this study suggest that the interactivity in an online class depends on group size, grade weight for discussion, use of web 2.0 technologies and multimedia and the discipline it belongs to.

INTRODUCTION

For hundreds of thousands of years, people lived in hunting and gathering economy until humans made the transition to an agricultural economy. The agricultural society continued until about 200 years ago, when the Western world ushered in the Industrial Revolution. A few decades ago, the industrial economy began to give way to the present day information-based society (Dagget, 1998). The advent of the computer and the Internet were instrumental in changing society to a global,

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knowledge-based economy or to what is known today as the information age (Crossman, 1997). This shift in society has had an insurmountable impact on institutions of higher education. Today higher education is reaching beyond the walls of the traditional classroom by providing alternative methods of educational delivery through the use of the Internet and the World Wide Web. This type of distance education delivery is referred to as online learning.

Facilitating appropriate and meaningful interactions in designing instruction is a major goal for anyone developing a course, especially an online course. Although not supported by a specific research study, Kearsley (1998) claims that the “single most important element of successful online education is interaction among participants.” He further states that it is “the instructor’s role as a facilitator to ensure that a high-level of interaction occurs in an online course” (p. 3).

The concept of interaction has received considerable attention in the literature related to distance Internet-based learning (Hill, Wiley, Nelson & Han, 2004). Daniel and Marquis’s (1988) challenged the educators to “get the mixture right” between independence (student-content interaction) and interaction (mainly student-teacher interaction). In the 21st century we are still challenged to get the mixture right (Anderson, 2003). Appropriate mixtures will result in increased learning and exciting new educational opportunities; inappropriate mixes will be expensive, exclusive and exigent. Our responsibility as experienced educators remain- to insure that the modes of interaction that we practice and prescribe maximize the attainment of all legitimate educational objectives and support and increase motivation for deep and meaningful learning (Anderson, 2003).

In this study the researcher assumes that the opinion of Kearsley (1998), “single most important element of successful online education is interaction among learners” (p. 3) holds and wants to understand the role the various instructional design elements and differences in discipline plays in

impacting the overall interaction among learners. Hence, the guiding question of the study is: do the instructional design elements and the discipline area impact the overall interaction among learners as defined by the number of learner-learner interactions?

BACKGROUND

As access to the Internet and World Wide Web has continued to grow, Web-based learning has continued to expand. With approximately half of the households in the United States (or 150 million people connected to the Internet), an estimated 2 million students are taking post-secondary courses that are fully delivered online (Galt Global Review, 2001). Millions of other students at all educational levels (primary, secondary, post-secondary, continuing education) participate online in hybrid, mixed mode, and Web-enhanced face-to-face courses (Picciano, 2002).

Interaction has been recognized as one of the most important components of learning experiences both in conventional education and distance education (Vygotsky, 1978; Holmberg, 1983; Moore, 1993). Gunawardena and Zittle (1997) revealed that social presence contributed more than 60% of learner satisfaction with computer conferencing courses. A common element for learning in a typical classroom environment is the social and communicative interactions between student and teacher, and student and student (Stubbs, 1976). The ability to ask a question, to share an opinion with a fellow student, or to disagree with the point of view in a reading assignment are all fundamental learning activities (Picciano, 2002). In online education, it is particularly important to provide an environment in which meaningful interaction can occur (Collins & Berge, 1996).

There is a scarcity of research on the importance of interaction in education especially in online education. There have been a few studies and opinion papers on the relationship of interaction

to learning (Picciano, 2002). Many observers and researchers have supported the concept interactions among learners are important elements in the design of a Web-based course (Fulford & Zhang, 1993; Kearsley, 1995; Klesius, Homan & Thompson, 1997; Kumari, 2001; Picciano, 1998; 2001; Sherry, 1996; Smith, 1996; Zirkin & Sumler, 1995). Both students and faculty typically report increased satisfaction in online courses depending on the quantity of interactions (Dziuban & Moskal, 2001; Gunawardena & Zittle, 1997; Hartman & Truman-Davis, 2001; Kanuka & Anderson, 1998; Shea, Fredericksen, Pickett, Pelz, & Swan, 2001).

Previous research has indicated a strong, positive relationship exists between student perceptions of their interaction in the course and their perceptions of the quality and quantity of their learning (Dziuban & Moskal, 2001; Shea et al., 2001). Interactions among learners and positive contributions to students' learning are directly related (Laurillard, 1993; Moore, 1993; Ramsden, 1992). Michael Beaudoin (2001) examined the relationship between student interaction and learning. In the study, he divided an online class into three groups (high interaction, moderate interaction, and low interaction). He finds that the high interaction students achieved the highest performance. Adelskold *et al.* (1999) suggested collaborative interaction among learners could have greater effects on learning in a problem solving situation than other types of interaction.

Rust (2006) in her study, found that there is a significantly positive relationship between the number of postings per person and the student retention rate. She also concluded that a significantly positive relationship exists between the students' perceptions of the interaction and their final grade. Picciano (2002) showed, using correlation analysis, that perceived interaction and the actual interaction were significantly positively correlated.

Taiwei (2006) used structural equation modeling to show that learner-learner interaction plays an important role in student motivation. Students

who were engaged in learner-learner interaction were more motivated than those who were not engaged in learner-learner interaction. Karayan and Crowe (1997) used surveys to examine students' perceptions of electronic discussion groups. Their research was designed to discover whether or not student behaviors changed as a result of participation in an electronic discussion group. They believed that the convenience of interaction, the provision for different kinds of learners, and the opportunity to "think through writing" would be evidenced in changes in student behaviors (p. 70).

According to Berge (1997), online class size is an area that is scarcely researched that may have significant affect on students learning and interaction. A research study by Jiang & Ting (2000) found that grades for discussion and requirements for discussion were significantly and positively correlated to students' perceived learning. Bouton and Garth (1983) stated that learning is a group process: the learner actively constructs knowledge by formulating ideas into words, and these ideas/concepts are built upon through reaction and responses of others (Harasim, 1990, p. 43). A unique feature of online education is its capability to support this interactive group process. As Internet-based education programs expand, educators are being challenged to go beyond delivering information to remote learners to building community among them (Bruffee, 1993; Dede, 1990, 1996; Harasim, Hiltz, Teles & Turoff, 1995; Kaye, 1995; Renniger & Shumar, 2000). Several researchers have found that the social aspects of the online learning environment are very important (Meyer, 2000).

MAIN FOCUS OF THE CHAPTER

John Dewey (1916) noted that "Every expansive era in the history of mankind has coincided with operation of factors which have tended to eliminate distance between peoples and classes previously hemmed off from one another" (Dewey, 1916,

p.100). Distance educators also follow this tradition of using the technologically “expansive” of eras to remove the distances from distance education.

The field of distance education has a very long history, however significant to this study, is the brief history of online learning and the need to expand the research base that exists specific to online pedagogy. The majority of research has focused on the continuous debate of comparing online course with traditional courses (Strachota, 2003). The majority of such research has arrived at the conclusion that both the environment of the face-to-face course as well as online course are considered to be equally as effective (Johnson, Aragon, Shalik & Palma-Rivas, 2000; Phipps & Merisotis, 1999; Saba, 2000).

Of concern to the practice of online learning is the scarcity of research studying the impact of effective design of instruction on appropriate and meaningful interactions. There is no single “best way” to improvise these interactions. “Each institution, discipline, region, and user group will develop unique cultural practices and expectations related to their need for and use of interaction. Too much of our practice in distance education is not evidence based and our actions and instructional designs are often grounded on untested assumptions about the value of the modes of interaction (or lack thereof). Thus, research that focuses on interaction in all its forms is critically important” (Anderson, 2003). The guiding question of the study is: do the instructional design elements and the discipline area impact the overall interaction among learners as defined by the number of learner-learner interactions?

SAMPLE

The data for this study came from the graduate online courses offered at the University of Wyoming during the fall of 2007. Ten classes each, from the College of Education, College of Business, and

College of Arts and Sciences and 9 classes from the College of Health Sciences, were analyzed. Hence, the analysis was conducted on a total of 39 online classes.

PROCEDURE

Data were collected on the actual number of student postings to the formal instructional discussion board. The site that provided the archived data for the study is recognized as being one that offered a large number of online courses each semester. The research courses were taken from the College of Education, College of Business, College of Arts and Sciences and College of Health Sciences. The postings to be counted included all comments or questions made to the formal instructional discussion board by the learner addressing other learner(s). These learner-learner postings were then sub-classified as Planning, Contributing, Reflecting, Social Interaction and Parroting, based on the rules developed by the researcher (Table 1). Actual number of student postings made to the formal instructional discussion board by the learner addressing other learner(s) was counted for three different weeks during the semester- week 3; week 8 & week 14, for each of the 39 online classes included in the study. So, the total number of the observation for this study was 117. To control for the variability in class size, this count of the number of learner postings per week was normalized by dividing by the class size and was the dependent variable for this study. By analyzing the Course syllabus and structure, data on exact grade weight assigned to the discussion, use of chat sessions, class size and group size statistics were recorded.

Rules for Sub-Categorizing the Learner-Learner Interaction

On the basis components of collaborative behavior described by Johnson & Johnson (1996), Curtis

Table 1. Rules for Sub-categorizing the Learner-Learner Interaction

ActivityLearner- Learner Interactions	DescriptionGroup skills: a generic code applied to expressions that encourage group activity and cohesiveness	ExampleI know that [names] have given you good advice, but I think it's worth knowing that you need patience.
	Organizing work: Planning group work; setting shared tasks and deadlines.	I just want to set a time-line for myself. Is everyone OK with that?
	Initiating activities: Setting up activities such as chat sessions to discuss the progress and organization of group work.	I would like to chat on the blackboard. What about this Friday at 7.30pm SA time?
	Monitoring group effort: Comments about the group's processes and achievements.	I believe the overall contribution and collaboration of working as a group requires an increase within itself as part of our learning.
	Help seeking: Seeking assistance from others.	Does anyone know how to read the chart on pg. 12 of the text..?
	Feedback seeking: Seeking feedback to a position advanced.	What do you think about answering the question that...has put forward?
	Help giving: Responding to questions and requests from others.	To read the chart, look at the Appendix A of the text..
	Feedback giving: Providing feedback on proposals from others.	I agree with you and I believe... Good point...
	Exchanging resources and information to assist other group members.	"With the implementation of an internet service ... there has been a major shift in the communication function in business."
	Sharing knowledge: Sharing existing knowledge and information with others.	I think we also need to give thought to the following. 1. The issues of quality/efficiency in teaching and learning...
	Challenging others: Challenging the contributions of other members and seeking to engage in debate.	I agree but I wondered about the applicability of the argument: "The individuals or other units in a system ..." (Rogers, p. 295). The example used in the book to support is a valid argument but I am unconvinced
	Explaining or elaborating: Supporting one's own position (possibly following a challenge).	Chery, you have a good point about generalizations but I think the cell phone is a little harder to see why the less fortunate may need it more than the wealthy. I think it has a lot to do with the marketing of the product.....
Learner – CMS interaction	Help seeking: Seeking assistance from others about the use of technology.	Does anyone know how to edit/add/append data on the student pages?
	Feedback seeking: Seeking feedback to a position advanced.	What do you think about tutorial on how toin an online class?
	Help giving: Responding to questions and requests from others about the use of technology.	To access the chat room, click on virtual chat in the blackboard; chat screen will come up; click on enter...
	Feedback giving: Providing feedback on proposals from others about the use of technology.	I like your idea of a generic booklet and everyone contributing aspects of interesting internet services...
	Reflecting on medium: Comments about the effectiveness of the medium in supporting group activities.	The email for the discussion group seems to work OK for me. You know it has gone through because you actually receive your email back almost straight away if it has worked.
Social Interaction	Social interaction: Conversation about social matters those are unrelated to the group task. This activity helps to 'break the ice'.	Regarding chat - my weekend is pretty hectic – I have my family flying in from Greece ... so the Greek festivities will be in full swing.
Parroting	Repeat or mimic (another's words, etc) unthinkingly, one line agreement/disagreement statements	I agree with you Me too...

Adapted from Curtis & Lawson (2001)

& Lawson (2001) developed a list to describe the various activities in an online course and based on that list, the researcher developed the following set of rules to categorize student postings into four sub-categories- Learner-Learner interactions, Learner- Course management system (CMS) interactions, Social Interactions and Parroting

ANALYSIS

Data were organized in SPSS 15.0 statistical software for analysis. Descriptive statistics were utilized to summarize, organize and simplify the data (Gravetter, & Wallnau, 1996). Means and standard deviations of the sample were determined to tell us about the distribution of the variables included.

To control for the variability in class size, the dependent variables (overall interactions per week) was normalized by dividing by the size of the class. Bivariate Correlation analysis was used to find the relationship between the dependent variable and the interval and ordinal independent variables- group size and grade weight for discussion and a t-test was employed to understand the differences due to the use of chat sessions. One-way Analysis of Variance was used to find the relationship between the dependent variable and the nominal independent variable, discipline. Follow-up tests were conducted to analyze the pairwise differences among the means and Scheffe's post hoc comparison test was employed for this purpose

Multiple regression analyses were used to identify the individual contribution of each of the independent variable included in the study. A change in R^2 test was employed to test if the independent variable made a unique contribution in predicting the dependent variable. Equation of the following form was estimated:

$$Y_i = \alpha + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \epsilon_i \quad (1)$$

where,

Y_i : Number of Learner-learner interactions per week normalized by class size.

X_1 : Use of chat session

X_2 : Group size

X_3 : Grade weight for discussion

X_4 : Discipline

α : Intercept

β_j : Regression coefficients

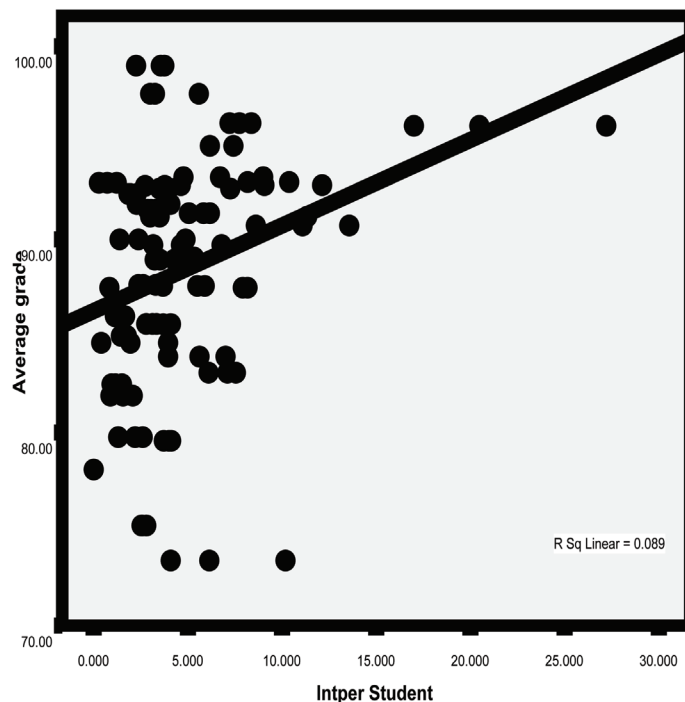
ϵ_i : Residual

Overall Interaction and Learning

This study is based on the assumption that the more the interaction, the greater is the learning. To test this assumption the researcher used average grade for classes included in the study as a proxy for learning. This is not the best measure of learning, but it does serve as a beginning point and a concrete measure of learning application. The result of the bivariate correlational analysis showed that the average grade was significantly positively correlated with the overall interactions per student per week, $\rho = 0.32$, $p < 0.01$ (Figure 1). One of the reasons for a smaller correlation coefficient might be that the grade is not the only or the best indicator of learning. The student's final grade is the undiscussed average (Biggs, 1999).

The above analysis tested the assumptions of this study. Hence, more interaction results in better learning, which also supports the opinions and researches by various authors in the literature (Dziuban & Moskal, 2001; Gunawardena & Zittle, 1997; Hartman & Truman-Davis, 2001; Kanuka & Anderson, 1998; Shea, Fredericksen, Pickett, Pelz, & Swan, 2001).

Figure 1. Scatter plot showing the relationship between the average grade and overall interaction



RESULTS

Correlational Analysis

Table 2 presents the Pearson's product moment correlation coefficients between the 4 variables included in the study. The result of the correlational analysis showed that 2 out of 3 independent variables (Grade weight and Group size) were significantly correlated with the independent variable, interactions per student per week.

The reader should be cautious while interpreting the magnitude of the correlation coefficient as most of the variables had skewed distributions due to the presence of outliers, which would reduce the magnitude of correlation coefficient (Lomax, 2007, p. 188). So, most of the coefficients shown in Table 2 are under-estimate of actual size of the correlation.

Regression Analysis

After testing the underlying assumptions, the researcher conducted the multiple regression analysis. The linear combination of independent variables was significantly related to overall interactions among learners, $F(4, 112) = 6.83$, $p < 0.01$. The coefficient of determination (R^2) was 0.27, indicating that approximately 27% of the variance of the overall interactions in the sample can be accounted for by the linear combination of the independent variables included in the study. The results of the regression analysis showed that discipline and group size were significant predictors of the dependent variable at 5% level of significance, while the use of chat session and grade weight were not significant in predicting the overall interactions per student per week.

To further support the above results and to find the individual contribution of each predictor variable, the researcher used multivariate regres-

Table 2. Correlation matrix showing the bivariate relationships among the variables included in the study

		1	2	3	4
1	Intper Student	1.00			
2	Grade Weight	0.19*	1.00		
3	Group Size	-0.35*	0.06	1.00	
4	Chat session	0.10	0.23	0.04	1.00

* Significant at 0.05 level

sion analysis to conduct a change in R square test. The result of this analysis is presented in Table 3.

Overall Interaction and Group Size

The size of groups is an important element of the success of the online learning process (Learning Team Handbook, 2003). A unique feature of online education is its capability to support the interactive group process (Gusky, 1997). This study found a significantly negative relationship between the overall interaction and group size (tables 1 & 2). Hence, the overall interaction among students was higher when the group size was small which supports the fact that smaller virtual learning groups build synergistic learning efforts among students in online courses (Scarnati, 2001).

Overall Interaction and Grade Weight For Discussion

Online courses included in this study incorporate a threaded discussion element in their courses with a varying grade weight assigned to it. This study

found a weak positively significant correlation between the overall interaction and the grade weight (table 1). But a more powerful regression analysis failed to find any significant unique contribution made by this variable in explaining the variation in the dependent variable (Table 3). Hence, the grade weight assigned to the discussions was not a significant predictor of the overall interactions among students. This result contradicts the views of Jiang & Ting (2000) who found a significant positive correlation among discussion grade weight and students' perceived learning.

Overall Interaction and Differences In Disciplines

In this study the researcher selected sample courses from 4 different disciplines. Ten courses each from Colleges of Business, Arts & Sciences and Education and 9 courses from College of Health Sciences were included. The results showed that the Health Sciences courses had a higher overall interaction per student per week then the other disciplines but the differences in interaction between

Table 3. Summary of regression analysis for understanding the individual unique contributions of the independent variables in predicting the overall interactions per student per week (N = 117)

Excluded variable	Change in SE	Change in R ²	F-statistic	Df (n,d)	p-value	VIF
Discipline	0.18	0.10	4.96	(3,110)	0.003	1.84
Group Size	0.10	0.05	6.77	(1,110)	0.011	1.28
Grade Weight	0.01	0.01	1.64	(1,110)	0.20	1.31
Chat Session	0.01	0.01	0.56	(1,110)	0.457	1.12

Table 4. Summary statistics for overall interaction per student per week for the different disciplines

College	Mean	SD
A & S	3.42	2.03
Business	2.81	1.35
Education	5.71	2.77
Health Science	7.36	6.16

Education courses and Health sciences courses was not significant (Table 4). The researcher did not find any literature that researched this variable in the past.

Overall Interaction and Use of Chat Sessions

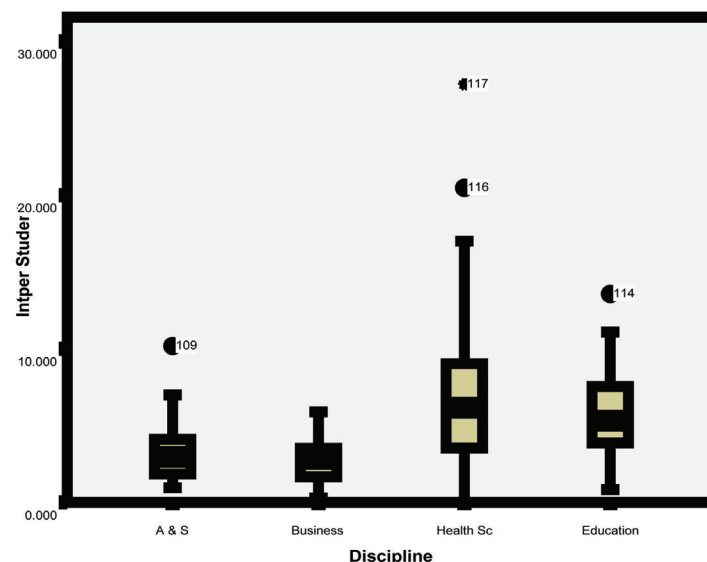
This study failed to find any significant relationship between use of chat sessions and overall interactions (tables 1 & 2), which is in direct contrast to the views of Rohfeld & Hiemstra (1995), who concluded that chat sessions are important to build a friendly and social environment which fosters learning.

CONCLUSION

This study began by asking “do the instructional design elements and the discipline area impact the overall interaction among learners as defined by the number of learner-learner interactions?” The following conclusions can be drawn on the basis of analysis done:

- Design Elements:
 - There is a statistically significant negative relationship between group size and overall interaction. The smaller is the group size, the higher is the overall interaction.
 - There is no statistically significant relationship between the grade weight for threaded discussions and the overall interaction.
 - There is no statistically significant relationship between use of chat sessions and overall interaction, i.e. the interactivity in an online class does not depend on the use of chat sessions.

Figure 2. Distribution of the overall interaction per student per week for the four disciplines



- Discipline:
 4. The differences in discipline made a unique contribution in predicting the overall interactions, i.e. the interactivity in an online class depends on the discipline it belongs to.

The results of this study can prove to be very important in designing effective and interactive online courses. To improve the interaction in an online class, students must be divided into smaller groups. The results of regression analysis showed that differences in discipline made a unique contribution in predicting the overall interactions and was the most important predictor of overall interaction. This result suggests that the interactivity in an online class depends on the discipline it belongs to and hence, future research must focus on impact of instructional design elements on overall interactions within a discipline.

FUTURE RESEARCH

1. Similar studies can be conducted using a more representative sample of online courses particularly from different institutions.
2. The researcher limited this study to interactions in online classroom but it can be extended to a face to face class as well.
3. This study was limited to graduate level classes but future research can be extended to undergraduate classes as well.
4. A longitudinal study should be conducted to understand the impact of technological advancement over time on overall interaction in an online class.
5. The researcher considered four different predictor variables but a future study may include more variables that can influence the interactivity of an online class.

6. A future study may be conducted on similar lines using non-parametric estimation techniques.

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KEY TERMS AND DEFINITIONS

Distance Education: In this dissertation refers to “online delivery of education to remote locations, using either or both synchronous and asynchronous delivery of course content” (Distance Education at Postsecondary Education instructions: 1997-1998). In this research project, Distance Education does not include correspondence or broad-cast based education.

Face-to-Face Learning: Refers to teaching and learning that occurs when both teachers and students are confined within a single room.

Instructional Design Elements: Refer to the components of a course that facilitate learning. For the purpose of this study 3 different instructional design elements will be considered: Group size, grade weight assigned to threaded discussions, and use of chat sessions.

Learner-Instructor Interaction: Refers to the human interaction consisting of communication

between the learner and the instructor (Moore & Kearsley, 1996).

Learner-Learner Interaction: Refers to the human interaction consisting of two-way communication between one learner and other learners (Moore & Kearsley, 1996).

Traditional Courses: Refers to the courses essentially taught in a face-to-face classroom environment but may use some web-based technology to support the course content.

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Chapter 2.5

Developing Prescriptive Taxonomies for Distance Learning Instructional Design

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INTRODUCTION

There are simple answers to all complex problems... and they are uniformly wrong. -- H.L. Mencken

One of the central problems and corresponding challenges facing the multidisciplinary fields of distance learning and instructional design has been in the construction of theory-grounded, research-based taxonomies for prescribing what particular strategies and approaches should be employed when, how, and in what combination to be most effective and efficient for teaching specific knowledge domains and performance outcomes. While numerous scholars and practitioners across a wide range of associated instructional design fields have

created a rich variety of effective, efficient, and very current prescriptions for obtaining specific learning outcomes in specific situations (Anderson & Elloumi, 2004; Marzano, 2000; Merrill, 2002a; Nelson & Stolterman, 2003; Reigeluth, 1999a; Shedroff, 1999; Wiley, 2002), to date, no single theory-grounded and research-verified unifying taxonomic scheme has successfully emerged to address all existing and potential educational problems across the phenomena of human learning and performance.

BACKGROUND

Descriptive taxonomies developed in educational theory and practice have provided rich organizational schema for classifying the structure of conditions for learning describing the approaches,

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types, events, methods, and goals of instruction (Gagne, 1977). While affective and psychomotor capabilities have gained increasing importance (Krathwohl, Bloom & Masia, 1964, Martin & Briggs, 1986), classic instructional design theory has tended to focus on the cognitive domain, as exemplified by the widely adopted hierarchical taxonomies of Bloom (1956) and Gagne, Briggs, and Wager (1992). There have been serious efforts to revise and update *Bloom's Taxonomy* with the applied focus towards more specific and pragmatic "best practice" teaching strategies in instruction (Anderson, Krathwohl, Airasian, Cruikshank, Mayer, Pintrich, et al., 2000). However, few correspondingly robust prescriptive taxonomies have emerged to encompass the optimal design solutions for distance education and online e-learning professions. This article examines the critical issues involved with understanding the nature and function of prescriptive educational taxonomies for improving the efficiency and effectiveness of rigorous instructional design solutions adaptable and applicable to the burgeoning field of online learning, user-centered design, and technologically distributed distance learning environments.

MAIN FOCUS: INSTRUCTIONAL TAXONOMIES - WHAT THEY ARE AND WHY THEY MATTER

In his hallmark narrative work on the complexities of successfully building a learning environment, media pioneer Edgar Dale identified important considerations for the development of any prescriptive taxonomy for instruction, as well as this encyclopedia broadly conceived:

Indeed product and process must not be separated, any more than we would separate form and content...A major issue in all learning deals with the processes by which learning experiences become structured, organized, mapped, patterned,

clustered, and systemized. We group experiences, using some kind of framework, paradigm...schema, summary, matrix, model, unit, brief, diagram, category, concept, hierarchy, grid, or outline. We use hierarchies, superordination and subordination...All these terms indicate a linking, a relating of experience on the basis of their differences and likenesses. Process and product, form and content become fused, structured. (pp. 82-83)

Human learning and the collateral formation, representation, acquisition, generation, and creation of knowledge in the mind of the learner are unquestionably immensely ill-structured and complex human problems (Reigeluth, 1999b). Philosophers and scholars have explored, for ages, questions of ontology and epistemology, and numerous competing schools of thought (i.e., instructional design paradigms) have developed across a wide array of knowledge domains (Richey, 1986; Visscher-Voerman & Gustafson, 2004). The enactive, intentional, unifying higher-order problem-solving endeavor is *design* itself, and numerous universal principles, exemplars, and epitomes of design have emerged (Lidwell, Holden, & Butler, 2003). "Designing is, therefore, more than ordering and arranging, more than constructing. It is composing. It is using the codes and pattern languages of a domain to create wholes with not only parts and relationships but also ordering-underlying principles (Rowland, 2004, p. 40)." Critical in this human design process for instruction are systems thinking, creativity and evaluative judgment, metacognitive awareness, and the seemingly paradoxical nurturance for an eclectic, broad-minded tolerance for ambiguity while simultaneously possessing a pragmatically strong drive towards tangible closure (i.e., deliverables) in the design activity (Lasnik, 2003b). To illustrate the relative complexity of this phenomenon, an easy-to-grasp architectural analogy is provided in Table 1.

Table 1. Simple analogical model of e-learning environments

BUILDING ARCHITECTURE	E-LEARNING ARCHITECTURE
Buildings, structures, bridges	Courses, scope & sequence (curricula)
Macrodesign form, leitmotif, treatment	Instructional design approaches/models
Purpose & function of building	Information design
Properties of materials	Media design
Patterns of interior/exterior space	Interactivity design
Structure lifecycle (repair, modification)	Iterative courseware design (improvement)
Settlements, zones, cities	Lesson activities, modules, units
Power, water, air, transportation	Courseware management infrastructure

First Principles of Prescriptive Theory: The Taxonomic Function

The critical problem of taxonomic formulation is to provide a cogent, comprehensive, conceptual model of phenomena that is (a) dynamic (capable of change), and robust (representing all relevant attributes) without being reductionist, and (b) parsimonious (graspable, usable) without being an oversimplification. Two broadly adopted exemplars are the classification schemes of Carl Linnaeus (i.e., his 1735 System Naturae that evolved into modern biology's kingdom, phylum, class, order, family, genus, and species schema) and Dmitrii Mendeleev (i.e., his 1889 Periodic Law of the Chemical Elements that evolved into today's Periodic Table). Mendeleev's perspicacious insights into the nature of atomic structure arguably rank him with Albert Einstein as the paradigm-shifting geniuses of modern science. Moreover, the Periodic Table has provided a unified scaffolding between the detailed description of matter and the effective prediction about how that matter will behave. In other words, a single, well-organized, seemingly simple diagram in fact illustrates a highly sophisticated metageography literally encompassing the known universe and simultaneously explaining how all matter within that universe will interact (Atkins, 1995). This is the fundamental character of prescriptive theory: the power to explain and to predict. It is arguable

whether a verifiable unified theory of learning and instruction can be found, is even desirable, and ultimately whether learning, instruction, and the active construction of knowledge are even truly capable of a single, complete prescriptive taxonomic classification. It is the premise of this article that such a comprehensive architecture will one day emerge.

Learning Taxonomies: Envisioning the Problem Space

Ideally, descriptive instructional schema can support the diagnostic function, and prescriptive schema can support the remedial, corrective function in the teaching/learning enterprise. The underlying rationale for hybrid descriptive-prescriptive taxonomies for instruction is (a) to demonstrate that content and method are inextricably linked and are synergetic (i.e., mutually reinforcing entities that create a combined, holistic design alloy greater than either in isolation), and (b) to provide a powerfully eclectic, flexible foundation of a more effective and efficient design solution for particular e-learning requirements.

Well-constructed taxonomic models should clearly and unambiguously represent all of the important concepts and principles (change relationships) in a knowledge domain, in this case connecting instructional activities (inputs) to learning performance (outputs). An effective

taxonomy can present a metatheory of the instructional design problem space complete with a detailed map of the possible routes between the origin and the destination. Moreover, Bertin (1981) emphasized that:

In considering hypotheses and methods, it is necessary to envisage the whole problem. The matrix analysis of a problem is a process which enables us to see the whole...and to "foresee" the possible choices and their repercussions. (p.17)

Therefore, the use of a taxonomic table or diagram can serve as a representational schema displaying both a heuristic method and an ostensible design strategy. Such a model could enhance the e-learning repertoire of distance teachers and contribute to their ability (a) to systematically define the educational problem (i.e., the content to be taught, the specific needs of the students, and the intended performance outcomes), and (b) to produce an appropriate instructional design solution. Unfortunately, much of what constitutes secondary and college-level instruction continues to be predominantly receptive learning approaches that separate content from method and disembodiment information into predigested, decontextualized, abstract chunks that are easy to deliver but provide little scaffolding for meaningful learning (Bransford, Brown, & Cocking, 2000; Lasnik, 1988, 2003a; Mayer, 1989, 1999; Perkins & Unger 1999; Shuell, 1986).

Levels of Complexity in Taxonomic Design

Complexity levels are key to the development of any robust taxonomy, but levels of cognitive, affective, or sensory-motor complexity may or may not directly translate to levels of difficulty and achievement in the learning experience. In course design architectures, simple taxonomies are often created to describe categories and subcategories of topics covered in the course (Posner & Rudnitsky, 2001).

Each of the taxa may also be comprised of various levels of subcomponents: for example, rules are logical control structures containing prepositions, concepts are logical schema containing critical attributes and variable attributes, principles are predictive change relationships containing static and dynamic concepts, laws combine into theories, and theories become explanatory systems. Viewed as layers of an onion, the organizational structure focuses on progressively smaller, less abstract units from higher-order macrolevel down to lower-order microscopic dimensions. More substantive taxonomic layers describe superordinate and subordinate rules, superordinate and subordinate concepts, superordinate and subordinate principles, superordinate and subordinate laws, and coherent, integrated, unifying theories that subsume the descriptive *taxa* of rules, concepts, principles, and laws. These perspectives are congruent with the salient dimensions of modularity, granularity, and combinatorial flexibility that have emerged in the evolving definitions of learning objects (Merrill, 2002b; Wiley, 2002).

The Emergence of the Postmodern Knowledge-Based Curriculum

Existing education and training curricula that reinforce the artificial division between information's purpose, structure, and the student's firsthand experiences within that information are vestiges of an earlier learning paradigm that is no longer relevant or effective in the postmodern e-learning environment. In fact, this is one of the principal flaws in Benjamin Bloom's (1956) widely adopted cognitive taxonomy: the Industrial Age percept of knowledge as the mere acquisition, storage, and retrieval of passive information is placed at the foundation level of the entire scheme! Ideally, perceiving knowledge itself as an integrated, learner-centered design process can ameliorate this disconnect and may serve to narrow the mind's gap between inert information and applicable, useful, and most critically *transferable* knowledge

(diSessa, 1977). The bridge between static information and dynamic, transferable knowledge is more soundly built on authentic competency and performance ability across a range of analytical, practical, and creative domains (Howard, McGee, Shin, & Shia, 2001; Perkins & Unger, 2001).

Dale's (1972) insightful systems view of how people learn also conveys the underlying rationale for designing instruction around practical, functional conceptual schema:

In mastering any subject, in learning to learn, we must map the field, note its basic principles, its key ideas and vocabulary, and its conceptual structure. For example, no sensible person studies the automobile by first trying to master the names of all its parts. Instead, he thinks in terms of systems—ignition, fuel, transmission, braking, and so on. In each of these classes are meaningfully related concepts...The crux of learning is to develop a conceptual scheme. (p. 52)

Perkins (1992) has further elaborated on the prescriptive practices that can contribute to a more effective and efficient instructional design across the curriculum from pedagogy to androgogy. Previously, Perkins (1986) had deftly proposed the intriguing, powerful metaphor of *knowledge as design* in constructing first principles of empirical (i.e., discovery-driven) teaching and learning. This is a reflective, recursive, parsimonious, and practical taxonomy with both descriptive (of product and process) and prescriptive (the inquiry-based learning activities) dimensions based upon four fundamental questions about the nature of a particular design: (a) what is its purpose?; (b) what is its structure?; (c) what are model cases of it?; and (d) what are arguments that explain and evaluate it? By carefully addressing each of these post-Socratic interrogatories, both descriptive and predictive components of concepts, principles, objects, and systems can be understood in the broader educational context and conversely, ef-

fectively (i.e., successfully and robustly), and efficiently (i.e., optimizing time, cost, and human resources) taught.

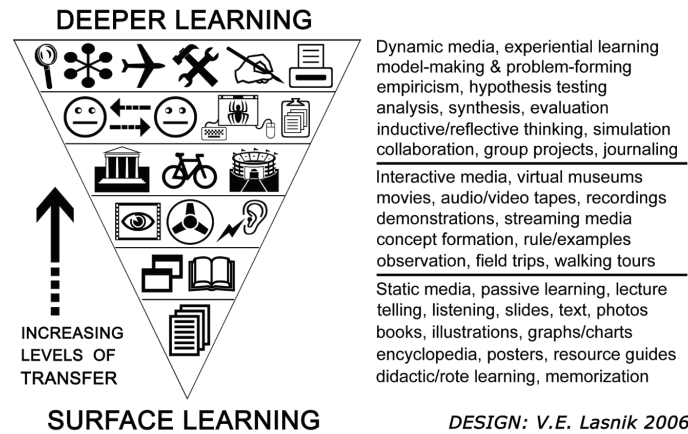
Experiential Learning Models: From the Student's Perspective

Edgar Dale's widely known Cone of Experience (Dale, 1954) is an exemplar of a simplified but parsimonious hybrid taxonomy that synthesizes both descriptive and prescriptive domains. Conceptually modeling a progressive spiral curriculum of media and learning types, Dale's Cone (author's interpretive update with significant modifications as shown in Figure 1) juxtaposed specific educational technologies with cognitive change, effectively providing a descriptive hierarchy where the level of increasing engagement with the active learner predicts deeper learning and acquisition of transfer. From the perspective of granularity with learning objects, Dale's learner-centered system uses large, aggregate technologies/levels across a spectrum from more inert, static, abstract, expository-declarative materials (e.g., texts, lectures, audio and video recordings) to more dynamic, concrete, discovery-experiential activities (e.g., field trips, discussions, and participatory, collaborative learning projects).

An Experiential Learning Taxonomy

While variations on this theme have emerged across the literature (Anders, 1999; Reigeluth, 1983, 1999b; Richey, 1986; Shedroff, 1999; Stolovich & Keeps, 2002; Wiley, 2002), the essential principles easily map into a cohesive topography (See Table 2) like a broad continent with two opposing coasts unified by the general observation that all learning is experiential and occurs across a wide multileveled continuum proceeding *from—to*.

Figure 1. A 21st century update of Dale's Cone of Experience Taxonomy (Lasnik, 2006)



Applying Prescriptive Taxonomies to Instruction

Prescriptive taxonomies attempt to address how specific learning types and capabilities can be enabled and achieved by which corresponding experiences. In recently examining the affordances and medial qualities of interactive game-based learning, Prensky (2000) posited a basic set of learning types (i.e., intended outcomes) and corresponding learning experiences (i.e., facilitating interventions). Extrapolating these observations

with other perspectives about how people learn (Allessi & Trollip, 1985; Bransford et al., 2000; Mayer, 1983; Merrill & Tennyson, 1977; Perkins, 1986; Screven, 1999) leads logically to a pragmatic prescriptive matrix constructed in Table 3:

Integrating Cognitive and Affective Domains

Conventional didactic classroom instruction in secondary and postsecondary institutions has been predominantly focused on the delivery of

Table 2. Selected summary of experiential learning dimensions

More passive learning to more active learning	More expository/delivery to more discovery/inquiry
More abstract concepts to more concrete activities	Less learner control to more learner control
From parts/components to wholes/systems	Teachers on top to teachers on tap
Deductive rules to inductive processes	Sage on the stage to guide on the side
Isolated part-tasks to situational whole-tasks	Less interactivity to greater interactivity
Rule-learning practice to problem-oriented	Surface learning to deeper learning
Independent facts to inter-dependent contexts	Extrinsic rewards to intrinsic value
Convergent thinking to divergent thinking	Lower order thinking to higher order thinking
Well-defined problems to ill-defined problems	Telling/showing/listening to doing/making/acting
More algorithmic solutions to more heuristic design	Less creativity to greater creativity
Less learning transfer to greater learning transfer	Receptive learning to applied learning
More quantitative data analysis to more qualitative observation & evaluation	Knowledge of results to constructive/remedial feedback

Table 3. Descriptive learning types & prescriptive experiences matrix

LEARNING TYPES (Learn this)	LEARNER EXPERIENCES (By doing this)
Facts, information, declarative knowledge	Drill, repetition, memorization, viewing data
Skills, performance capabilities/competencies	Practice part/whole tasks, receive coaching & training, continual hands-on practice
Concepts, rules, associations, classifications	Identify attributes, view multiple examples & non-examples, compare & contrast
Principles, change relationships, correlations, critical paths, inheritances & comparison & contrast across time dimensions & functions	Critical thinking, analyze & synthesize data patterns across x/y dimensions; create concept maps, fault-trees and troubleshooting protocols
Procedures, processes, cause-effect reasoning	Deconstruct problem or process into component parts, sub-systems, beginning & goal states; analyze independent & dependent variables, inputs & outputs; map IF-THEN logical control structures; identify functionality & model cases; “work the problem” & “follow the data”
Systems, theorems, explanatory schema	Reflective inquiry & observation; conduct experiments, formulate & test hypotheses, understand tradeoffs & interdependencies; search for patterns, create conceptual models
Creativity, innovation, novel & original ideas, resourcefulness, collaborative decision-making, resolving complex, ill-structured problems	Divergent thinking, team role-playing, problem-solving, simulation games, group design tasks, “break set”, brainstorm, generate alternatives, challenge assumptions, take calculated risks

“content” as abstract information and, at best, employs critical thinking, reflective thinking, collaborative learning, and creative problem solving as ancillary scaffolding activities to ostensibly engage learners to acquire this predominantly declarative knowledge. Convergent thinking assessments generally designed for administrative convenience are then often employed to evaluate how well this specific content has been absorbed. This instrumentalist paradigm tends to dilute the essential role of thinking, reflection, and both creative and technical communication (e.g., writing, composition, art) emphasized in exemplary constructivist course design, and has the additional onus of reinforcing a surface approach towards all instruction and learning (Nickerson, Perkins, & Smith, 1985; Perkins, 1992; Perkins & Unger 1999).

Stolovich (1978) and Stolovich and Keeps (2002) have engineered a variety of interesting and helpful ways of addressing prescriptive approaches in education and training. A sample of their integrated “learner-centered, performance-based” strategies for instructional media is outlined in Table 4.

Identifying Critical Attributes of Taxonomic Philosophy

For any instructional taxonomy, it is essential to identify the core epistemological assumptions underlying the categorization scheme. The cognitive-constructivist pedagogical approaches all appear to recognize the following broad observations: (a) Real-world knowledge develops from active, authentic (i.e., realistic, actual), and engaging experiences within personally meaningful contexts; (b) this knowledge is cross-disciplinary, multisensory, multidimensional, and problem-oriented; and (c) the principle inner experience of learning is discovery-driven, meaning-seeking, sense-making, goal-based and intrinsically self-motivating towards the actualization of achievement and competency (Lasnik, 1999).

Rather than emphasizing abstract, iconic, conventional, static, and redundant expository descriptions of various empirical phenomena on an idiosyncratic case-by-case basis, the teaching of concepts and principles are better founded on a deeper level of human cognitive processing. All robust learning is viewed as operational and

Table 4. Modified Learning Element & Instructional Method Taxonomy (Significantly enhanced while broadly adapted from Stolovich 1978, and Stolovich and Keeps 2002)

LEARNING ELEMENT	INSTRUCTIONAL METHOD
Environmental	The learner activity provides non-abstract, real-world contexts in which the skills are to be applied. Employ actual case studies, local events, conditions, and current problems to engage learners, augment direct relevance, and connect learning to application.
Enhancement	In teaching a procedural task, the supporting media should clearly and unambiguously show each of the steps during the demonstration of the skilled performance from start through goal. Learners should be provided opportunities to replicate tasks and practice skills to enhance their performance mastery/competence.
Examples	In teaching a concept or principle, the media provide a divergent set of examples and non-examples across a range of complexity, difficulty, and thinking skill (lower to higher) dimensions. Opportunity to compare & contrast independent and dependent attribute variables will support identification & generalization.
Instructions	The training provides directions given in the procedure or process that ensure the learner will follow them, including part tasks & whole tasks. Instructions and remedial help should be aligned and embedded (context-sensitive) to task performances.
Summary	The training provides summaries of the principles and procedures taught in the lesson and module. Summarize and organize rules, concepts, unifying theory, and best practices to be used as job aids (performance mnemonics) and cognitive strategy scaffolds.
Enrichment	The media facilitate logical opportunities to go beyond the specific instructional objectives of the module without interfering with its essential focus. Provide supplemental “value added” media resources and additional opportunities for applying new knowledge through advanced projects, creativity, & collaboration.

experiential in nature: that is, by doing tasks, hands-on activities, experiments, comparisons of examples and non-examples, individual and group interactive role-playing simulations and tasks-manipulating attributes, and rule parameters, variables, and constants. These firsthand, inquiry-driven, inductive reasoning, heuristic-based approaches are particularly vital for compelling distance-learning educational experiences requiring reproducible outcomes in improved thinking skills, longer retention and integration of content, and a better transfer to on-the-job task performance (Dede, 2002; Lasnik, 1988; Schank, Berman, & Macpherson, 1999).

Deep vs. Surface Approaches Toward Learning

Insufficient serious attention to the problematic effects of the dichotomy between deep learning and surface learning continues to plague educational policy and practice worldwide. A student with a surface approach towards learning maintains an instrumentalist view towards coursework char-

acterized by an impersonal disengagement and extrinsic motivation toward learning tasks, little interest in integrating new knowledge with prior knowledge, concern about the duration of learning tasks, and the reliance on memorization to learn new material. Conversely, a student with a deep approach towards learning develops a personalized engagement and intrinsic enjoyment in learning tasks, interest in integrating new knowledge with prior knowledge, and the search for hypotheses, explanations, and meaningfulness in new material (Biggs & Rihn, 1984). This observation is critically important to the future design and development of effective e-learning courseware because instruction emphasizing heavily expository delivery of information, content that students can acquire perhaps more efficiently on their own via books, Web sites, libraries, in the field on their own), reduces the power of the online communication environment to a mere convergent thinking funnel. Meaningful deep learning can be facilitated by appropriate levels of thoughtfully designed interaction between students and teachers, students and content, and student peer-to-peer communica-

tion. Moreover, “the challenge for teachers and course developers working in an online learning context is to construct a learning environment that is simultaneously learning centered, content centered, community centered, and assessment centered” (Anderson, 2004; p. 50).

A Learner-Centered Media Taxonomy

Bruce and Levin (1997) proposed a four-part user-centered instructional media taxonomy based broadly on the well-known learner-centric Progressive pedagogical philosophy of John Dewey. Like Dewey, their organizational schema places the conventionally central roles of both technology and traditional “content domain” disciplines into the background, and elevates the individual’s intrinsic interests and social learning needs into the focal plane of the educational experience. In particular, they emphasize the constructivist notion of technology as media: reconceptualizing learning activities as well as hardware and software infrastructure as enabling, mediational,

motivational, growth-fostering components of the learning intervention and learner’s transformation (Keller, 1983). Their inclusive model of media acts as an instructional catalyst, a dynamic scaffolding between passive and active realms much like the muscles of the forearm provide the medial function of motion between the (active) brain and the (passive) bones of the ulna and radius. These metacognitive media models are defined by their respective functions for inquiry, communication, construction, and expression, and apply prescriptive activities and experiences for their attainment. An expanded synopsis of their taxonomy is shown in Table 5:

Teaching Learners Heuristic Reasoning

Heuristic principles and strategies are ostensibly at the heart of all meaningful instructional design treatments. The word origin is *heuriskein*, the Greek term for “to discover, find.” It is the source of Archimedes proverbial “Eureka!” (i.e., I have

Table 5. Media Taxonomy for Inquiry, Communication, Construction, & Expression (modified from Bruce & Levin, 1997)

MEDIA LEARNING FUNCTION	PRESCRIPTIVE LEARNER EXPERIENCES
INQUIRY	1. Theory-building; media for thinking: visualization, simulation, procedural & parametric modeling, knowledge representation schemes 2. Data-mining: online libraries, hypertext tools, accessing digital media assets, databases of audio, video, text, voice, music, graphics 3. Data-collection: active audio/video recording, remote real-time scientific data acquisition tools, tablet PCs 4. Data-analysis: environments for inquiry, hypothesis testing, statistical search for patterns, make tables, graphs, diagrams, matrixes to model problems, inter-relationships
COMMUNICATION	1. Design & produce communication artifacts: outlining ideas, arguments, writing clear & compelling documents, creating presentation materials, persuasive use of text & visuals 2. Collaborative synchronous & asynchronous media: threaded discussions, computer conferencing, email, blogs, wikis, podcasts, listservs, online journaling, multiuser domains 3. Teaching & training multimedia: instructional simulations, telementoring, tutoring, coaching
CONSTRUCTION	Student goals: build and make things; similar to <i>Communication</i> function but learner experiences are designed to produce tangible, transportable multiple media artifacts for use in portfolios, Web sites, software applications, tools and affordances to affect, influence, and impact physical, intellectual, and cultural worlds
EXPRESSION	The uniquely personal creative design function: original, self-expressive writing, scripting, music composing, 2-D & 3-D drawing, painting, animation, video, digital photography, Web design, interactive multimedia microworlds, and so forth.

found it!) exclamation. Heuristic techniques and devices, far more than mere “rules of thumb” in the problem-solving vernacular, profoundly assist discovery and guide further investigation. Insightful, deftly employed heuristic pedagogies can designate “the educational method in which the student is allowed or encouraged to learn independently through his own investigation.” (Morris, 1976, p. 620). In other words, heuristic design principles are at the epicenter of every deep learning-centered environment. For example, a cognitive-constructivist prescription for an e-learning course might redesign, reformulate, and restructure content from the learner’s perspective, or more precisely, based upon how people actually learn (Bransford et al, 2000). There would be no arbitrary arrangement of course structure or metacurriculum, but one carefully organized around logical, intuitive, organic patterns and models of knowledge acquisition within the particular subject or discipline. Heuristic courseware focuses the affordances of the online environment on the learner as user, the learner as client, and ultimately on the experiential transactions between the dyads of learner-teacher, learner-learner, and learner-content. An exemplary prescriptive instructional-design scheme superbly adaptable to distance-learning courseware can be applied from the five “First Principles for Effective Instruction” (Merrill, 2002) as summarized and elaborated in the following five paragraphs:

1. *The courseware should be presented in the context of real-world problems.* This is one of the premises of problem-oriented learning. It is also helpful to clarify the importance of integrating concepts within realistic contexts and demonstrable learning outcomes. Learner activities should utilize a range of problem difficulty and complexity that gradually reduces the need for scaffolding as competency increases across problem types. The activities might involve a progression of problems rather than a single problem, and should engage students at the problem or whole task level and not just the operation or action levels.
2. *The courseware should attempt to activate relevant prior knowledge or experience.* This is the precursor to a learner’s acquisition of transfer skills, and recognizes the need to scaffold learning activities between the gap of prior knowledge and new knowledge. Also, appropriate online help and coaching should also be provided, but the need for assistance should gradually be diminished as the new skills/knowledge are successfully acquired. The courseware activities should direct learners to recall, relate, describe, or apply knowledge from relevant past experience as a foundation for their new knowledge. For example, embed the use of analogical and inductive reasoning from prior examples/cases as scaffolds for improved transfer to the newly encountered situations or problems. These analogies should help learners recall or form appropriate structures for organizing the new knowledge, thereby augmenting new schema formation and concept acquisition.
3. *The courseware should show examples of (demonstrate the new skill) what is to be learned* rather than merely tell information about what is to be learned. For active learners, showing is better than telling and doing is better than showing (principle 4 following), and knowledge goal-state exemplars need to be as explicit and as concrete as feasible (i.e., clearly show learners the task they will be able to do or the problem they will be able to solve as a result of completing a module or course), applying an appropriate use of media to reinforce, supplement, complement, augment, enhance, clarify, and scaffold learning. The kind of showing is important (i.e., examples and non-examples

for concepts; demonstrations for procedures; visualizations for processes; and modeling for behavior).

4. *Learners should have an opportunity to practice and apply their newly acquired knowledge or skill*, consistent with the learning objectives. This learner demonstration of transfer competency should be routinely occurring throughout the instructional intervention and not only at the end of instruction (summative finals). It is a core instructional design practice to facilitate congruence and alignment between learner practice activities and measured performance criteria used to evaluate learning attainment. Also, the courseware should ideally require learners to solve a varied sequence and range of difficulty of problems while receiving corrective (i.e., remedial) feedback on their performance. Moreover, the kind of practice (i.e., doing) is very important in prescribing what specific activities are most beneficial for various learning objectives: (a) **Information-about** practice requires learners to recall or recognize information; (b) **Parts-of** practice requires the learners to locate, name, or describe each component part; (c) **Kinds-of** practice requires learners to identify new examples of each kind; (d) **How-to** practice requires learners to perform the skill or procedure; (e) **What-happens** practice requires learners to predict a consequence of a process given conditions, or to troubleshoot faulted conditions given an unexpected consequence.
5. *The courseware should provide techniques that encourage learners to integrate (transfer) the new knowledge or skill into their everyday life*. This extends the prescriptive curriculum from problem-oriented to project-based activities that foster a deep approach towards learning, as described in this article. Also, while systematic, indi-

vidual student practice of skills is suggested in principle 4, this principle requires learners to reflect on, discuss, defend, and demonstrate their new knowledge in some public or semipublic capacity (e.g., online forums, threaded discussions, wikis, blogs, etc.). Finally, the e-learning experience should also provide an opportunity for learners to create, invent, or explore new and personal ways to use their new knowledge or skill (See parallel with Communication, Construction, & Expression functions of Bruce & Levin, 1997).

While it is true that the practice of instructional design involves more than consideration for these “first principles,” per se, a judicious application of these guidelines to the iterative information-interactivity-media design process of learner-targeted products like immersive real-time educational simulations, and both synchronous and asynchronous distributed courseware would ostensibly accommodate the needs of as many learners as possible and in effect, meet or exceed many of the collateral concerns about the economic, engineering, cultural, and environmental impact of the prescriptive design solution. Moreover, while these principles are not exhaustive in scope or detail, they provide a helpful starting point for a pragmatic heuristic evaluation of any online learning product’s learner experience portfolio.

Future Trends and Conclusion

Experiential instruction designed for deep-learning heuristic skills, critical and reflective thinking, creative problem-solving, and project-based, problem-oriented activities combines a superior educational paradigm with far richer and compelling utilization of new media accessible through the computer platform and Web infrastructure (Firdyiwek, 1999; Fraser, 2001; Harvey & Lee, 2001). The emergence of theory-grounded and

research-validated prescriptive taxonomies for e-learning instructional design will offer an invaluable contribution to the successful achievement of this new, comprehensive paradigm in learning. Anderson (2004) has cautiously observed, however, that:

There is no single, right medium of online learning, nor a formulaic specification that dictates the kind of interaction most conducive to learning in all domains with all learners. Rather, teachers must learn to develop their skills so that they can respond to student and curriculum needs by developing a set of online learning activities that are adaptable to diverse student needs. (Anderson, 2004, p. 54)

While much of “the message” is subsumed by “the medium,” it is an equally valid proposition that much of the content is, in actuality, the method. This is particularly relevant to incidental learning, collateral learning, creative and practical performance skills, heuristic and procedural knowledge, and problem-solving transfer capabilities, long after the immediate content of the current lesson has been forgotten. To this end, pioneering innovation in the field of distance learning will require a design synthesis towards the deliverable goal of fully integrated courseware built within a research and theory-grounded, learner-centered, problem-oriented focal architecture based on the active acquisition of real, transferable skills and metastrategies, and authentically assessed performance competencies. To the degree that the development and implementation of sound prescriptive taxonomies for learning can contribute toward this goal, the distance-learning enterprise shall lead the educational reform of the 21st century.

Perhaps the most intriguing paradox of the continuous search for a “unified field theory” of instruction is the fallacious premise that it can actually be achieved. Despite emerging efforts to create ubiquitous standards of learning achievement across the curriculum, we are no closer to

achieving this lofty albeit suspect goal. In a new and fascinating exploration of the foundations and fundamentals of design competence, Nelson and Stolterman (2003) caution that perhaps the most common mistake in systems design “is to assume that there are universally ideal systems. That one size fits all, so to speak. In reality, this is never the case (p. 112).”

It might be just as self-delusional to seek an absolute standard that conclusively and perfectly integrates all of the descriptive phenomena and prescriptive practice within a holistic design solution paradigm for instruction. It has been a nearly intractable challenge to establish unequivocal technical standards across ANY industry, as current competing specifications for DVD, HDTV, widescreen format aspect ratios, Web-streaming formats, SCORM compliance and transportability, interoperability, reusability, and granularity controversies associated with learning object models continue to rage on. While over time many competing technology systems find some reasonable accommodation to coexist on some level within the same universe (e.g., AC and DC, AM and FM, Apple and Microsoft), idiosyncratic conceptual paradigms like learning theories, educational philosophies, and instructional design models have ultimately “agreed to disagree” in addressing the same, similar, or related issues and problems from different perspectives. And this is not only intelligent and mature but probably wise, for as the redoubtable learning psychologist and teacher Jerome Bruner posited in his collection of seminal essays *In Search of Mind* (1983):

I think the best that we can do is get on with it, but with a Wittgensteinian skepticism. Learning about each use or facet...will itself be revealing. We will delude ourselves if we think it will come out singular and comprehensive. And we make the pursuit less revealing and doubtless less enjoyable if we insist that any one approach...in the one to which all others should be reduced. (p. 176)

The compelling task of creating comprehensive explanatory models of complex phenomena that are parsimonious and robust without being overly reductionist, and concise and cogent without being over-simplifications, continues to be formidable. This emerging future will need to integrate the many complex factors involved in the human—information—learning triad, including the learner's dynamic cognitive and affective states, the nature of the knowledge domain being taught, and the implicit assumptions of the learning environment. A reexamination of the fundamental issues in designing epitomes of prescriptive taxonomies for instruction might positively contribute to this collaborative endeavor.

As described in this article and throughout this encyclopedia, numerous scholars have labored in the creation and development of comprehensive, subsuming descriptive and prescriptive principles and practices for improving instruction and learning environments. It is also evident that today's students are now fully independent clients, customers, and peripatetic shoppers for their learning. There is an increasingly imperative need for systematically designing active learner experiences requiring cross-disciplinary higher-order thinking skills (analysis, synthesis, evaluation), procedural knowledge, reflective inquiry, model-building, theory-linking, decision-making, creative expression, complex (i.e., ill-defined and with no single universal solution) problem-forming and collaborative problem-solving, and improved communications skills. As the dynamic and burgeoning fields of online learning and distance education continue to play increasingly vital if not central roles in the evolution of education generally and globally, future research and development of hybrid descriptive-prescriptive instructional design taxonomies will augment our ability to transform the pragmatic nature and quality of distance education in the new millennium.

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KEY TERMS AND DEFINITIONS

Descriptive Taxonomy: In educational theory and practice, an organizational scheme for classifying the structure of conditions for learning describing the approaches, types, events, methods, and goals of instruction. While affective and psychomotor capabilities are also of importance, classic instructional design theory has focused on the cognitive domain and has been exemplified by the widely adopted hierarchical taxonomies of Bloom (1956) and Gagne, Briggs, and Wager (1992).

Granularity: Granularity is a hierarchical concept associated with the relative degree of complexity of a component part to its aggregate, subsuming structure. Fine silt is more granular than sand, which is more granular than rock, and so forth. In taxonomic development, the smaller the relative size to the taxons (units) of classification, the higher the degree of granularity. In instructional design, the concept of granularity is multifaceted, and can refer to the size of learning units or scope (e.g., degree or certificate curricula, courses, lessons, modules, activities); learning element prioritization or sequencing (e.g., logical order of lessons, concept formation and skill acquisition to optimize scaffolding in new knowledge construction); content domains archi-

tecture (e.g., superordinate concepts, subordinate concepts, rules, principles); teaching strategy (e.g., individual vs. group learning, passive learner/expository vs. active learner/discovery, inductive vs. deductive, tutorial vs. simulation, abstract vs. problem-oriented, synchronous online chat vs. asynchronous threaded discussions, etc.); media design and utilization (e.g., relative size and complexity of single components or combined components, type of media element including text, graphics/visuals, audio, animation, degree of user control, etc.); and learner assessment (e.g., conventional declarative-convergent testing using multiple-choice, matching, and short-answer questions vs. holistic, constructivist-divergent portfolios with demonstration work-product artifacts from individual and group projects, internships, and service learning).

Hybrid Learning Taxonomy: A comprehensive organizational scheme in applied learning and instructional design theory and practice that integrates both descriptive and prescriptive taxonomic domains. While a number of conceptually useful hybrid learning taxonomies have been proposed, there is, to date, no single, inclusive, unifying hybrid taxonomy that effectively synthesizes all of the design elements of instruction to sufficient practical levels of granularity and application.

Instructional Design: An applied, cross-disciplinary professional (postgraduate) design discipline that integrates human learning theory and instructional practice to develop, produce, implement, and evaluate effective educational experiences and learning environments to improve human performance outcomes, knowledge construction, and the acquisition of robust transfer competencies.

Prescriptive Taxonomy: In educational theory and practice, an organizational scheme for specifying the optimal and appropriate approaches, types, events, methods, media, strategies, techniques, activities, tasks, projects, scope and sequence of instruction to achieve corresponding specific learning objectives and desired performance out-

comes. While numerous scholars and practitioners across a wide range of associated instructional design fields have created a rich variety of effective and efficient prescriptions for obtaining specific learning outcomes in specific situations, to date no single theory-grounded and research-verified unifying taxonomic scheme has successfully emerged to address all existing and potential educational problems across the phenomena of human learning.

Taxonomy: From the Greek *taxis* (for arrangement, order) and *nomos* (law): Every serious taxonomy is an organizational scheme that includes a system representing structure, order, and relationship. Some form of hierarchical structure is generally defined, but this may be multidimensional and nonlinear in form. The purpose, domain, attributes and granularity of schema vary, but all taxonomies attempt to provide a robust (i.e., logical, coherent, cohesive, internally consistent) architecture. Prominent examples include the widely adopted schema of Carl Linnaeus (biology) and Dmitrii Mendeleev (The Periodic Table of Elements). Most taxonomies contain their own nomenclature for describing the taxons (singular) and taxa (plural) that correspond to formal units in the classification scheme, such as kingdom, phylum, class, order, family, genus, species (adapted from Linnaeus). Taxonomies may evolve over time. Neither systems of Linnaeus or Mendeleev are exactly in the original form when they were first presented, but they are fundamentally and substantially the same in all relevant aspects and overall structure, changing only as our knowledge of science changed over time to add additional granularity to the taxons and taxa of their brilliantly original and enduring descriptive taxonomies.

User-Centered Design: User-centered (a cognitive/perceptual term) and usage-centered (a behavioral/functional term) are postmodern design descriptors often arbitrarily or ambiguously defined and interchangeably used and misused. In the context of 21st century instructional product

design theory and practice, user-centered design focuses on constructing a user experience and environment with physical and virtual affordances that are manipulable, controllable, customizable, and adaptable from the essential perspective of the *conceptual model of the learner*. This means both (a) the learner's metamodel of their own learning processes and the learning activities and environment, and (b) the designer's model of the learner and the corresponding educational activity and experience, with the former driving and superseding the latter in the design solution. Thus, the conceptual model of the learner becomes the superordinate principle guiding the design process

and learning outcomes (i.e., the highest level of the prescriptive taxonomy). Usage-centered design focuses primarily on the functional goal-based behavior of learners and structuring activities, procedures, processes, and corresponding affordances to optimize the effectiveness of the learner to efficiently accomplish those intrinsic goals. In both of these approaches, however, the conventionally deterministic structure of the content and the underlying information architecture of the knowledge domain are secondary considerations, while the learner's conceptual model and intrinsic goal-driven behavior provide the guiding blueprint for the instructional design solution.

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Chapter 2.6

Drawing Circles in the Sand: Integrating Content into Serious Games

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ABSTRACT

One of the most important differentiators between Commercial Games and Serious Games is content; delivered in a way that is successfully integrated with engaging game play and achieves the desired learning outcomes by delivering skills and knowledge effectively to the end-user. This ability to integrate content effectively is the key to producing “killer” Serious Games that deliver demonstrable learning outcomes, business benefits and overall value. However, achieving this nirvana is not a trivial task. Utilising lessons learned and case studies, this chapter provides an overview of why this process can be so challenging, including the differing experiences from the perspective of

three stakeholders (game designer, instructional designer/learning psychologist and subject matter expert), how to manage preconceptions and balance their priorities. The case studies will also show how different methodologies, techniques and technology have been applied to help solve this fundamental challenge of delivering a successful serious game. Advice is provided on how to facilitate this process, capture the correct requirements and create a design that meets and exceeds the expectations of all the stakeholders involved, including the client/customer and the end user.

INTRODUCTION

Much interactive material and training has, in the past, consisted of ‘click to turn the page’

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applications, where the technology was merely used as a delivery tool for the content. Recently we are seeing more focus on other more interactive applications for the technology, moving from a delivery platform to products with actual educational significance. The technology can be used to engage learners and provide experiential opportunities which learners may not have had before. As Kurt Squire explains... “For educators designing games, this shifts the question from one of delivering content to one of designing experience” (Squire, 2006, p20). Serious games are considered to be the new interpretation of what e-learning can offer, but with the benefits of engaging story lines, player rewards and goals, and true interaction.

Serious games also offer instruction beyond traditional means of skill and drill, multiple choice questionnaires and text with fancy graphics; however, the skill sets required to develop them are often out of reach of many instructional designers and subject matter experts. Therefore a partnership is required, forged by the passion of creating something exciting: a learning program that people actually want to complete and come back to again and again in order to practice and improve.

Unfortunately it is not as easy as finding a games designer, subject matter expert and an instructional designer and locking them in a room together, expecting a game design within the week. Communicating with someone that speaks a different language can be very difficult and shouting or speaking slowly is not the answer! The serious games industry is no different. Game designers and instructional designers often speak very different languages and have very different requirements.

Now drawing circles in the sand is a slight exaggeration, but communication between each of the parties involved in serious games design is one of the major challenges faced by the industry going forward; however, it is one that can be solved. Using real examples in the form of case

studies, this chapter aims to translate practical experience into lessons learned for the industry when designing and developing serious games with diverse subject content.

So why is it so hard? There is also a misconception by many new to the industry that serious games will be successful because they use games technology (Gee, 2005). Simply by forcing content into games technology will not produce an effective learning environment. Commercial off the shelf (COTS) games may act as the motivational wrapper, but there is a lot more to achieving real, tangible learning outcomes than that.

Many claims have been made in the past two decades that link real life behaviours to the influence of video games, and often in a negative light. A popular culture reference to the impact video games can have, came from the movie ‘Snakes on a Plane’ which depicted a character able to pilot and land a plane safely due to his skills learned from Microsoft’s Flight Simulator game. This is the ideal, but rather unrealistic goal of serious games.

It could be asked, why a training course could not just be taken to create a simulation or a game that uses all the learning outcomes? The answer is that most learning is seen in black and white and is extremely linear. This is the course, this is the content, and this is what you will learn. Most training material is created focusing on the ‘What’ and not the ‘How’ and this is one of the contributing factors to high drop-out and low retention rates of traditional training and e-learning. In most cases, learning outcomes are only achieved through facilitation and one to one interaction with a skilled teacher or trainer; however, this is often an inefficient, costly and lengthy process, particularly for large numbers of learners. Serious games are more flexible in the way you can interact with them. You can choose whether to follow the story line or explore the environment, sometimes you are able to choose which missions you tackle and you can experiment with how you choose to play. The learner takes a far more ac-

tive role with a game than in other, more passive forms of learning. Quinn (2005) concludes this nicely: ‘We are not, cannot be, about designing content. A fundamental perspective I want you to take away is that we are designing experiences. If nothing else, start thinking not about creating content but about designing learner environments and architecting experiences.’

Serious games must also work in the domain of learning theory. ‘The use of instructional theories has been shown to enhance learning, increase motivation and student achievement’ (Gunter, Kenny, Vick, 2006). Gunter, Kenny and Vick aimed to create a unique design rubric specifically conceived for serious games by analysing instructional methodologies and comparing them against current game design ‘best practices’. They conclude instructional strategies must be applied concurrently to the content development in game design, and therefore students would quickly adapt to the process of learning and actually enjoy the conditions under which they learned the concepts. Piaget (1970), and Vygotsky (1978), both leading names in learning psychology, shared the commonality of an interest in the active role a learner must play in the learning process, and Vygotsky (1978) placed an emphasis on the interpersonal aspects of learning, including collaborative group work, where he demonstrated students achieved higher intellectual levels when working in a group, compared to working on their own.

Gagne (1977) highlighted nine “events of instruction” that contributed and facilitated an individual’s learning, each of which can easily be applied within a serious games environment.

They were:

- Gain attention; where the learner’s attention is initially grasped by an exciting story line or animation, for example.
- Set out clear learning outcomes; give the learner a set of instructions or goals that they are aiming to achieve.

- Stimulate recall of prior learning; where the individual has to use prior knowledge to aid them in the current situation.
- Present the content.
- Provide guidance to help the individual; this could take the form of step-by-step instructions, for example.
- Elicit performance; this is achieved through practice and completing tasks.
- Provide feedback; this allows the individual to understand areas that need improvement, and also gives them positive, motivating feedback on areas where the individual excel, or are improving.
- Assess performance; which typically occurs through a post-test evaluation, or debriefing session.
- Enhance retention and transfer; allowing the learner to generalise the information they have learnt and apply it to other situations.

Keller (1987) developed the ARCS model of motivational design as an alternative to Gagne’s events of instruction. Keller proposed four steps, instead of nine, that could be put in place to promote and maintain learning; attention, relevance, confidence and satisfaction. For Keller attention involved both perceptual and inquiry arousal, where inquiry arousal relates to providing questions and problems for the individual, as well as varying the content presented. Relevance referred to achieving goals and matching motives (where the learning style of the user and the users interests are matched as closely as possible), whereas confidence was associated with the learners’ perceived self-control and opportunities for success. Satisfaction looked more at the extrinsic rewards (external rewards) and intrinsic reinforcements (internal reinforcements) an individual could gain from the task. Attention, relevance and confidence all have a dependence on the content.

UNDERSTANDING CONTENT

To understand how to integrate content, one needs to understand what the content is. Gee (2004) refers to this as ‘a central paradox of all deep learning’. Gee analyses the two sides of the coin by arguing that it will not work to throw the learner into the deep-end due to a lack of knowledge to leverage the environment effectively and that the domain of knowledge needs to be built up over time and is a complex process that will be beyond a novice. This paradox is a concern to both instructors and advocates of immersion. The key as Gee explains is to use “post-progressive” pedagogies that combine immersion with well-designed instruction; and one area that is exceeding in this mix is the use of Video Games and Simulations.

Just in Time content delivery is easily exploitable within games. Shaffer, Squire, Halverson, & Gee (2005) have created an emerging model of games and propose that they excel by providing learners with situated experiences of activities, whereby they develop new ways of thinking, knowing, and being in ‘Worlds’.

It is understood that content is central to a serious game, but what exactly counts as content? Aldrich (2004) describes 3 categories of content: Linear, Cyclical and Open-ended content. Each category requires a different approach.

Linear content, that of movies, books or television is most familiar to us. It is a recipe that works for entertainment. Most training is also linear: lectures, PowerPoint presentations and most e-learning. Linear content allows most online courses to easily be stored in a Learning Management System (LMS). LMS’s are very often used in large organisations; however they vary immensely from one another. The LMS is the interface between the learning content and the learner, and is the place where the learner’s records of achievement are kept. Serious games have no standard methodology for LMS integration and therefore it is a choice to be made by both the developer and customer or client on how important

this issue is. What is certain however is that in order for more flexible, non-linear user-centred content to become the norm, LMS structures must be reconsidered to be relevant in the Web 2.0 world (Derryberry, 2007).

Cyclical content is the same action performed repeatedly, whilst the action or method is perfected. Aldrich defines cyclical content as the ‘DNA of video games’ (p26). For example, a user spends hours perfecting micro movements in order to shave a few seconds off the time left by taking a corner more smoothly.

Open-ended content refers to content where there is no right or wrong answer, and two experiences are rarely the same. Second Life or The Sims are good examples of open-ended content in games.

Each content category is valid in its own right, and can be used independently; however Aldrich argues that for any educational game all 3 should be combined, liberally. The authors would argue that there is a 4th category of content that is well used in games and simulations, which is non-linear, branching content that sits somewhere in the middle between traditional linear content and completely open-ended content. At the end of the day these categories sit on a continuum, rather than as discrete classifications.

Malone (1981) defines two alternative categories of content in games: Intrinsic and Extrinsic. The example mentioned above where the movie character was able to land a plane from playing a simulation in his spare time, is an example of intrinsic content, which is integral to the structure of the game. Achieving success in the game is equal to learning to fly the plane. Extrinsic content, Malone’s second classification, is less tightly linked to the game play, where there is a structure which has flexible content, such as quiz shows and question/answer-based role-playing and adventure games. Again, these categories are not an either/or but a continuum of possible options that compliment different content styles.

Training and e-learning generally use Linear Extrinsic content, whereas games can use a mixture of all the categories defined above. The challenge is combining each category effectively with the existing subject matter to produce an effective serious game. Early choices made in the development cycle will impact the effectiveness of the content and the effectiveness of the game as a learning tool. If the wrong game genre is chosen for the wrong content, it is likely that a poor learning tool will be produced.

SYNERGISTIC ALIGNMENT OF GAME AND CONTENT

We know what content is and we know that certain types of game suit particular content types. So what are the rules? Prensky (2001) argues that there is no one way for developing applications and that serious games must be created on a case by case basis. In his description of game-based learning, he calls out principles of instructional design, domain or subject knowledge and game design. However, as mentioned previously the likelihood of success from locking these skill sets in a room together, no matter how long for is minimal. This is a view that is expressed by many serious games experts. One thing is true, however, in that the content must be intertwined with the subject matter within the game and usually with some kind of emotive context. Separated game play from content is merely the carrot on the stick; the reward completely independent of any learning and is not what the authors would consider a serious game.

The balance of content with affective components within serious games is a delicate one and in order for the application to be effective, the right balance must be achieved. Appelman & Goldsworthy (1999) argue that to create the most effective learning environment, the designer must balance the content density against the level of understanding of the content by the user, and

continuously adapt this balance throughout the game experience. For example, as the learner's familiarity with the content increases, the presentation can become more abstract and the level of fun or 'affective experiences' required can be reduced. This inverse relationship highlights the reason why simply integrating content into games technology will not work: too much instruction will 'suck the fun' out of the game, but too much fun, particularly in an abstract or context-less game environment, can make the learning harder to contextualize without extensive reflection or a skilled facilitator.

METHODOLOGIES IN PRACTICE

In their study to create a new instructional design paradigm, Kürşat and Kaplan (2006) concluded that instructional design requires teamwork consisting of very diverse skills including, field knowledge, proficiency in technology, strategic, holistic and especially creative thinking abilities, project management skills, leadership qualifications, communication skills, responsibility, honesty, empathy, professionalism. High-level programming knowledge and advanced coding skills were also required, although these are highly specialised skills that are often sought from experienced computer scientists and game developers. They also concluded that the quality and qualifications of the team members affect the quality of the instructional system produced.

They emphasised flexibility and a holistic approach to instructional design, where a modular approach would be ideal. At the centre of their ideal instructional design methodology is prototyping and evaluation. They defined their own model for instructional design for game based learning entitled the FIDGE Model which stands for "Fuzzified Instructional Design Development of Game-like Environments" for learning. Within FIDGE there is a dominant focus around context, both in regards to the situation in which

the instruction takes place, and the socio-cultural needs of the organisation.

Most serious games companies, such as TPLD, have no, or very limited, credible direct subject knowledge in many domains. Although when moving into a new area we try to immerse ourselves in the subject matter and content, we do not try to learn everything or become experts in a condensed timeframe for a particular project or product development; rather, we look to engage with appropriate and credible subject matter experts, who become integral to the project.

Here are the key participants typically involved in a successful Serious Game design process at TPLD:

- **Game designers:** Responsible for recommending the most appropriate game genre and game rules/mechanics for achieving the desired learning outcomes, creating any storylines and defining any characters required, as well as designing levels and helping to define the artistic style (although this is often done in collaboration with an experienced artist).
- **Instructional designers/learning psychologists:** Responsible for validating whether the learning outcomes will be achieved by the proposed game design during all stages of development, typically including a number of evaluation studies with target end users (ideally throughout the entire development cycle, through the use of iterative development methodologies, such as Agile), often working in collaboration with the game designer on the pedagogical aspects of the design, as well as ensuring that good learning practices are being adhered to. TPLD utilise a number of serious games essentials to ensure sound pedagogical design. (Routledge and Seeney, 2003)
- **Subject matter experts:** Responsible for defining the desired learning outcomes and

the necessary subject content required to deliver these outcomes, often in the form of processes, decision trees, standard templates/exhibits as well as more traditional text-based content or character dialogue, depending on the game genre and content delivery mechanism

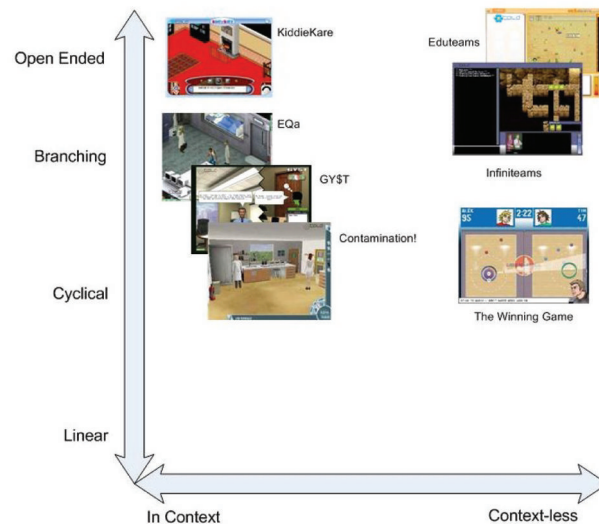
We also work hard to ensure that throughout the process the whole development team assigned to a project is involved to some level with the design, whether in conceptual brainstorming or reviewing a final idea. This ensures that as the application is developed, the team are aware of what they are creating and why, which helps give them a sense of ownership. It also makes it easier for them to know intrinsically what to build, as not everything can always be defined or effectively communicated up front.

In software terms we have moved to AGILE development over the last year and this too encourages involving the whole team with continual reviews and refactoring through iteration. Taking this one step further, with much of our more recent work we try to create opportunities for our developers to see the game actually being used by the target audience, as without this it is often difficult for them to step away from the ‘gamer’ perspective and move to that of, for example, a 45 year old executive or a 14 year old high school student.

CASE STUDIES

Using a number of case studies and examples, the authors now aim to share their first-hand knowledge and experience to better inform those working on serious games, either at present or in the future. These case studies range from games where the content and the game play are completely seamless, to more context-based simulations where the content and game are less tightly integrated. (Figure 1)

Figure 1. Case study classification



eQA

eQA, which stands for Electronic Quality Assurance, was created as a bespoke project for a molecular diagnostics company in the UK. The client came to TPLD with a fairly well-defined design and script, and we were given the task of embedding this content within an immersive 3D environment, primarily in the form of dialogue interaction between a player avatar and multiple non-player characters (NPCs).

After an initial review of the design, we encouraged the client to consider adding some further elements to the game to provide more engagement for the target users, who were primarily University students. These included a laboratory management aspect, where users must purchase and install lab equipment, after which required diagnostic tests can be performed and some kind of feedback is given to indicate whether the dialogue, tests and other decisions within the scenario are going down the correct or incorrect path. The proposed feedback mechanism consisted of a sick patient in an adjoining room, who was visible through a large window. The patient would gradually become worse or get better depending on the

player's choices. In reality this situation would never occur, and the patient would most likely be quarantined in an isolated hospital ward many miles away from the laboratory; however, this instant feedback mechanism provided some much-needed emotional engagement for the player, who (we hoped) would become genuinely concerned about the well-being of the patient.

The scenario consisted of 4 NPCs for the player to interact with, not always present at any point in time. The script we were given for these characters was initially very dry and technical and didn't enable the player to form any emotional or memorable attachment to the characters. Therefore, another proposed change was to give each character extreme personalities, occasionally going as far as major personality disorders. For example, a megalomaniac boss intent on taking over the world and a paranoid lab technician, who was convinced that everyone was out to get him! This led to some humorous dialogue exchanges that we felt enhanced the game significantly and provided the engagement that was previously lacking.

Unfortunately these dialogue changes were a step too far for the client and many of them were

removed late in the project; however, some of the character quirks remained and this did enhance the learning experience. Overall we think it would be fair to say that this game does not represent our most successful attempt to integrate content into the game play in a seamless way. However, because the game was primarily dialogue-based, with scripted NPC movement and basic interaction with objects, it was relatively simple to create a game editor to allow some of these aspects to be easily customised, and even author entirely new scenarios using the existing game's art assets.

GY\$T

GY\$T, which stands for Get Your Sales Together!, is another example of a primarily dialogue driven game targeted at sales training and development; particularly in a Business-to-Business context. This game was a joint product development with an American-based creative learning company and a leading subject matter expert (SME) in the field of sales training.

Although the subject matter expert had authored a best-selling book and the creative learning company had run many sales training workshops, there was actually very little content present at the start of the design process. Therefore, we held a series of workshops to step through a typical sales engagement process and to identify the desired learning outcomes from the game, as well as listing a number of common "traps" that sales people fall into, which often lead to an unsuccessful conclusion or lost opportunity. This led to a well-defined process consisting of a number of steps to close a sale, including "doing your homework", "getting in" and "closing the deal" as well as mapping out a decision making process within the target customer's organisational structure.

From a content perspective, this naturally led us to the conclusion that a branching scenario, which consisted of a combination of research and dialogue interaction with the target customer, was the best way to go. Early in the project we

decided that because of the importance of getting the language right (including the appropriate level of "Americanisation"), as well as being able to successfully embed many of the messages from the SME's book, the majority of the content would be authored by the SME directly, using specific tools and templates for the project.

Due to the globally dispersed nature of the team, this led to a clearly defined separation between the game play development and the content creation, with minimal levels of understanding about each other's respective disciplines, despite a number of face to face meetings to try to get things back on track when they started going awry. An experienced game developer was brought in by the content authors to help mitigate this issue, but due to differing ideas and priorities, this solution caused as many problems as it solved from a content perspective (although this individual made a significant contribution to the technical design of the game).

The game was created as a template or shell for the subject matter content and some excellent graphical authoring tools were created for the SME to define scenarios and dialogue with NPC's. A demo scenario with dialogue content designed specifically to show off all aspects of the game's functionality was also created, which included a number of powerful concepts that moved it well beyond the typical multi-guess dialogue systems found in most e-learning simulations and dialogue-based games. A number of guides and tutorials were also created for the SME to learn how to use the tools to create the content they desired.

Unfortunately, the content that was created during the lifetime of the project was generally poor and made very little use of the powerful features provided by the game framework. Although the dialogue was professional and reasonably engaging, many opportunities were missed due to the SME's lack of experience with basic game design principles, such as having an appropriate difficulty curve and introducing new features and complexity slowly over time. A good example was in the

up-front research phase that required the user to do background research on the target customer in the game. This was supposed to consist of some basic information to get the user started in the objective of understanding the customer's needs in order to create an initial communication that included a value proposition to get the company's attention. What actually happened was that over 40 documents needed to be reviewed by the player before they could extract this basic information and move forward in the scenario. Engaging and captivating the audience, within the first 5 minutes, this certainly was not! Unfortunately the end result became yet another not entirely successful attempt to seamlessly integrate gameplay and content.

Our experience with this project and others has led us to seriously question and doubt the approach of getting a subject matter expert with no knowledge of game design principles and best practice to directly author game content without any consultation and collaboration with a suitable intermediary, such as an experienced designer of serious games. However, over the last couple of years we have seen an increasing trend towards this model for content development, particularly with the advent of web 2.0 and its user-generated content model. From our perspective, the only place we believe this approach may work is with younger, game-savvy SMEs (or even school pupils and University students) who can effectively balance the game play and content. With tools requiring little of no technical expertise, we believe that powerful and engaging learning experiences can be created. Designing a serious game also requires a developer to become completely immersed in the relevant subject matter, even when an SME is involved, which in itself is a very effective learning process (many of TPLD's developers are now experts in molecular diagnostics for example!). This is the reason why this type of high-level authoring and customisation tool remains core to TPLD's company strategy in relation to content development.

After two examples where the content has not been particularly well integrated with the game play we will now go through another four examples where this integration is almost entirely seamless, with the content being delivered directly through the game play as opposed to via dialogue or direct simulation.

Contamination!

This project originated from the same molecular diagnostics company who commissioned the eQA project. Due to their previous experience working with us on the eQA project, they had been approached by a government organisation to create an immersive 3D simulation for teaching quality control processes in laboratories in conjunction with a tutorial book. Traditionally this has been a difficult area to teach, due to the high cost of getting access to laboratory equipment and the consumables required to perform and practice particular tests. Therefore, a 3D simulation that accurately modeled the process and outcomes of these tests was a logical solution.

The initial content consisted of a fairly detailed walkthrough of the desired scenario and a decision tree to show the different points in the process where things could go wrong. Like any simulation, one of the initial questions was whether the game would encourage or force the player to correct a mistake or wait until later in the scenario to see the actual impact of the mistake. We strongly encouraged the latter approach, along with some supporting information to show the player what they had done wrong in order to help them improve next time.

Our initial reaction to the content was that it provided a very useful starting point for the game design, but like the previous eQA project, it was fairly dull, dry and technical, which was not appropriate for the intended student audience. Therefore, we suggested adding an engaging back-story to provide some emotional context to

the player. Given the nature of the content and desired learning outcomes we suggested setting the game in a fictional town where there has been an outbreak of a disease and the player needs to identify the source of contamination by going through the actual process of testing the samples. This concept was met with approval and during a face to face meeting with the subject matter experts we were even able to suggest a further embellishment to the story by making the disease turn everyone in the fictional town into zombies and using this as a direct feedback mechanism in the game! Depending on whether the user is following the correct process (i.e. if mistakes are being made), the zombies will start to attack the lab and more people within the town will be killed. We also decided to give the player regular updates about the current situation via a series of news reports that break up the simulation-based gameplay. Finally, we were able to integrate a couple of engaging mini-games to provide an effective metaphor for some of the diagnostic tests (these would normally be automated and conducted by a machine). The primary reason that these changes were accepted without question was because the subject matter expert was actually a gamer and one of her favourite games happened to be House of the Dead! Another reason was because the SME had seen some of the engagement issues with the eQA project and did not want to fall into the same trap.

Overall, despite some quite dry and very technical content, due to the additional elements that were added to the story and game play this was a very effective example of how to integrate subject matter content with game play to create a powerful learning tool. We have taken many of the lessons learned from this project forward into more recent developments, such as:

- Try to ensure the SME is familiar with games and encourage them to play games and genres that may be relevant to the current project or product development.

- When working in partnership with an SME for more than one project, always be sure to take on board any lessons learned from previous projects to ensure a more successful outcome next time.
- It is often a good strategy to split the serious game design phase up into a high level design to articulate the overall concept, game play and walkthrough of the game to non-technical subject matter experts and other key project stakeholders.

Once this has been agreed and signed off then move into a detailed design phase.

Concept demonstrators will often be needed throughout the entire design process to help communicate concepts and ideas that will not be familiar to non-gamers.

Is important to define any assessment criteria or metrics within the design, as well as tying any game mechanics and content directly back to the desired learning outcomes, using game genres and an appropriate graphical style for the target audience.

KiddyKare

KiddyKare was created just before the eQA project and, unlike any of the previous examples; this was developed on a speculative basis rather than for a particular client. The concept was to provide an effective marketing tool for suppliers of child safety devices for the home, such as Mothercare. The gameplay consists of a typical house on two levels, with a baby walking and crawling around, being drawn towards areas of danger. The user has an RTS-style view on to the world and can scroll around without any constraints, trying to buy and deploy child safety devices before the baby can injure itself.

Examples include an iron that could fall, an electrical socket the baby could poke its fingers into, a fire that could burn the baby, a set of stairs the baby could fall down and a dog that could get

a bit over-zealous while playing with the baby. Given that the baby was not always in view, the user had a baby monitor that would sound an alarm when the baby was getting close to a hazard, which would prompt rapid deployment of the correct safety device before the baby got hurt. However, due to the humorous nature of some of the injury animations, players often preferred to see the effects of not deploying the safety devices around the home!

Although the game never became a commercial success, we felt it was a perfect example of how to successfully integrate content and gameplay, and took many of the concepts and lessons learned forward into subsequent products and projects.

Winning

The Winning Game was commissioned by the Scottish Institute of Sport Foundation and is based on a concept and theory devised by a leading Israeli-based subject matter expert in Winning and what it takes to become a Winner, called Yehuda Shinar of Winning Enterprises. The concept and an original computer-based simulator, which encapsulated the Winning theory, had been successfully piloted in a number of market sectors by Winning Enterprises, but TPLD was given the task of evaluating its effectiveness in Scottish Education (primarily at high school level). Our initial findings concluded that the concept was extremely valuable and provided significant benefits to school pupils for their general studies, sport and music. However, the user interface needed substantial development in order to create a deployable commercial product.

The Winning Game teaches the user to think correctly under pressure and utilises continual debriefing to improve in all aspects of the game and maximize personal potential. Unusually, the theory and content are very tightly integrated with the gameplay. The Winning principles are codified as a series of rules that are defined as “combinations” within the game engine. These

combinations are constantly monitored to assess whether certain actions are triggered while the game is in a particular state. If a combination is fired, the player is given direct and instant feedback on their actions by an intelligent coach, with results summarised at the end of each game in the form of a detailed assessment report, including graphs to show metrics and improvement over time. Combined with a personal learning plan framework and an opportunity to debrief continually, with the assistance of the coach and a comprehensive replay mode, the game includes all the tools required to become one of the most successful serious games so far.

At the time of writing, we are still finalising the development of the game, so we cannot state definitively that it is a successful integration of content and gameplay; however, all indications from pilot activities so far indicate that this is the case. Perth High School, Scotland, has worked with the game’s designers to help modify its design and assist in determining how the game can be applied within a high school environment. The initial part of the pilot has evaluated the game’s impact on developing a culture of self-improvement and success within the school, both on a personal and an academic performance level. Feedback from the pupil’s has been very positive, with comments such as “The in-game coach does help; it teaches you to be calm, take time and always give encouragement” and “This is the first game I have ever played that has actually taught me anything useful”. (Boyle and Seeney, 2008)

Eduteams/Infinteam

Infinteam, and its education-oriented cousin, Eduteams, are very good examples of how to effectively integrate content with gameplay. These award-winning products developed by TPLD as boxed products rather than commissioned projects, are targeted at developing team building, communication and leadership skills through a range of collaborative problem solving modules. The

modules provide a safe environment to practice working as part of a team to solve a variety of problems commonly faced in outward bounds-style physical training activities, such as getting across a river using limited resources and effective communication within the team.

These soft skills are becoming increasingly important in today's society, particularly as more organisations move towards having globally dispersed virtual teams. One could argue that the modules within *Infiniteams* and *Eduteams* are literally just collaborative multiplayer games with no visible learning value or subject matter content; however, this would be missing the point entirely. Simply watching a group of young high school pupils or a senior executive management team playing the games, it is easy to see that real learning is actually taking place. Anyone who has experienced the game would also agree that the way a group of individuals approaches the problems and challenges they face, provides a strong correlation with the thought processes involved and actions in the real world.

However, in order to bring this learning to the team's attention, it is often necessary to have a skilled human facilitator on hand to provide support and conduct debriefing exercises with the individuals as each of the modules are completed. Failed attempts, communication breakdowns and underlying problems with the team dynamics can be brought to the forefront of everyone's mind, with the consequences clear to see; along with the evidence of real improvement during subsequent attempts, once the team has talked about and resolved many of these issues, through reflection and debriefing, with the help of the facilitator.

In order for anyone to facilitate a session with *Eduteams* and *Infiniteams* effectively, they need to be given training on how to use the software, how it can fit in with a blended learning approach (particularly if they have existing team-based course material) and how to accurately monitor team and individual behaviour and performance

within the game to help stimulate discussion during the subsequent debrief.

This training and the player's learning is further enhanced through the use of social networking and web 2.0 technologies such as blogging, forums and wikis to share experiences and note down personal thoughts and opinions. The use of this technology helps establish communities of best practice by allowing others to learn from how the game has been applied in different ways. This type of surround and community-based support is becoming increasingly important for successful serious games, because it is unrealistic to assume they will operate in isolation in the vast majority of cases.

Both *Winning* and *Eduteams/Infiniteams* have heavily utilised user-centric design approaches throughout the design and development cycle. Early prototypes were tested with large numbers of target end users (these included both teachers/facilitators and pupils/adult learners). This process has continued through subsequent product updates, to ensure that functionality is only added or changed when repeated requests have come directly from end users. We believe that utilising a user-centric design methodology is essential for any successful serious game development. This approach also fits very well with the AGILE development methodology.

CONCLUSION

"What you want to do is create a game that's built on a set of consistently applied rules that players can then exploit however they want. Communicate those rules to the player in subtle ways. Feedback the results of player choices so they can make intelligent decisions moving forward based on earlier experience. Rather than crafting single-solution puzzles, create rules that describe how objects interact with one another and turn players loose – you want to simulate a world rather than emulate specific experiences".

Warren Spector, creator of Thief, as quoted from Aldrich (2004, p. 97).

The rules used within each game should also apply to the content used. The most important rule to communicate is to ensure the medium chosen is appropriate for the content that the developer and/or client wish to get across. Also, ensure that the content is linked to learning goals, which, in turn, are linked to experiences within the game. Remember to gradually build up with content density in the game, as too much too soon can be damaging to the learner and will continue the self-fulfilling prophecy of dull serious games.

The quality of the content is incredibly important. To writers, they say, write what you know. The same is true for game designers...and if you do not know it, find someone who does. Starting with existing content will make the whole process less painful and more efficient.

As can be seen from the discussion and examples mentioned above, content needs to move from text based presentation to be truly interwoven with the game play; the choices and actions the player makes within the game. Only when this is achieved, will true stealth learning be achieved.

Achieving a balance between learning theories such as those of Gagne (1977) and Keller (1987) and engaging experiences as created by games designers will aid developers to be on the right path to creating an effective serious game.

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Chapter 2.7

A Model for Knowledge and Innovation in Online Education

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ABSTRACT

The objective of this chapter is to introduce a model that outlines the evolution of knowledge and sustainable innovation of community through the use of social software and knowledge management in an online environment. Social software presents easy-to-use, participatory technologies, thus bringing increased interaction with others and a diversity of perspectives into the classroom. Knowledge management provides the opportunity to capture and store information so that content and learning can be personalized according to learner preferences. This model describes a circuit of knowledge that includes instructional systems design, individualization of learning, interaction

and critical reflection. It also represents a new framework within which communities develop and become more sustainable.

Introduction

In this chapter, we suggest that the field of online education adopts effective practices from knowledge management, and the best social software tools to create a knowledge community. As social software tools become more available for formal online learning environments, current conceptualizations of online communities must be modified. Where are these social technologies leading us and what are the impacts?

This model proposes a more dynamic online classroom where learners use cutting-edge social software tools to capture and disseminate collec-

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tive knowledge from the participants in the course, as well as the virtual and local community. This model facilitates the evolution of knowledge within the classroom, and encourages a sustainable knowledge community, wherein innovation

may be enhanced. Our vision of this dynamic partnership of knowledge management, online education, and social software is described in the following scenario (Table 1).

Table 1.

<i>Futures of Technology and Knowledge in an Online Classroom</i>
Fiona, Tim, and Vita are enrolled in Organizational Learning and Instructional Technologies (OLIT) 565, a graduate course designed to function as an interactive online course using multimedia content, information literacy tools, tests, assignments, and small group projects. The course requires intensive study of the content available in numerous formats for many devices, including desktop computers, iPods, and smart phones. The content can be read online or offline. Interactions with classmates, instructor, mentors, and experts are a critical component of the course and occur through discussion forums, chats, and Web conferencing in the learning management system (LMS), as well as wikis, blogs, and virtual content outside the LMS. Through a pre-assessment the students completed when registering for the course, the LMS captured their profiles, past performance, and interests. With this information, the LMS organizes several approaches to present course content according to learner preferences. An interactive concept map presents multiple ways of exploring and integrating the content with prior knowledge and outlines the suggested path for each learner. Clicking on the nodes in the concept map brings up the content, supplemental materials, assessments, and group discussions. The concept map also lists the times and places that experts who produced the examples will be available for discussion. The learners explore the content, applying their own structure to it. Additionally, the social networking software inside the LMS connects the three learners based on their shared interests. During the orientation, the instructor provides an introduction to the synchronous and asynchronous communication technologies, LMS and social software. The instructor, mentors, and learners negotiate ground rules, expectations, roles and responsibilities when using asynchronous and synchronous communication and social software technologies. The ground rules and expectations support active participation in achieving the development of a future sustainable community. The students come to realize that careful attention to one's online presence, reputation, and contributions to discussions is crucial, as they influence trust, cognitive presence and social interaction for learning purposes. On her way home from a movie, Fiona posts an audio message and a journal article she scanned using her mobile phone. She tags the document with metadata enabling future searching and sharing for reuse and repurposing. The wiki notifies Tim's iPhone and Vita's e-mail account. Tim responds to the message, agreeing with her ideas but providing minimal additional information. The LMS and Fiona both note Tim's brief response and prompt him to think more critically and elaborate on his message. Essential components of the online environment are evaluation and reflection. For this reason, users provide feedback on the user-created content, the contributions to the discussions, wikis, blogs, and podcasting, and the system. Learners are encouraged to rate each posting using rating systems similar to e-Bay or Slashdot. The ratings are used to continuously improve the posted content and to identify gaps in the material. With the abundant amount of choice in the ways information and knowledge are created and shared, Fiona looks for the tagging, certification of fact-checkers and group rating systems before making a content selection. Course designers specify multiple routes through a collection of learning objects. Just-in-time information is organized into small units and presented to learners precisely when they need it. The LMS identifies Fiona's preferences for learning, as well as recognizes that she needs to develop other ways of learning in case she encounters online courses without such individualized features. The LMS monitors and logs the student's individual learning processes and creates a collaborative memory to offer aid when needed. The instructor and group mentor review the logs before communicating with the individuals and group, and responding to the group's requests for guidance. The enrolled learners are not the only participants in the course. In previous courses in the OLIT program, instructors have encouraged emergent leadership from the group—meaning that learners with great interest in the content and technologies take a leadership role in the course. Some of these learners were so stimulated by the content and interaction that they have organized a community in which members meander in and out of courses, as they see fit. Additionally, the social software outside the course LMS is hosted, and the content created, reviewed, and shared by community members. Previous course enrollees and program graduates bring their work experiences to the community. The lessons they have learned through interacting in the world, reflecting on the experiences, and making sense of them through collaboration with others in the community become powerful stories that create part of the community's resources and memory. This community of learners and experts may choose to participate in the online OLIT courses; however, they may also decide to focus on spreading the collective knowledge co-constructed in the community to local schools and organizations. This knowledge community expands and contracts throughout its existence, but the common feature is that a passionate group of contributors collaborate to solve problems within the community and share their learning and expertise with others outside of the community. The interaction within and between the course and the community creates a space for reflection where learners, leaders and instructors constantly consider necessary changes that need to be made so that the course continues to evolve, as does the learning. Belonging to such an innovative community that provides valuable learning opportunities gives identity to the members and further motivates their participation. This evolutionary process facilitates the innovation and sustainability of the learning community.

Although the case scenario may seem like a list of items for online instructors to buy, the reality is that these tools are currently available for learners and instructors alike to manipulate to create meaningful and long-lasting online interaction. Granted, adaptation is a constant challenge, but it is our hope that through describing this model, more practitioners will realize the potential for incorporating social software tools and knowledge management in online learning. This model breaks the previous boundaries presented by virtual communities and suggests possibilities for increased collaboration and participation.

Definition and History of Key Terms

Knowledge Management

Knowledge Management (KM) was a concept initially established by Peter Drucker in the 1970s. However, it was not until the 1990s with Nonaka and Takeuchi's introduction of a knowledge organization, that it became a more integrated concept in business practices. At that point, publications and university courses expanded peoples' understanding of the benefits of KM (Wiig, 1997). Within the past few years, a larger number of educational institutions have begun implementing KM systems to enhance the community knowledge and encourage innovation (Hirschbuhl, Zachariah, & Bishop, 2002; Kidwell, VanderLinde, & Johnson, 2000; Na Ubon & Kimble, 2002).

Traditional KM initiatives are often divided into three processes: (a) design, (b) development and (c) technology (Conway & Sligar, 2002). Not all KM plans follow a rigid process flow; some are flexible enough to incorporate, "how people learn, how they implement what they learn, and how they share their knowledge" (Bassi, 1997, p. 426). By connecting the KM system to the users, the advantages become more apparent. The terminal goal of a KM plan is to create a sustainable system that enhances the growth of the organization's knowledge (Salisbury, 2003)

with the ultimate purpose being to enhance organizational creativity and innovation.

Online Education

Distance education supports the learning process when learners and instructor are physically separated and hence rely upon technology to interact (Moore and Kearsley, 2005). Distance education has made great advances since its inception in the 1800s, with the most recent innovation being online education (OE), defined as distance education delivered through the Internet. Current trends in OE include the incorporation of social software, which is a central feature in this chapter.

One of the major benefits of OE is that instructors are forced to be as technologically savvy as the students that they are teaching. Another advantage is that learners have access to the professor and to a community of peers all hours of the day so that they can debate, problem-solve and discuss the concepts associated with their course. OE has been especially helpful in connecting remote students to each other to form an online learning community. Most important to the progress of education, the online platform encourages learner-centered activities, where the instructor guides learners to co-create knowledge, and share that knowledge with other members of the learning community.

Social Software

Social software (SS) is not a single type of software, but instead a combination of two or more modes of computer-mediated communication, resulting in the formation of a community. A social network built from SS allows members to create and participate in a self-made community. With the rise of Web 2.0, SS applications seem to be introduced at such a rate that not even the most technologically savvy can keep up. Yet these communication and interaction tools influence how virtual communities form, and how they sustain themselves even after the online course has ended.

The affordances of SS include ubiquity, searchable content and referral to people with common interests. These benefits then support multi-scale social spaces and conversation discovery.

Some of the latest applications include 30 Boxes, a social calendar; Lazybase, a site where individuals are given the tools to create and share a database; Zoho Show, a tool that helps create and publish presentations; and voo2do, a task management tool (Brown, 2007). In fact, this paper was developed using *PBwiki*, a secure, open-source wiki that allowed us to co-create this chapter at a time and place that was convenient for each of us. When one person edited the chapter, the other person received an email update, so she could see the progress being made. When we needed to communicate synchronously, we used *Yahoo! messenger*.

Although SS tools have not been typically applied to educational settings, we side with Dalsgaard (2006) in that we believe SS tools can and should be used to support learning. These tools encourage the creation and contribution of user-created content and facilitation of learning instead of management of learning—a paradigm shift that calls for a new model for OE.

This model acts as a plea for the target audience including researchers, teaching practitioners, and educational technologists to embrace a paradigm shift that applies social systems in OE. SS can increase the diversity of perspectives in the content, virtual presence of a community and establish and enhance peer-to-peer social networks, as suggested by the case illustration. The incorporation of this emerging trend in this proposed model will facilitate the dynamic evolution of knowledge beyond the classroom and contribute to the innovative and sustainable community outside of the formal learning environment.

Existing Literature

The first collaboration of OE and KM was envisioned by Albert and Thomas (2000) who taught

at the Business School at Britain's Open University. They focused on the tools and technologies used to teach an online course on KM. Similarly, Townley, Geng and Zhang (2002) collaborated between New Mexico State and Beijing University to teach a class on KM. They explained that global education was becoming a rapidly growing field that addresses the need for the development of international relationships. Both collaborations were primarily interested in the course management tools used, not on learning or community development.

Fry (2001) explained how many organizations turn to OE as a strategy for transition and corporate development. The Ernst and Young Center for Business Knowledge, for example, has applied components of OE to assist in the organization's strategic development by using asynchronous discussion groups and online communities of practice, as well as personalization and profiling techniques. Different from the studies mentioned above, Fry (2001) uses OE to enhance current KM practices.

Universities are working to close the gap between the change in technology and the learning needs in an online environment. Hirschbuhl, Zacariah and Bishop (2002) suggest that this gap can be minimized by using KM tools to deliver OE. By fitting the instruction to the individual learning needs of the student, KM can provide increased success for all learners, regardless of their ability or familiarity with technology. Hirschbuhl, Zacariah and Bishop (2002) encourage students and instructors to shift their mental model of teaching methodologies and collaborative strategies in order to develop successful online courses that can be customized to meet individual learner needs. KM is the suggested remedy to smooth and prepare all participants in the paradigm shift from traditional face-to-face classrooms to OE. Almost opposite from the study above, in this case, KM tools are supporting OE.

Saxena (2007) proposes that the integration of KM tools within OE will provide online dis-

tance education administrators and instructors with data that could result in improved decision making, reduced course development time, improved academic and administrative services, and reduced costs. He believes the integration of the two will reveal patterns and relationships that provide the knowledge necessary for improving OE. Lytras, Naeve and Pouloudi (2005) also believe in the promise of KM in contributing to the evolution of online learning, and believe that, "The convergence of e-learning and knowledge management will be evident in worldwide initiatives that will foster a constructive, open, dynamic, interconnected, distributed, adaptive, user-friendly, socially concerned, and accessible wealth of knowledge" (p. 68). Only one article was located that connected the fields of OE, KM and SS. Pettenati, Cigognini, Mangione, and Guerin (2007) built a model in which SS was used to track personal knowledge in an online learning environment. However, they do not consider the potential for knowledge development and innovation in a dynamic community environment.

Gaps in the Literature

KM and OE share several common elements, including community, collaboration, trust, knowledge sharing and SS tools (Na Ubon & Kimble, 2002; Saxena, 2007). Despite the availability of tools and technologies and increase in familiarity with these tools, universities seem reluctant to integrate OE and KM. This is demonstrated by the minimal capturing and sharing of knowledge assets in the university environment. An additional gap in the KM literature is the lack of information related to the affective domain which is frequently described as underlying cognition. Emotions and attitudes are critically important in order to interpret experiences positively and to learn effectively, as well as support and trust others.

Although there is literature on the combination of KM and OE, there is not a true collaboration

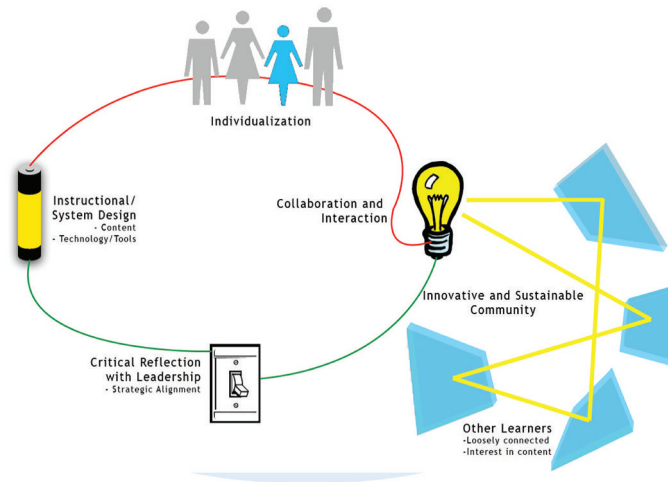
where they are working together towards an improved system as envisioned in the case scenario. Since SS tools are such a recent introduction to the field, there is even less literature on their role in this relationship. Saxena (2007) recommended that KM be used to gather data on students so that universities can then use that data to better understand distance learners and their learning environments. He concludes his article by encouraging researchers to more deeply explore the opportunities for KM in an online setting. This chapter provides a model and an outline for a system where KM, OE and SS combine to create a more dynamic formal online learning environment, as described in the case illustration.

Description of Model

The model shown below represents a cyclical process with five major components: (a) critical reflection with leadership, (b) instructional design, (c) individualization, (d) collaboration and interaction among course participants, and (e) an innovative and sustainable community. This community development of graduates and interested others is ongoing, and feeds experiences and resources back into the model.

The interplay among the components that contribute to the evolution of knowledge occurs throughout the online course. There is not a particular order in which it happens—the boundaries are blurred. For example, instructional design may be the first step for the instructor, followed by implementation in which individualization of the learning experience is considered. Critical reflection may be a structured process at the end. And it may not be until the course ends that learners diverge from the cycle and engage in the community development process. On the other hand, the community development may be a carry-over from a former online course or provide authentic learning opportunities during the course, thus allowing the interaction to be a central component of

Figure 1. Evolution of knowledge and community development model



the online course, with learners who already know each other well. We will describe each component of the model in the section below.

Instructional Design

We will explain the innovative relationship among KM, OE, and SS beginning with instructional design. Instructional design provides the template for determining learner needs, collecting appropriate content and designing interaction to enhance the growth and development of future professionals. A significant amount of the work of instructional designers and instructors is not accomplished through declarative and procedural knowledge alone. Working with instructors and students involves affective aspects, such as responding to emotional or evaluative responses. We remind designers that affective and social content must be a part of the implementation process.

Content

The goal of a majority of KM systems is to capture the most essential knowledge assets for the users (Conway & Sligar, 2002). This may include course projects, archived dialogue or recorded

voice conversations. Content will not magically appear in the learning environment—learners and instructors must collaborate to select, contribute, and rate the knowledge that is pertinent to the learning environment. Often times in KM systems, a Subject Matter Expert (SME) is selected to maintain cohesion in the community and distinguish the most essential content to be shared with the group. In the corporate setting, the SME is typically the most knowledgeable member of the community, yet in an online course, it might be more effective to have a rotating SME so that a variety of perspectives can be a part of the knowledge capturing process. An outside member of the community, such as an expert in the field or a former class member, may also act as the SME, providing relevant content that is applicable to the course objectives. All members of the learning community must work with the SME to continually reflect upon and refine the content that is captured and stored. New information should be frequently reviewed and assessed, and older information should be regularly revisited to determine if it is still valuable to the learning community.

In order for these captured knowledge assets to be accessed frequently, the content must be prepared in standardized formats that can be

later customized in ways that are meaningful for individual users and support carrying the content forward. As LMS programs become more sophisticated, they allow online courses to offer more individualized content that is adaptable to needs of each learner, as indicated through describing the process of tagging in the case illustration above. Until that becomes common practice, passionate content creators and fanatical reviewers are needed to maintain a dynamic system so that learners look forward to accessing and applying content to different contexts (Conrad & LaPointe, 2007).

Technology and Tools

It does limited good to have extensive knowledge sharing without the technological means to enhance the information. Fortunately, advancements in technology afford users from around the world the ability to participate in the knowledge sharing process in real-time (Kilby, 2001; Lan, Xian, & Fu, 2000; Na Ubon & Kimble, 2002). All technology and tools chosen to support the learning process must facilitate the multiple phases of learning, including exploration, reflection, collaboration, testing out new ideas, knowledge construction and feedback. These technologies do not necessarily need to be complex. Instead, the critical characteristic is that the technologies allow easier communication in the online course to facilitate in the process of interaction.

RSS feeds notify learners whenever a new entry, podcast, email message or wiki posting has been added. Instead of checking in frequently with the constantly updated LMS, an RSS feed allows learners to create and distribute a list of Web links to quickly review at a time and location that is convenient for them. This provides organization for the online participants to know what they have already accessed in contrast to what they still need to review. Online participants depend on ease of use to get started and build confidence in using the tools. Thereafter, accessible support is essen-

tial. The technology helps learners organize and find their way through the LMS, as well as make sense of the content presented in many formats and through multiple perspectives.

The type of technology used should depend on the participants. If learners do not understand the functionality of the interface where content is displayed, then the significance of the content may be lost. Content should also be available in the platform preferred by learners, such as computer, cell phone, mp3 player, instant messenger, wiki posting, etc. Na Ubon and Kimble (2002) encourage the use of advanced technologies because they have the potential to increase the sense of trust, identity and commitment of the community. Pre-established standards help guarantee a useful and progressive product. Despite the recommendation to use cutting-edge software and tools, we suggest that the instructor establish a balance between user-friendly and innovative technologies.

Individualization

Although content, technology and tools are essential components of the instructional design process, as illustrated in the model, they are not the only factors to consider. Throughout the design and development process, instructors and course designers must think of the learners for whom they are developing the course because KM and OE are more complex than technology and multimedia tools (Liebowitz, 2001; Na Ubon & Kimble, 2002). The focus cannot simply be on the use of technology, but also on the human issues behind the success or failure of the technology (Davenport, 2005).

All participants enter a course with different levels of familiarity and confidence in terms of technology and content. Whereas some learners are willing to immediately engage in online communication and capturing knowledge, others are more hesitant to participate in this type of online interaction. Other still may apply signaling to pres-

ent themselves as different people to the online class. It does not come as a surprise that a small percentage of individuals usually create a majority of online content (Kamel Boulos & Wheeler 2007). Instructional designers and instructors must determine how to develop an individualized system that encourages equal participation from all learners. Fisher and Baird (2005) encourage the use of peer mentoring to build students' levels of confidence in using online tools. Similarly, Gunawardena, Linder-VanBerschot, LaPointe, Barrett, Mummert, Cardiff, et al. (2007) reported that e-mentoring facilitated in cross-cultural learning transformation. Community members may volunteer to be mentors for students, establishing their confidence in the learning platform at a pace that is appropriate for each individual. Once students become more familiar with tools and determine how to best apply them for their personal needs, a stronger sense of community begins to emerge. Due to these benefits, instructors are increasingly utilizing community programs like Living Treasures to bring community members and community culture into the classroom to localize course content.

Additionally, there must be space for users to provide feedback on the system (Wiig, 1997) so that the effectiveness can continuously be improved. When communication between knowledge creators and SMEs is limited, the knowledge often becomes outdated and users stop accessing the system after losing interest (Ravitz & Hoadley, 2005). LMSs such as WebCT Vista have a rating option on discussion messages, so learners can rate messages that they find useful, as described in the scenario. When a particular message has a high rating, learners are more likely to visit it because they want to be accessing the most pertinent information in the course, as described in the case illustration. This rating system allows all users to become SMEs in capturing data that is most important to the collective whole.

Interaction

Interaction is a central component to OE. Moore (1989) outlines three types of interaction: learner-content, learner-instructor and learner-learner. A fourth type of interaction is especially important in OE—learner-interface (Hillman, Willis & Gunawardena, 1994). Similarly, interaction is a foundational component of KM and is facilitated by SS tools. It has even been found that groups of individuals who regularly share knowledge tend to perform better than those who do not (Davenport, 2005). Through interaction, individuals learn to analyze, question, interpret, and make sense of phenomena. Members of the community facilitate their thinking and innovation through the questions, problems, issues, solutions, resources, and tools that members bring to the community.

Collaboration is not always a natural process for learners in an online environment. In fact, Anand (2007) expresses concern that online services coupled with KM software may reduce the need for human interaction. Therefore, instructors must minimize transactional distance and establish a strong sense of social presence so that learners *want* to interact with each other. SS tools can be used to develop and enhance interaction and social presence in the course. Online learners often have different personal goals, and, thus, there is not one tool that will fit the interaction needs of all learners. An additional concern to consider in an international online course is Internet accessibility of all learners (Beldarrain, 2006). McLoughlin and Oliver (2000) provide several suggestions for online instructional designers, one of which is to include communication tools that encourage social interaction so that all learners have the opportunity to co-construct knowledge.

Conrad and LaPointe (2007) remind us that just because these tools are included, it is not guaranteed that they will necessarily facilitate enhanced interaction, or even be used. Their research revealed that collaboration depends on

the design, nature, purpose and structure of the SS tool. In their course wiki learners were willing to post content, but did not want to edit other classmates' content. Instead, the learners wanted additional opportunities to discuss the content on the wiki. This adds to our growing awareness that merely capturing and sharing information does not necessarily lead to deeper understanding. New information can only lead to shared knowledge when it is integrated with prior data and tested through dialogue with other learners. In the end, it is the learners who will decide whether or not they will accept and apply the tools to their thinking and learning processes through interaction within the course.

Critical Reflection

In order to make sense of an experience, learners must interpret it. This interpretation then guides learning actions. Mezirow (1990) suggests that this process of reflection "enables us to correct distortions in our beliefs and errors in problem solving" (p. 1). It is a necessary strategy for all online users, as it directs future professional practice and improved performance through the discovery of personal meaning. *Critical* reflection takes the learning process a step further to include "challenging our established and habitual patterns of expectation" (Mezirow, 1990, p. 12). This process provides a potential transformative learning or teaching experience.

Although reflection is embedded in every step of the process, we believe it is important enough to explicitly detail through the description of strategic alignment and leadership. Instructors and instructional designers must reflect on every step of process. For example, instructors must reassess the applicability of the content in the online class. As course objectives change, the content must also be adapted to support learners' needs. Additionally, the instructional designer must reflect on the applicability of the tools chosen to meet course objectives. Both the instructor and

instructional designer should review the sense of individualization of content that then encourages collaboration both within and outside of the online course. Finally, we recommend that the instructor and instructional designers ensure critical reflection holds a central position within the learning activities so that learners can also participate in the process.

Strategic Alignment

The goals and objectives of the online course must drive the selection of SS and KM tools. What works for a problems-based biology course cannot be plugged into a lecture-based math course and expect comparable results. Similarly, cultural differences hinder the effectiveness of the drag and drop method. For example, an instructional technology course taught at a university in southwestern United States must be culturally adapted before implementing it at a Chinese university. This has become more apparent as open content and open educational resources are shared between academic institutions, as described in Caswell, Henson, Jensen and Wiley's (2008) recent article on universal education.

All SS tools and KM processes must be connected to the institutional culture and overall course goals so that users feel like it is a valuable use of their time. In fact, Liebowitz (2001) mentioned that one of the three reasons for a failed KM strategy is that it was not connected to the central goals of the institution. If that is the case, users will not see the functionality of the initiative and will most likely not engage. The model proposed in this chapter provides a broad structure within which instructors can adapt to fit their course objectives.

Alignment of the proposed initiative with the organizational strategic plan should be closely related to leadership characteristics, internal organizational structure and external characteristics of the institution (Rogers, 1995). The degree of centralization of power and control in an organiza-

tion, the formalization of rules and policies, and the degree to which new ideas can flow among organizational units all impact organizational innovativeness and its implementation. Additionally, strategic alignment supports the future sustainability of the initiative.

Leadership

As mentioned above, leadership has the ability to minimize or maximize the impact of this innovative model. Leadership's purposes, expectations, and goals for the model will vary, depending upon the lens through which it views the system. In a formal educational setting, most people define the leader as the instructor or instructional designer who may perceive the model as a way to encourage learners to become involved in a community to create, share, and use content to solve problems and instigate change. Yet, if the leader is unwilling to recognize, encourage and share the collective knowledge, s/he is putting the entire online course community at risk of losing vital information.

Openness to a variety of perspectives enables new understandings and encourages innovation. Sustainable improvement depends on successful and sustainable leadership (Hargreaves & Fink, 2006). This may mean that the leadership is equally distributed across the course—members of the online course take turns in holding the leadership role. This not only provides different perspectives, but also encourages emergent leadership within and beyond the course.

Community Development

When learners take responsibility for their learning goals and take on a leadership role in their online class, they develop confidence not only in their knowledge of the content and technology, but also in their ability to lead others. They further value the interdependence and the responsibility of all members of the community to teach and to learn.

Knowledge management uses the term Community of Practice (CoP) to describe a place where people unite for a common purpose so that they can work together to achieve a particular goal (Conway & Sligar, 2002; Wenger, McDermott & Snyder, 2002). A CoP may emerge from the community development process. However, we feel that a knowledge community does not have to be as structured as a CoP in order to be successful. Learners may come in and out of the community, as they feel necessary. Some learners may share their knowledge from the online course with the community, while others may distribute information from the community with the online course. The community development moves beyond the classroom to peer networks before, during and after the online course. It is this flexible interplay of expertise that creates an environment of knowledge sharing and innovation.

People choose to belong to social organizations where value is gained through the exchange of information and life experiences from highly credible sources. The value received reinforces the connections between course members and the community. The partnership of community with online course participants allows flexible groupings of students and practitioners to work on projects. Students have increased opportunities for authentic experiences and research that they can bring back to the online classroom.

Innovation

Organizations cite innovation as one of the primary benefits of implementing KM practices into organizational practices (Conway & Sligar, 2002; Davenport, 2005). It is an educational institution's responsibility to determine how to encourage innovation at all levels (Kidwell, VanderLinde & Johnson, 2000; Rogers, 1995). Brown (1998) suggests that "innovation is everywhere; the problem is how to learn from it" (p. 156). Through having the capability to search and navigate a diverse,

extensive knowledge base, learners may build new connections, and in turn, enhance the likelihood of developing further innovative products (Merlyn & Välikangas, 1998). Innovation contributes to a greater institutional knowledge base, providing information of value that the community members want to continually access and contribute to; thereby, creating a sense of community rather than a collection of content.

Even the best innovations will get lost in the shuffle if leadership does not know how to communicate them with other members of the community (Brown, 1998; Rogers, 1995). Leaders cannot pass a memo and expect the innovation to be diffused in to everyday practice. Brown (1998) suggests that users need to have the opportunity to experience it in a way that “evokes power and possibility” (p. 168). Sustainability of the innovation is more likely to occur if learners participate and give input throughout the generation and diffusion process (Rogers, 1995).

Sustainability

Organizations that use KM and SS to enhance OE must plan for a dynamic system. Barron (2000) mentions that online content can be considered outdated in less than eight months. Additionally, learner experiences are consistently transforming and are always open to reinterpretation. For these reasons, the dynamism of economic and social change requires a flexible system that is created to adapt to future changes. Thus, the role of KM is to keep the knowledge base “alive and vibrant” (Wiig, 1997, p. 2) with knowledge gained through everyday practice in the community as well as with current research in order to secure the online course’s buy-in and later sustainability of the learning community.

The learning and performance supported by this model are based on the recognition and philosophy that learning is a way of being. It is an ongoing set of attitudes and actions by a community of learners who try to keep abreast the myriad of events that are

occurring in their field. The leader must embrace the vibrant nature of the online community and work to sustain it. All participants can participate and contribute to knowledge building. Trust and confidence must also be nurtured to support the sustainability. Again, it is recommended to apply shared leadership so that the leader does not burn out and cause the captured knowledge to be outdated and minimally applied.

Future Trends

With the rapid expansion of the fields of OE, KM and especially SS, leaders in the field must step back and review broad trends in the field, as well as reflect what those trends mean for the field. Social software presents easy-to-use, participatory technologies, thus bringing increased interaction with others and a diversity of perspectives into the classroom. Knowledge management provides the opportunity to capture and store information so that content and learning can be personalized according to learner preferences. Online education offers instructional design and facilitation of presence and learning. The relationship of KM, OE, and SS supports participation that encourages innovation. This will bring opportunities and challenges.

Security of content and provision of a safe learning experience while inviting the community into the online course will require a solution. Copyright and digital rights management will impact the viability of the model and our case illustration. Websites such as Creative Commons has found a way to provide a space for users to share content with one another with the goal of creating something greater than what one person could develop working independently. Content and interaction, as described in the current model, will blend with virtual world technology. Extensive future evaluative and research opportunities exist to determine the pragmatic value of the model and to build a body of knowledge related to the convergence of technologies and communities to support

continued innovation of the organization through the dynamic development of faculty, students, and interested others. Additionally, international interpretations of this model are welcomed.

Conclusion

This model describes the evolution of knowledge and sustainable innovation of community through the use of SS and KM in an online environment. Two major limitations to this model exist. First, it was developed using western pedagogy. However, an international literature base was used to build the model. The second major limitation is the lack of a discussion of the model's security concerns—given the extensiveness of this topic, it could not be covered in this chapter.

The model describes a new method of learning—one in which the tools from KM and SS facilitate the learning cycle of an online course. Feeding into this model is innovation that comes from our relationships with the community outside the classroom. We are long past the time of believing that instructors are the only people who can create and maintain the course. Emergent leadership is needed to sustain the evolution of knowledge, thus leading to increased innovation. As online education, knowledge management and social software become better known, research must be done to combine these fields in order to effectively integrate more formal and informal learning communities.

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KEY TERMS AND DEFINITIONS

Community: A purposeful group of people centered around a knowledge concept who collaborate through the use of knowledge management and social software tools to support a sustainable and innovative online course and to share learning experiences with person(s) outside of the group.

Individualization: A process in which differentiated instruction based on learners' needs and interests allows the learner to personalize the knowledge in a meaningful way.

Instructional Design: The systematic application of instructional content, technology and tools used to design an individualized, interactive and reflective online learning environment.

Interaction: An exchange of knowledge and ideas between learners, instructor, content and learning interface(s) that encourages sustainable community development and innovation.

Knowledge Management: The process of capturing, storing and distributing information across learning environments to improve the application of knowledge to a variety of social contexts, thus increasing its availability to others to increase innovation in the evolution of community development and learning.

Online Education: A dynamic learning format taught by means of the Internet in which learners

and instructor interact through the use of several of technologies for the purpose of intentional learning.

Reflection: A process in which online participants (learners and instructors) and community members (former learners and experts in the field) observe and interpret the learning experience so that they can consistently adapt and improve the high quality instructional systems design.

Social Software: A combination of two or more online tools encouraging learning, interaction and community development between two or more people.

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Chapter 2.8

A Large-Scale Model for Working with Subject Matter Experts

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INTRODUCTION

The evolution of complex and distributed commerce requires the implementation of training design and development models that capture and mold the expertise of subject matter experts (SMEs). A SME is defined as “that individual who exhibits the highest level of expertise in performing a specialized job, task, or skill within the organization”. SMEs possess in-depth knowledge of the subject you are attempting to document (http://www.isixsigma.com/dictionary/Subject_Matter_Expert_-_SME-396.htm). This chapter describes a unique issue, and potential risk, along with a solution to work with a large number of geographically dispersed SMEs (separated from one another due to their respective locations), whose efforts are standardized and synchronized.

This solution is based on a collaboration model implemented and led by an integration team whose role and responsibility is to allow the SMEs to achieve consensus, efficiency, and standard of quality in both products and processes.

The model is exemplified using a current large-scale military eight-year initiative to design training support packages to prepare soldiers to use advanced technologies and employment concepts in a blended delivery format of live, virtual, and constructive. The Live-Virtual-Constructive environment combines any of these three approaches to create a common battlefield, on which live units can be represented along with virtual and constructive. These units can interact with one another and conduct a coordinated fight as though they were physically together on the same ground (United States Army Combined Arms Center, <http://usacac.army.mil/CAC/functions/constructive.asp>). This initiative will be used throughout

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the chapter as our illustrative example as we describe the rising challenges and opportunities.

Therefore, this chapter will provide a detailed examination of the existing education and training development fundamentals that provided the framework to meet the requirements of this training design and development challenge. The first step in the process was to identify potential problems, issues, and/or potential risks of this training initiative. Two obvious issues were identified: 1) working with three different companies, each with their own internal structure and philosophy on training and development thus, resulting in a need for standardization; and 2) having a large number of individuals geographically dispersed, responsible for contributing to or creating the initiative's policies, processes, and products resulting in a need to find a means to work collaboratively from a distance.

Adding to the complexity of the initiative was acknowledging the nature of the training design and development team; the fact that it consists of forty (40) SMEs, analysts in the initiative, representing three leading defense contractor companies, known as the One Team Partners (OTP). To resolve the issue of standardization, a three-member integration team (IT) was assigned to facilitate the design and implementation of policies, procedures, and processes to accomplish the expected project goals and objectives of their primary customers by synchronizing, integrating and standardizing the SMEs' work.

The end-product (instructional/training product) was designed to support the instructional and training efforts for soldiers deployed, awaiting deployment, or conducting combat operations. The authors of this chapter are two members of the three-member IT, serving as the lead instructional designer and lead content SME. During the first three years of an eight-year initiative, this joint effort, using the collaboration model, has completed or is nearly completed with the initial planning and analysis phases (i.e., mission,

job, and task analyses) in preparation for the next phase, the design and development of training support packages.

Typically when managing an educational or training initiative, instructional designers (IDers) depend on the SME for their expertise in curriculum content. The IDers' involvement is critical during the analysis and design phases of a systematic instructional design approach.

However, in our illustrative example, the content SMEs were the lead component and instrumental in actively participating in the planning phase (the design and development of the policies, procedures, and processes) and were primarily responsible for writing the analyses results/findings. The content of the results were then reviewed by OTP IDers for writing convention format (e.g., use of acronyms, punctuation, spacing and numbering) and instructional design format (e.g., sequencing of steps, alignment of performance steps and sub-steps with performance measures). To meet this ID review requirement, each OTP has a SME IDer whose responsibility was to guide analysts (OTP SMEs) and to comply with the standards and guidelines related to instructional format and writing conventions. In addition, there were vertical and horizontal reviews conducted by other content SMEs (e.g., internal and external to the OTP) for accuracy and completeness in terms of breadth and depth of content, in context.

The intent of the IT in designing this methodology was to actively involve the SMEs from the onset, not only to capture their expertise, but also to gain and sustain their buy-in and commitment throughout the different phases of the initiative, and to do so primarily from a distance. Therefore, to resolve the second issue of the OTPs collaborating from a distance, the lead IT developed a process using technology (e.g., Web-based application and tools, relational database) to lessen the impact of being geographically dispersed.

BACKGROUND

The goal of this large-scale collaboration model is to integrate the contributions submitted by multiple subcontractors (known in our illustrative example as the OTPs). To meet this goal, the prime contractor appointed a lead IT with the responsibility to the customer, prime contractor, and the OTPs to synchronize (move along at same rate) and standardize (end-product has the same structure and language) processes and products.

Systems designers envision the entity to be designed as a whole; as one that is designed from the synthesis of the interaction of its parts. Systems design requires both coordination and integration. We need to design all parts interactively, therefore simultaneously. This requires coordination. The requirement of designing for interdependency across all systems levels invites integration. In an age of continuous and intensified change, the understanding of the role of systems design in creating our future and the development of competence in systems design are of the highest priority (Banathy, 2000).

Since the overarching component of such an initiative was the integration of work produced by the multiple OTPs, the lead IT adopted a systemic approach to achieve process and product standardization. To understand instructional development, it is helpful to view from within the context in which it functions. An educational or training environment is, in effect, *a system of systems*. By definition, a system (the whole) is a structure that is dependent on the product of the interrelationships of the parts rather than the attributes of any individual part (Ackoff, 1995). Therefore, it is imperative to view an instructional development initiative within a systems approach context based on general systems theory.

General systems theory (Gharajedaghi, 1999; Rothwell & Kazanas, 1992) is based on the belief that for significant and long-term change or opportunity to become institutionalized, it is imperative to recognize and manage the organization as a

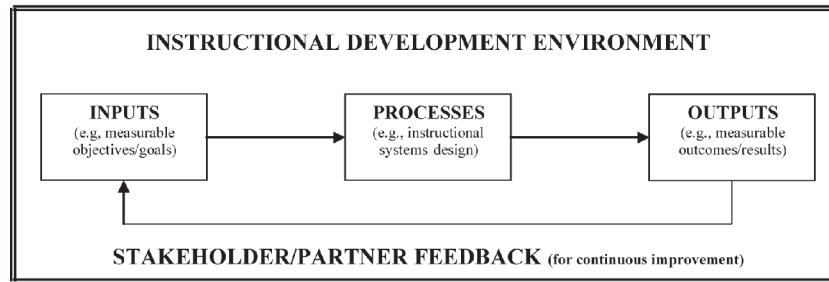
system. A system, composed of the performance of interrelated subsystems, forms a unified whole which is more than the sum of its individual parts. The application of general systems theory develops performance and instructional strategies in a systematic manner and includes the following: identifying specific requirements, designing an optimum solution, developing an intervention, and comparing results to plans (Branson & Gilbert, 1997).

Keeping the system healthy and functioning at a level in which its goals are being met by means of actively contributing inputs, outputs, and continuous feedback is referred to as maintaining an open-system. A system in which all subsystems share a common goal must be receptive to inputs and outputs in making its goal a reality (Converso, 2001, p. 16). In order to create and sustain an open-system, the IT from the onset actively engaged the partners by formally requesting input and feedback as the initiative policies, procedures, and processes were being designed and developed.

Instructional development systems or models are then transformed through systematic design functions within the system (e.g., planning, analysis, design, development, and delivery/implementation). Similarly, open-systems continuously receive feedback from stakeholders/partners indicating how well these functions have been carried out. To survive, an open-system must gain advantages (e.g., return-on-investment) from its transactions with the environment (Rothwell & Kazanas, 1992, p. 10) (see Figure 1).

In our illustrative example, the instructional development structure has multiple tiers of partners functioning in change roles. The change roles are based on role assignments for change projects as defined by Conner (1992). "Working relationships can be highly complex and convoluted, with people playing more than one role and frequently shifting roles once a change is under way" (Conner, 1992; p. 105). The role assignments are defined as (Conner, 1992; pp. 106-107):

Figure 1. Components of an open-system organization (adapted from Rothwell & Kazanas, 1992)



- *Sponsor*: an individual or group who has the power to sanction or legitimize change. A sponsor decides which changes will happen, communicates the new priorities to the organization, and provides the proper reinforcement to assure success. Sponsorship takes far more than ideas and rhetoric; it requires the ability and willingness to apply and to enable the meaningful rewards and pressure that produce and enable desired results to be made on time and within budget.
 - *Initial Sponsor*: an individual or group who has the power to break from the status quo and sanction a significant change (e.g., primary customer - military or government agency). An initial sponsor is usually higher in the hierarchy than those who must perform the duties of sustaining sponsors. The initiating sponsor must be able to enlist the support of sustaining sponsors down in the organization, or the change is certain to fail.
 - *Sustaining Sponsor*: one who supports and follows through with the sponsor commitment and allocation of resources for his/her area of influence. A sustaining sponsor has enough proximity to local targets, those individuals or groups who must actually change, to maintain focus and motivation on the change goals (e.g., prime contractor). Sustaining sponsors minimize logistic, economic, and political gaps that exist between layers of the organization and produce the appropriate structure of rewards and punishments that promote achievement.
 - *Advocate*: an individual or group who wants to achieve a change but lacks the power to sanction it. However, advocates are influential and valued for their advice and recommendations given to the sponsor and others (e.g., dependent on the situation this role can be filled by the OTP project managers, the lead IT, or the SMEs themselves).
 - *Change Agent*: an individual or group who is responsible for implementing the change (e.g., IT, project managers). Agent success depends on the ability to diagnose potential problems, develop a plan to deal with these issues, and execute the change effectively.
 - *Change Target*: an individual or group who must change (SMEs - analysts, designers, developers). To increase the likelihood of success, they must be educated to understand the changes they are expected to accommodate, and they must be involved appropriately in the implementation process.
- In our illustrative example, the *initial sponsor* is the military or government agency (a.k.a., primary customer) who has the ultimate/final authority and

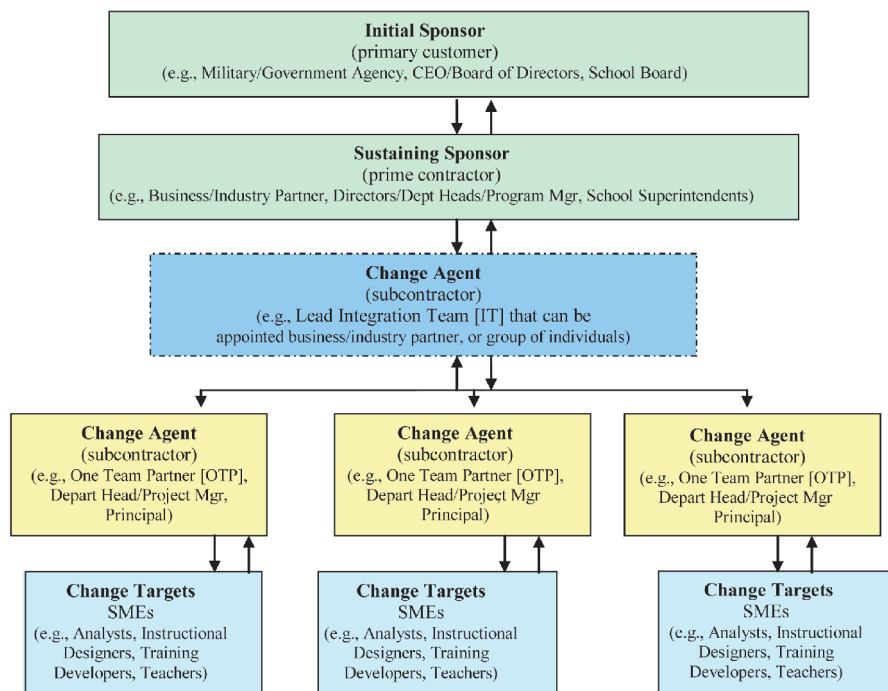
responsibility to accept/reject the end-product. The *sustaining sponsor* is the government contractor (a.k.a., prime contractor) who has the authority and responsibility to accept/reject end-product). The *change agents* are the OTP project managers (a.k.a., subcontractors) and the lead IT that has managerial roles and responsibilities to comply with standards and guidelines when submitting the end-product for approval/acceptance. The *change targets* are the content SMEs, OTP instructional designers, and training developers who follow the policies, procedures, and processes for creating the end-product (see Figure 2).

As noted by Conner (1992, p. 105), as with any change initiative, this large-scale model had individuals with roles and responsibilities that are multi-disciplined (having more than one area of expertise) and multi-functional (having to perform more than one role). For example, a project manager may have the following roles/responsibilities: 1) as a change agent leads/supervises the work of his respective team within the OTP organization/

structure, 2) as an advocate for individual analysts within his respective team, and 3) as a change agent who performs as approver of product that moves along the tiers of internal review/approval for submission to the external review team (i.e., the lead IT).

To oversee the instructional development (ID) initiative described herein, the lead IT adopted a systematic model for working with SMEs. ID models provide communication tools for determining appropriate outcomes, collecting data, analyzing data, generating learning strategies, selecting or constructing media, conducting assessment, and implementing and revising results (Gustafson & Branch, 2002, p. 2). The core elements/phases of any ID model are *analyze*, *design*, *develop*, *implement*, and *evaluate* (ADDIE)—each element informs the other as development takes place and revisions continue throughout the process via ongoing planning at the onset of each phase and formative evaluations conducted during each phase. The ADDIE ID Model is well documented

Figure 2. Chain of responsibility and authority within in a change management role-based organization



and widely used in military, business/industry, and academic training/education programs. However, the lead IT modified the ADDIE ID Model that appeared in Gustafson and Branch (2002, p. 3) to incorporate the upfront strategic planning phase and technology components.

For example, the ID Model adopted by the lead IT includes the following modifications and operational definitions: 1) upfront strategic planning (SP) – the phase where ADDIE is employed for the initiative or project as a whole, consisting of interrelated parts and 2) technology components that are comprised of tools and applications (T) to manage (e.g., relational database/repository, report generator, search engine); to produce (e.g., standardized tools to create documents); and to communicate (e.g., availability and accessibility of online collaborative meeting/classroom environment) aspects of development process/product, thus the new acronym SP/T-ADDIE (see Figure 3).

A critical task of the lead IT was to establish business rules (i.e., guidelines for developing consensus-building). Kaufman, Herman, and Watters (1996) present an educational strategic planning framework with a focus on the primary client and beneficiary of what gets planned and

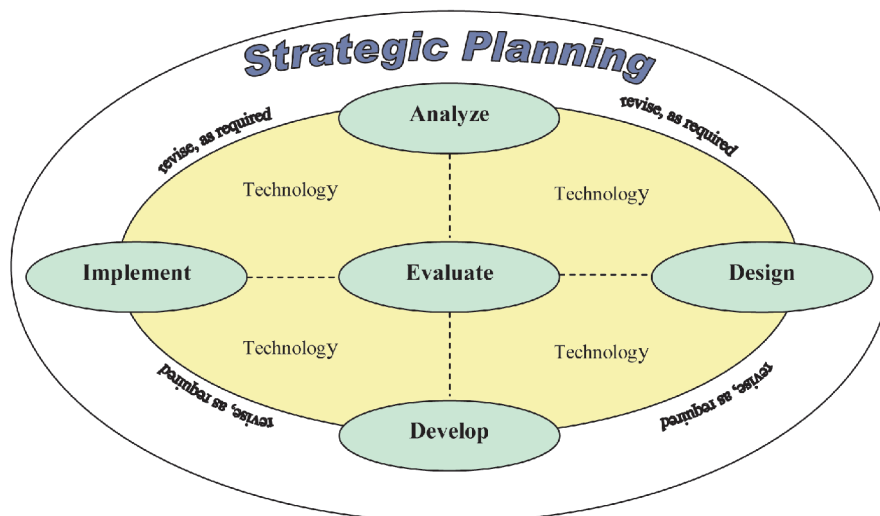
delivered. This framework or model embraces a systems approach and illustrates the interrelationships among three major clusters 1) scoping, 2) planning, and 3) implementation and continuous improvement.

The *scoping* cluster begins the guiding star or ideal vision, defined as the kind of world we would want for tomorrow's performer, and then selects what the educational system commits to deliver. This delivery selection identifies the needs and mission objectives (e.g., what is and what should be and how to close the gap between the two).

The *planning* cluster includes the strategic plan devised by examining the strengths, weaknesses, opportunities, and threats of the implementation and identifying the long and short-term milestones (e.g., measure of incremental successes).

The *implementation and continuous improvement* cluster includes tactical and operational planning (e.g., how to get from here to there), securing resources, diffusing the initiative, and conducting formative evaluations for continuous improvement of the initiative policies, processes, and procedures. For the purpose of continuous improvement, criteria must be developed to measure the effectiveness and efficiency of the

Figure 3. Core elements of instructional development: SP/T-ADDIE Model



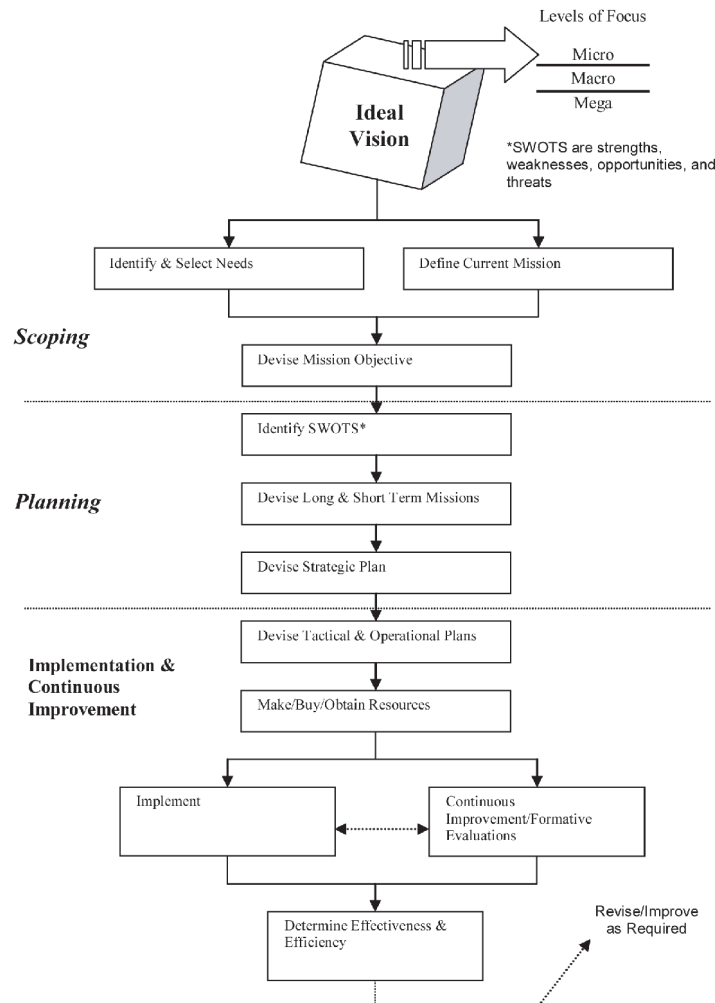
initiative. This was accomplished via the technical and management plans adopted by the OTPs, IT, and primary contractor.

Kaufman's strategic planning and decision-making model (1998) focuses on making societal contributions in addition to meeting its own requirements for contribution and survival, thus the three levels of focus 1) micro (e.g., individual), 2) macro (e.g., organizational), and 3) mega (e.g., societal). In our illustrative example, the true outcome or mega contribution to society is the development of a well trained soldier that has the skill, knowledge, and abilities to protect

home and abroad, resulting in the saving of lives and property (see Figure 4).

As stated previously, an important element to working with SMEs is the ability to develop and manage collaboration and decision-making. Therefore, the lead IT developed two main components: *Real time* (collaborative online learning/consensus-building environment) and *relational database/repository* (capabilities to manage document development; review with multi-tiered feedback; store documents in various states of development; search document whole

Figure 4. Strategic Planning Model Source. © 2008 Roger K. Kaufman, PhD. Used with permission.



or parts; and generate reports and automated notifications).

LARGE-SCALE COLLABORATION MODEL FOR SUBJECT MATTER EXPERTS

As with any implementation effort, there are inevitably issues, controversies, and/or problems. The following paragraphs discuss specific issues or problems and the resolutions to manage, minimize, or eliminate them.

Use of Technology Tools and Applications Issue

In order to provide a seamless environment to its end-users, the initiative required modifications of an existing relational database to meet the requirements of the implementation effort. Once the technology was in place, there was the matter of developing workable templates to capture the required data to produce the end-product.

This was accomplished via collaboration with the system technicians and analysts (i.e., those who would capture the data from multiple sources and entering data into the system). Then the issue of offline word processing for exchanging specific comments and edits on draft documents (e.g., track change features using MS Word or features within the relational database) became an issue to those unfamiliar with the features and techniques to work through the reviewing procedures.

Resolution of the issue was accomplished by the IT, OTP instructional designers, task leads, and analysts via formal training and direct one-one-one help/guidance. This training was delivered in a blended format, which constituted a combination of face-to-face live sessions and virtual online sessions, based on time and location constraints.

Real-time Online Collaborative Environment Issue

To meet the challenge of working at a distance, the lead IT selected to work within a real-time online collaborative environment. This mode of communication, fairly new to many of the partners, resulted in a training solution designed by the instructional designers representing the OTPs and IT. The real-time online collaboration minimized the requirement for travel, while greatly reducing associated costs (e.g., food and lodging, telephone charges, time away from office/work settings). However, the greatest value was in the ability to work at a moment's notice in an environment that closely resembled a live face-to-face setting. The key was having the facilitation skills and expertise to coordinate and conduct such meetings/training sessions. The lead IT was fortunate to have key personnel with these knowledge and skill sets and years of experience working within collaborative online environments, both in education and training contexts. The greatest controversy was a security issue when using such an environment when contracted by a military or government agency. There are license agreements and access issues; however, in our illustrative example the military had access to a proprietary online environment that had many of the same features as available commercial systems.

Nature of the Subject Matter Experts Issue

The areas of SME expertise are often focused on specific function (e.g., knowledge and skill set, experience) and oftentimes overlap and were interrelated with other SME expertise. To better understand the complex and multi-dimensional aspects of working with multiple SMEs, it is useful to first explore the very nature of SMEs from an expert-performance perspective. The relationship between nature and nurture has been a long-standing debate (Tenenbaum, 1999) since

it determines the quality of instruction and the amount of learning needed to acquire skills and establish a knowledge base. However, most would agree that nurture plays a significant role in the development of expertise and that in order to reach any significant level of expertise in a given domain, the performer must have the desire to excel and at least some domain-specific knowledge and skills that are acquired through practice and feedback.

It is particularly interesting to consider the role that SMEs are given within a project team. Typically, ID projects are structured such that the SMEs contribute to solutions, processes, and product design by providing their content knowledge to trained IDers. In our illustrative example, the SMEs were the driving force behind the effort and were therefore in key roles such as analysts, managers, and supervisors, going above and beyond their domain specific expertise. That is, the SMEs were serving as a project or team lead and had to make decisions and act from a perspective other than that of their domain knowledge. When you have such a vast number of SMEs with varying areas of specialization working together, lines of communication are of the utmost importance from the onset of the project for efficiency and effectiveness.

To deal with this issue of working with SMEs it was imperative to adopt a systemic approach where the interrelationships are known, understood, and embraced as strengths for problem solving and decision-making and not viewed as obstacles or challenges to the ID process. For example, in the initiative there were seven task leads (TLs), representing the OTPs. Their role was to follow the lead of the project manager and to oversee the work of the analyst. They served at times as a change agent, a change target, and advocate, depending on the situation or context of the problem or issue. The lead IT had to establish business rules that would guide the process for reaching consensus (e.g., accepting a common definition of approved terms and illustrative examples). Their

collaboration and recommendation was then reviewed by the OTP project managers and the IT. The goal was to get beyond an arbitrary decision or policy and adopt, based on active participation/decision-making process and procedure. It was the experience of the lead IT that this approach not only strengthens acceptance/adoption, but better ensured sustained buy-in and commitment because of the active involvement of the partners in the decision-making process. The key was to develop a continuous and open feedback loop, once again embracing a systemic and systematic approach to planning and decision-making.

Standardization and Compliance Issue

To carry out a large-scale initiative it was important to understand the power of standardization for outcomes/products and the compliance with standards and guidelines for processes and products. Compliance was resolved by creating an internal and external review process of product drafts and final versions. The business rules that governed the internal review process was determined by each of the OTPs, knowing that the external review would be dependent on certain criteria being met at the internal level. As it was the responsibility of the lead IT to approve the end-product that was then forwarded to the prime contractor, it was imperative that the end-product appear as if it were written by one partner, not three separate partners (OTP SMEs) – standardization enabled that to be accomplished.

Another important issue that emerged during implementation was the value of having a pressure-release - a means or process in which senior level managers had the ability to influence process and product via business rule set. An analogy would be a court of appeals. This capability provided the analyst an avenue to gain support/advocacy from senior management.

Collaborative Issues

Jensen (2002, cited in Warner, Letsky, & Cowen, 2003) addressed collaborative challenges, issues that can hinder or prohibit successful implementation if not address in a timely and organized/planned manner. Jensen went on to cite the following major factors influencing military collaborative teams:

- Increasing problem complexity– team effort needed
- Integrated Technology/Communications technology widening accessibility of contributors
- Problems addressed at international level – coalitions required
- Defense Transformation to agile and coalition operations
- Information overload condition

The lead IT revised this list of collaborative challenges based on its experience as noted below.

- Increasing problem and task complexity – team effort needed (e.g., resource reallocation: moving SMEs other roles/responsibility beyond the scope the original work order)
- Integrated Technology/Communications – technology widening accessibility of contributors and archiving and collection of end-products
- Problems addressed at a multiple tier level (e.g., IDers, TLs, IT, PMs) – where coalitions are required. For example, the PMs agreed to conduct a specific task analysis outside the scope of the contracted work, formed a coalition to how they would attack the problem and then presented a proposed solution to the prime contractor for approval/acceptance.

- Information overload condition. As with any adult learner, the learning curve is steep when experiencing new knowledge and skills. The lead IT developed training for the OTPs based on the theoretical framework of Ausubel’s meaningful reception learning and schema theory (Ausubel, et al., 1978), where a learner transfers previous learning to new information. For example, the lead IT designed the delivery of new information via illustrative examples so that the learner could relate to the information based on their prior experience, or learning. In addition, situated cognition theory, or situated learning, served as a theoretical framework. Situation learning is defined as occurring when declarative knowledge (“knowing that”) and procedural knowledge (“knowing how”) are integrated within a single framework (Driscoll, 2005, p. 154). Through constant feedback and training within the context of the situation and the community of learners that the partners formed, the information load was manageable and productive.
- Content SMEs must be balanced with instructional design analyst SMEs. It was understood that the content, or technical, SME was not expected to have the knowledge and skill set to write instruction; however, we found the greatest value when they worked in tandem with the instructional SMEs – to integrate or combine the expertise of both to make the whole.

FUTURE TRENDS

The use of online collaborative learning/training environments is gaining greater popularity in academic and business/industry settings. Military and government agencies are seeing the value and benefit, in terms of cost and effectiveness in training programs, as well. Hofmann (2004) states,

“like every innovation, learning technologies are a mixed blessing. They allow us to present content in many different formats and deliver that content to widely dispersed audiences at a relatively low cost” (p.1). In the illustrative example, the lead IT took the online learning environment and used it for that purpose, as well as to serve as a meeting and consensus building forum for its OTPs. As more individuals learn the features of the online collaborative environment (its tools and applications) and best practices for using those features, these types of environments will become a rich resource for many groups and organizations.

CONCLUSION

How do stakeholders or partners deliver successful large-scale ID initiatives? Everett Rogers in his book, *Diffusions of Innovations* (1995), defined diffusion as “the process by which an innovation is communicated through certain channels over time among the members of a social system” (p. 10). This concept is the backbone of implementation.

Rogers further defines an innovation as “an idea, practice, or object that is perceived as new by an individual” (p.11). The concept of lead integrator and learning communities of geographically dispersed SMEs was proposed as an innovated form of ID. Systems thinkers may suggest an elaboration to Rogers’ definition of innovation “what is perceived new by an individual” to include “a group, organization, and system as a whole (Converso, 2001).”

Inevitable to the implementation of this type of model is the diffusion of innovation. Critical to successful implementation is the understanding that problem/tasks are: increasingly more complex; technology is ever-changing; SMEs have a greater diversity in their experience, knowledge, and skill sets; and learning communities are geographically dispersed and hindered if limited to one/common or shared location (same place, same

time) – unless done virtually (any place, any time or in a blended delivery format). A most significant opportunity for those implementing large-scale ID initiatives is to use a collaborative model, such as the one described herein, thus breaking through the barriers of geographical locating and capturing of a combined level of expertise only made possible by employing a variety of SMEs collaborating via virtual environments.

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KEY TERMS AND DEFINITIONS

Blended Delivery: A combination of instructional delivery options (e.g., instructional including face-to-face sessions with virtual online sessions).

Collaboration Model: A conceptual management and communication tool designed to work with a large number of geographically dispersed subject matter experts.

Collaborative Online Learning/Consensus-Building Environment: A web-based environment that allows participants to come together via their desktop computers at the same time, from any location in some kind of social interaction to work together to solve problems, reach consensus, or brainstorm/generate ideas. Success is much dependent on the skill level of the online facilitator(s) to meet required goals and objectives of the organization and/or of the group gathered online.

Geographically Dispersed Population: A group of learners or workers who are separated from one another and/or resources, including an instructor, due to their respective locations (e.g., individuals living in different parts of a region, nation, continent, or globe).

Instructional Development Model (SP/T-ADDIE Model): Communication tool for determining appropriate outcomes, collecting data, analyzing data, generating learning strategies,

A Large-Scale Model for Working with Subject Matter Experts

selecting or constructing media, conducting assessment, and implementing and revising results.

Integration Team: Group of individuals whose role and responsibility is to standardize, synchronize, and incorporate the efforts of participating subject matter experts (SMEs). The integration team's efforts allow the SMEs to achieve consensus, efficiency, and standard of quality in product and process.

Standardization of Processes and Products: Means provided to the subject matter experts allowing them to work within an organization consistently and with regularity and sameness; desired outcome is to create processes and produce

products that appear to the customer or end-user as seamlessly created and produced.

Subject Matter Expert (SME): Defined as that individual who exhibits the highest level of expertise in performing a specialized job, task, or skill within the organization. SMEs possess in-depth knowledge of the subject you are attempting to document (http://www.isixsigma.com/dictionary/Subject_Matter_Expert_-_SME-396.htm).

Systems Approach: A methodology used to create and sustain a system (e.g., educational, instructional), composed of the performance of interrelated subsystems, to form a unified whole which is more than the sum of its individual parts.

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Chapter 2.9

Instructional Challenges in Higher Education Online Courses Delivered through a Learning Management System by Subject Matter Experts

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ABSTRACT

The authors are Instructional Designers developing online courses in higher education. These courses are facilitated by Subject Matter Experts and delivered through a Learning Management System. They propose that instructional alignment with pedagogic beliefs is the best instructional foundation for original course designs in this instructional context, and examine three factors

unique to this context. They propose new instructional design models and a new instructional system of design to address the instructional challenges specific to their learning system context.

INTRODUCTION

As Instructional Designers (IDs) in higher education, one of our main responsibilities involves working with Subject Matter Experts (SMEs) to design online courses for delivery in a Learning

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Management System (LMS). We have identified three main factors specific to this instructional context. The first is the ongoing nature of the relationship between SMEs and IDs as they collaborate on the design and delivery of online courses. The second is the constraint that these never-delivered courses must be designed without the benefit of learner-generated data to inform the process. The third is the foundational role which the course facilitator's pedagogical beliefs play throughout the course design process.

In this chapter we propose a taxonomy for an ID-designed Online Course and define the terms used in our discussion. We then discuss the three factors associated with our instructional context. We propose a model for achieving learner-driven course designs through a phased approach. We examine two elements which shape our learning system context: the pedagogical effects of LMS adoption and success factors related to Online Learning Environments (OLEs). We explore the role of context in ID. Finally, we present a framework for an Instructional System of Design

(ISD) we are developing to produce original course designs for our learning system context.

TAXONOMY AND TERMS

In order to communicate more effectively about our instructional context, we have developed the term "SME-F (Subject Matter Expert-facilitated) online courses" to refer to online courses taught by the same individual responsible for providing a course's content. We will refer to this person as the "SME/F" (Subject Matter Expert/Facilitator). We propose the following taxonomy in order to situate our terms within the larger context of online courses designed by IDs (see Figure 1).

We believe that there are critical distinctions between the instructional context for the type of course we have described and the instructional context for other types of online courses. For example, in an I-F online course the Instructor is facilitating a course with content provided by a SME, and she or he may or may not be an expert in the content. Also, the Instructor is not likely to

Figure 1. Taxonomy of online course designed by instructional designers

Course Type	Design Resources				Course Facilitator			
	ID	SME	SME/F	I	L-F	PA-F	I-F	SME/F
L-F	X	X			X			
PA-F	X	X				X		
I-F	X	X		X			X	
SME-F	X		X					X

L-F = Learner-facilitated

PA-F = Pedagogical Agent-facilitated

I-F = Instructor-facilitated

SME-F = Subject Matter Expert-facilitated

ID = Instructional Designer

SME = Subject Matter Expert

SME/F = Subject Matter Expert/Facilitator

I = Instructor

have played a significant role in the course design process, so one would not expect to find course design choices aligned with his or her pedagogical strengths.

For the purposes of this chapter we will use the term “course design” to represent the entire process of Instructional Design as represented by the phases described in the ADDIE model: analysis, design, development, implementation and evaluation (see, for example, Dick & Carey, 1996). We will use the terms Learning Management System (LMS) and Course Management System (CMS) interchangeably. We will use the term “learning system context” as defined by Tessmer and Richey (1997): “those situational elements that affect both the acquisition and application of newly acquired knowledge, skills, or attitudes” (p. 87). We will use the term “pedagogical beliefs” to refer to “teacher’s educational beliefs about teaching and learning” (Ertmer, 2005, p. 28).

THREE CONTEXTUAL FACTORS

We are part of a team of IDs providing ID (Instructional Design) services at a research-based university. Designing original online courses facilitated by SMEs is a major component of our responsibilities. In the course of our practice, we have identified three factors that we believe are unique to this instructional context.

Ongoing Relationship

Each ID on our team is assigned to work with specific university departments on an ongoing basis. Our IDs and SME/Fs work together throughout the entire pre- and post-semester cycle of course design. This arrangement creates an opportunity to make course design decisions driven by the pedagogical beliefs of the individual providing the course content and facilitating the delivery of the course.

Designing without Learner-Generated Data

By definition, never-delivered courses must be designed without the benefit of learner-generated data. According to Geber & Scott (2007), for designers operating “from the theoretical orientation of learning as interdependent with context and experience, it is not possible to know learners’ perspectives in advance of course development” (p. 464-465). The ID and SME/F are forced look to second-hand sources of information to construct assumptions about potential learners: data gathered from learners in similar traditional or online courses, research-based findings about online learners, learner characteristics implied by the LMS, etc. In their examination of ID practices using established instructional design methods, Sims and Stork (2007) state that IDs “...will often predict or assume certain characteristics of the learners” (3) and incorporate these assumptions into a course design.

For original course designs, we propose that IDs need to limit the assumptions made about the potential learners to one source: the SME/F. We posit that the SME/F’s assumptions about how the course’s future learners will achieve course objectives are inherently linked to their pedagogical beliefs and practices. We stipulate that documenting and incorporating these assumptions into a new course design will create an instructional foundation that maintains alignment with the SME/F’s pedagogy, and consequently his or her pedagogical practices throughout the course.

SME/F Pedagogical Beliefs

Working with the same individual throughout the design and delivery process presents a unique opportunity for instructional continuity. Our experience has led us to conclude that the pedagogical beliefs held by the SME/F are the best instructional foundation for original designs of courses

delivered online through a LMS. This conclusion is supported by Ertmer's (2005) examination of the research conducted on teacher beliefs: "... beliefs are far more influential than knowledge in determining how individuals organize and define tasks and problems" (p. 28). She also draws a direct connection between pedagogical beliefs and technology skills:

Given that these [technology] skills are unlikely to be used unless they fit with teachers' existing pedagogical beliefs, it is imperative that educators increase their understanding of and ability to address teacher beliefs, as part of their efforts to increase teachers' technology skills and uses (Ertmer, 2005, p. 37).

Zhao & Cziko (2001) also emphasize the importance of teacher beliefs when creating their Perceptual Control Theory (PCT) framework for understanding teacher adoption of technology. PCT defines three necessary conditions:

1. The teacher must believe that technology can more effectively meet a higher-level goal than what has been used.
2. The teacher must believe that using technology will not cause disturbances to other higher-level goals that he or she thinks are more important than the one being maintained.
3. The teacher must believe that he or she has or will have sufficient ability and resources to use technology. (Zhao & Cziko, 2001, p. 6)

Ertmer (2005) demonstrates how pedagogical beliefs have a global effect on a teacher's perceptions about new instructional tools and practices when she states "Even new information (about technology, alternative teaching methods, etc.), if attended to at all, will be filtered through these existing belief systems" (p. 30). Our in-

structional process recognizes and embraces this filter by systematically exploring, documenting, and integrating the SME/F's pedagogical beliefs into the course design. We share the hope that a greater understanding of the relationship between pedagogical beliefs and technology use:

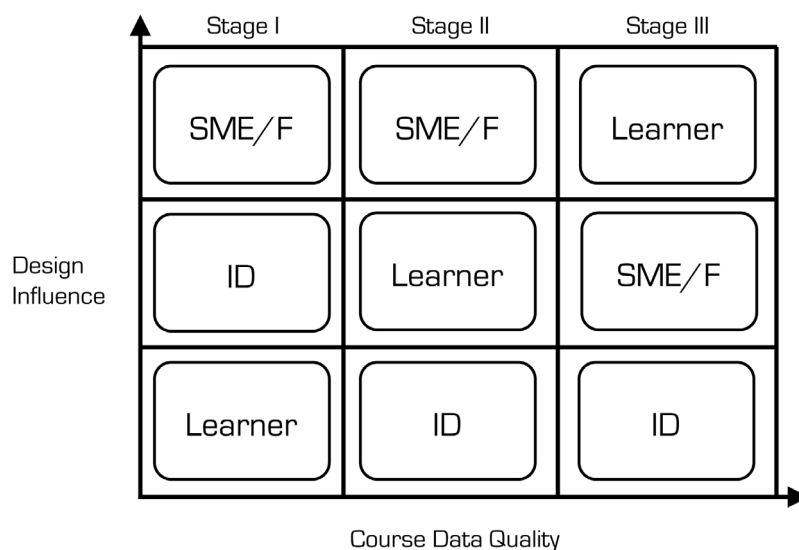
...may enable us to facilitate a better alignment between research, practice, and beliefs and to provide more effective ways of supporting and documenting teacher change. Ultimately, the goal is to facilitate uses of technology that lead to increased student learning (Ertmer, 2005, p. 27-28).

We propose that creating and maintaining instructional alignment with the core beliefs of the individual responsible for the course's content and for the facilitation of the course will lead to the most significant learner outcomes. We suggest that it is the responsibility of the ID to gather and interpret course data, and then present evidence of course outcomes which are aligned or misaligned with the SME/F's pedagogical beliefs. If the evidence induces a shift in the SME/F's pedagogical beliefs, the ID should recommend changes to the course design that will increase instructional alignment, and then implement the changes that are approved.

DATA-DRIVEN DESIGN EVOLUTION

An ongoing relationship between an ID and a SME/F may lead to an evolution of the course design. Ideally this evolution would be the result of evidence derived from course data that led to changes in the SME/F's pedagogical beliefs. We have created the term "data-driven design evolution" to describe this process. We propose a three-stage model in which the course design shifts from "SME/F-driven" towards "learner-driven" (see Figure 2).

Figure 2. Data-driven Design Evolution in SME-F online courses



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In Stage I, there is an insufficient quality of course data to justify changes to the course design decisions/revisions based on learner feedback. This occurs in courses which have yet to be delivered, but it may also be the result of an insufficient quantity of course data. The ID creates a course design based on instructional alignment between the SME/F's pedagogical beliefs and assumptions about learners.

In Stage II, the quality of the course data is high enough to identify learner characteristics that can replace the SME/F's assumptions. The ID provides the SME/F with evidence based on course data that demonstrates instructional alignment or misalignment. When the evidence produces a shift in the SME/F's pedagogical beliefs, the ID recommends changes to the course design that will increase instructional alignment, and implements the approved changes.

In Stage III, the increase in the quality of the course data has led to a fundamental shift in the SME/F's pedagogical beliefs. He or she has become willing to learner feedback drive design

changes to the course. The ID assists the SME/F in interpreting the learner feedback from the latest cohort of learners by using the entire set of course data to control for anomalies. The ID recommends changes and implements the approved changes.

TWO CONTEXTUAL ELEMENTS

Researchers have explored the role of context in ID for more than a decade. In 1994 Edmunds, Branch & Mukherjee stated:

Concepts, theories and models have an ecology, a context within which they function. Importing a theory or model from a significantly different context, without attention to contextual differences, violates this ecology, and subsequently results in inefficient solutions to instructional problems (p. 66-67).

Tessmer & Richey (1997) described the context of a learning system as "those situational elements that affect both the acquisition and application of newly acquired knowledge, skills, or attitudes

(p.87).” They identify the social, physical, and political elements which combine to create “a multilevel body of factors in which learning and performance are embedded (p. 87).” We have identified two contextual elements that interact with the previously-discussed instructional context to create our learning system context: the pedagogical effects of LMS adoption and the success factors associated with Online Learning Environments (OLEs).

Pedagogical Effects of LMS Adoption

The majority of the technological resources we use to deliver our courses are embedded in an LMS. In a comprehensive study of faculty and instructional staff in a multi-campus university system, Morgan (2003) found that more than a third of respondents stated “to solve a pedagogical problem or challenge” as their reason for CMS adoption (p. 3). Despite pedagogical problems or challenges being the number one reason stated for CMS adoption, Morgan (2003) found that “when probing below the surface, however, it seems that most of these needs have less to do with pedagogy, per se, and more to do with class management” (p. 2). Morgan (2003) reconciles this apparent contradiction:

Faculty using course management systems find that they achieve a number of pedagogical gains. This is something of a paradox given that faculty look to a CMS to provide them with organizational tools. But in the process of using these tools, many faculty members begin to rethink and restructure their courses and ultimately their teaching. The end result is a sort of “accidental pedagogy”. Faculty teaching is improved through the use of a CMS, but this is a side effect of the use of the software rather than a direct result of its use (p. 4-5).

We have also seen shifts in pedagogical beliefs among the faculty and instructors we work with that they attribute to their use of a LMS. Because our process is designed to establish “baseline” pedagogical beliefs, we will be in a position to document the changes to these beliefs. By following a research-based model of success factors in online learning, we can recommend changes to the course design that utilize these pedagogical shifts to generate increased learner outcomes.

Success Factors in OLEs

In order to identify success factors in OLEs, Bekele (2008) reviewed 82 studies from educational technology journals. Based on his review, he developed a model that identifies seven success measures: learning outcomes, student satisfaction, higher learning, faculty satisfaction, sustainability, scalability, and rate of return. The model illustrates that “...success in the OLEs was a function of a complicated interplay of human, technologic, course, pedagogic, and leadership factors” (p. 237). We have adopted this model to guide our ongoing development of an ISD specific to our learning system context.

THE AERO ISD

The AERO ISD is being developed to create course designs for our learning system context. By focusing on a specific learning system context, we believe our process will be practical, detailed, dynamic and flexible. We also believe that by maintaining a strict vision of solving the instructional challenges presented in our environment (as opposed to taking on global instructional challenges), we are creating a process that will evolve to be not only systematic, but systemic, where “the outcomes of each component directly or indirectly impact every other component of the instructional design to some degree (Edmunds,

Branch & Mukherjee, 1994, p. 56).” The AERO ISD utilizes two new context-specific ID models, incorporates the ADDIE design phases (see, for example, Dick & Carey, 1996), encompasses the instructional phases identified in Merrill’s First Principles of Instruction (Merrill 2002, 2006), and is being guided by Bekele’s model of success and success factors in Internet-supported learning environments (Bekele, 2008).

Assumptions

There are a number of assumptions that we have made as IDs in developing the AERO ISD. We assume that our process will be applied to courses for which: a) a needs analysis has been conducted, b) a need for the course has been established, and c) there is an institutional commitment to develop the course. We also assume that the SME/F has the necessary expertise in the subject area, and that they have, and/or can obtain, the necessary course content. We assume that IDs will be designing online courses to be delivered through a Learning Management System (LMS) or Course Management System (CMS). We assume that the extra effort expended in learning and utilizing our systematic process will be justified by increases in:

- Course usability for SME/Fs and learners
- Instructional alignment with the SME/F’s pedagogical beliefs
- Data-driven design choices
- Learner outcomes

The OAR Model

The OAR model (Figure 3) is a visual tool which represents the components of SME-F online courses in higher education, and their relationship to each other. The OAR model was developed to meet four criteria: a) maintain a strict focus on our particular learning system context, b) create a simple graphic-based aid which facilitates

communication among design stakeholders, c) remain inclusive by avoiding the use of jargon, and d) represent the basic order of operations in our ID process. The OAR model has proven effective in meeting these criteria by organizing the components of SME-F online courses in higher education into three domains: Resources, Objectives and Activities.

The OAR model defines resources as the physical, electronic and intellectual assets with which a course can be created. These resources are determined by an analysis of the learners, SME/F, ID, learning and performing environments, available instructional technology, and other relevant contextual factors associated with a course. IDs and SME/Fs use the results of this analysis to identify real-world problems and tasks to inform the design of objectives.

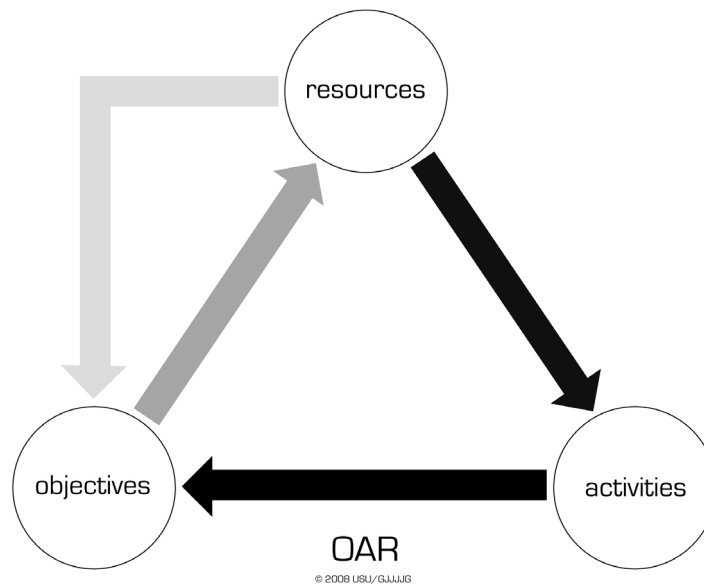
The objectives domain contains the learning and performance goals that are designed to guide the course. Objectives determine which resources will be delivered to influence learner behavior under specified conditions to meet defined criteria. Opportunities for learners to accomplish the objectives are created through activities that are as closely aligned with real-world problems and tasks as the available resources will allow.

Activities are the actual events that learners engage in to acquire and develop new knowledge and skills. At a minimum, these events involve an agent (most often the learner, but at times the facilitator) following an objective to engage with a resource. Activities are primarily delivered by a LMS and are facilitated and assessed by the SME/F.

Merrill’s First Principles of Instruction

The AERO ISD is being designed to generate activity types which correlate strongly to a well-known instructional theory: Merrill’s First Principles of Instruction (2002, 2006). In an effort to establish the most fundamental principles of instruction,

Figure 3. The OAR model



Merrill reviewed and synthesized several instructional theories and research reports. Merrill writes that learning is promoted when:

- Instruction takes place in the context of real-world problems or tasks that are progressively difficult
- Learners activate relative cognitive structures by recalling or demonstrating prior knowledge or experience
- Learners observe a demonstration of new knowledge
- Learners apply new knowledge, receiving feedback and coaching that is gradually withdrawn
- Learners integrate their new knowledge by reflecting on, discussing, defending, presenting new knowledge and creating personal ways to use it

Figure 4 illustrates these phases and their relationships to each other. The task/problem plays a central role by defining the learning context. The instruction begins with activation, moves clock-

wise to demonstration, followed by application, and ends with integration.

Figure 5 illustrates how Merrill's First Principles of Instruction relate to the three domains of the OAR model. The task/problem is a resource. Objectives determine how this and other resources will be delivered to create two types of activities: acquisition and application. Acquisition activities are the opportunities provided for learners to gain new knowledge and skills and encompass Merrill's activation and demonstration phases. Application activities are the opportunities provided for learners to use and develop the new knowledge and skills they have acquired, and correlate to Merrill's application and integration phases.

The OAR communication model is adapted to create an ISD-specific model by the addition of an evaluation component. The AERO model (Figure 6) represents the theoretical foundation of a new ISD for creating and revising SME-facilitated online courses developed by IDs in the higher education environment. The AERO ISD incorporates the ADDIE phases of instructional

Figure 4. Merrill's first principles of instruction

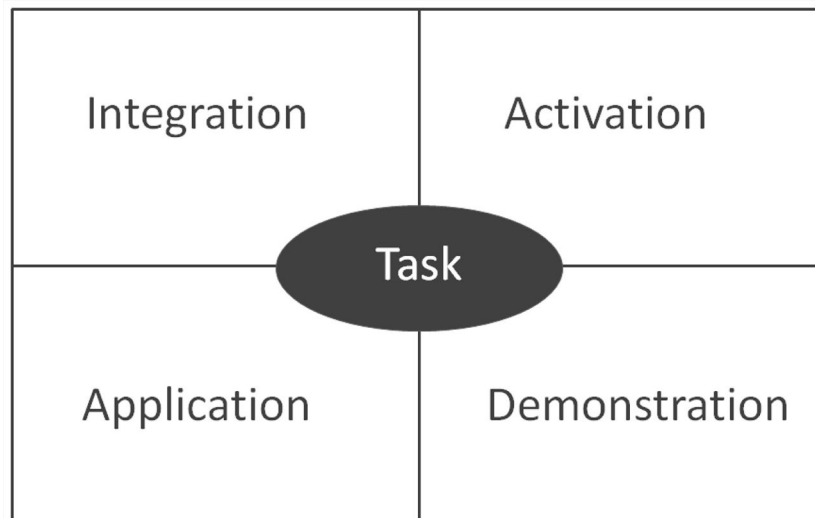


Figure 5. Merrill's first principles in the OAR domains

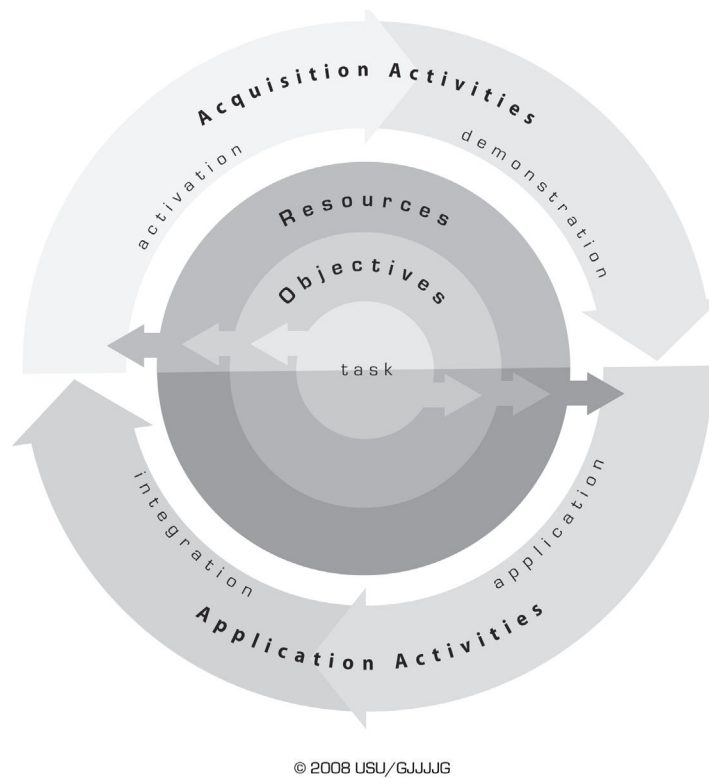
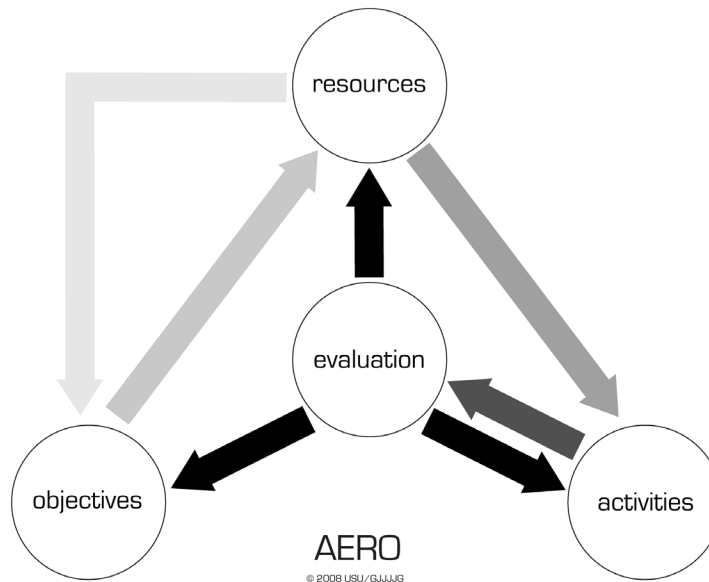


Figure 6. The AERO model



design and Merrill's First Principles of Instruction to create a systematic, research-based process targeted at this context.

An AERO ISD “cycle” represents the steps of the process when applied to one of three design levels: course, interunit or unit. The “course” design level refers to acquisition and application activities that may incorporate elements from all of the available objectives and resources, including introductory papers/discussions, assessments of prerequisite knowledge and skills, and comprehensive activities such as final exams, portfolios, capstone projects, etc. The “interunit” design level encompasses activities based on the objectives and resources from more than one unit such as midterm exams, projects, and learner presentations. The “unit” design level is the smallest grouping of related objectives, resources and activities, and in our experience is labeled by SME/Fs with a term denoting a “chunk” of instruction (ie, “Module 1”), or with a temporal unit (ie, “Week 1”).

An AERO ISD cycle (Figure 7) begins with an analysis of the resources available at the selected

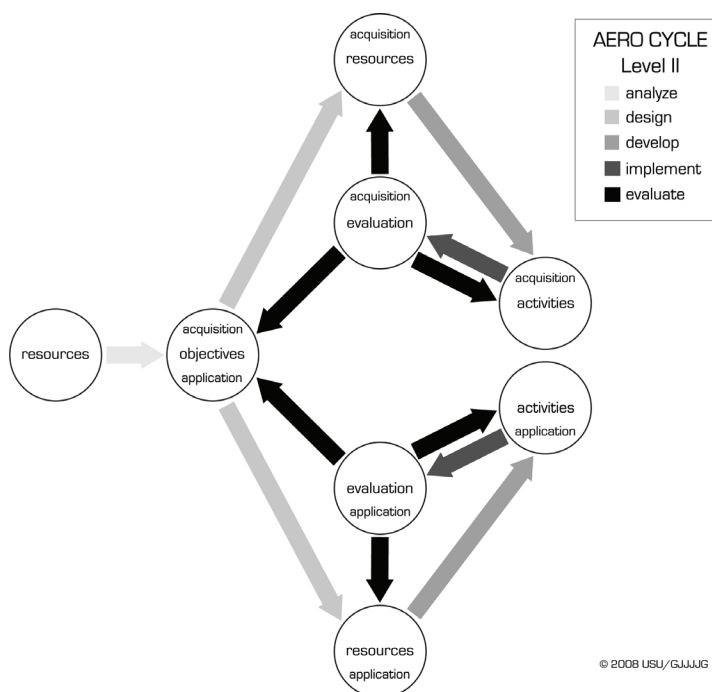
design level. The results of this analysis are used to design acquisition and application objectives. These objectives are used to select resources and develop the vehicles for delivery to learners. The cycle is implemented when the learner engages in activities which are facilitated by the SME/F. The results of the activities are evaluated and the results of the evaluation are used to make necessary revisions or additions to the relevant objectives, resources, and/or activities.

FUTURE TRENDS

In our practice as IDs, we have experienced positive outcomes and feedback from our use of the OAR communication model. We are in the process of continuing to gather data from course stakeholders to design formal evaluations of this model. The results of these evaluations will allow us to determine the validity of its theoretical foundations and make research-based revisions.

The development of a systematic process based on the AERO ISD is in its preliminary stages, and

Figure 7. The AERO ISD cycle



continues to be challenged and revised based on the feedback we receive from our clients. We encourage other IDs operating in higher education to utilize any of its components that they might find helpful in developing a process for their own practices.

CONCLUSION

Three factors unique to new online higher education courses facilitated by Subject Matter Experts and designed by Instructional Designers create an instructional and learning systems contexts with unique challenges. We created the two context-specific ID models (OAR and AERO) and are continuing to develop the AERO ISD to address these challenges. Original designs in this context are most effective when aligned with the SME/F's pedagogical beliefs. As learner-generated data is gathered, our process documents shifts in the

SME/F's pedagogical beliefs and encourages a data-driven evolution from SME/F-driven designs to learner-driven designs.

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Chapter 2.10

Functional Relevance and Online Instructional Design

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ABSTRACT

Online instruction will more likely be effective if it fits with, and is perceived by, students as being functionally relevant for their education, work, or other personal contexts. Existing practice may emphasize an ad hoc approach to online design by being pragmatic and somewhat unsystematic. It is proposed that using a functional relevance perspective, as described in this chapter, is more likely to have designers and online learners attain a greater advantage in using the capacity of the Internet to support teaching and learning. This chapter introduces the concept of functional relevance and identifies some of the underlying theories. Discussions are made on how the concept of functional relevance can be used as

a conceptual framework to identify and to drive decision-making processes that occur during the design and development of instruction.

CHAPTER OBJECTIVES

The reader will be able to:

1. Understand the meaning of—and conceptual foundation for—functional relevance
2. Apply functional relevance as a conceptual framework to clarify and drive decision-making processes during the design and development of online instruction
3. Recognize how general guidelines from this chapter may be applied to the design of online instruction

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4. Understand how a functional relevance perspective can aid designers to:
 - Decide whether particular theories or research findings might improve some aspects of their instruction
 - Identify those situations where social presence might constitute an area that merits careful study and possible important modifications in the online instruction, and
 - Consider which learner attributes may be most relevant for the instruction being designed and to discern how those particular attributes may warrant additional instructions of modification of the online instruction

INTRODUCTION

The proliferation of Internet use in general and online learning in particular has dramatically changed the landscape in K-16 education (DuCharme-Hansen & Dupin-Bryant, 2005; Salpeter, 2003). Fernback (2003) pointed out that Web-based instructional delivery has allowed educators to experiment with flexible, innovative, and progressive learning techniques that “permit students to contribute the learning process in new and active way” (p. 28). Although the idea of delivering instruction online has been heralded by teachers, administrators, parents, and students, doing so effectively takes more than a mere shift in modalities (DuCharme-Hansen & Dupin-Bryant, 2005). Recently, there has been a concerted effort among educators to create a successful online learning environment through *design* (Lim, Plucker, & Nowak, 2001). For example, DuCharme-Hansen and Dupin-Bryant’s model of distance education planning and Jones, Harmon and Lowther’s (2002) framework for online instructional implementation reflect the efforts in that direction.

Several important issues in online instructional design involve pedagogy and theoretical orientation. These issues include deciding whether: (a) an existing or a new pedagogical or instructional approach would be appropriate for learning; (b) someone’s research findings are likely to “fit” with teaching and learning; and (c) using a new pedagogical approach or new research findings might cause a change in the design of teaching. Some instructors respond to these issues by using an ad hoc approach to online design. This is to say that often they take a pragmatic but unsystematic approach, which usually, in the end, fails to take advantage of the capacity of the Internet for teaching and learning. An alternative position is taken by some who propose that online practice should be grounded in theory through a systematic application of evidence-based strategies (Wilson, 1999). With this position, what is important is the congruence between practice and theory, rather than selection of a correct theory (Bednar, Cunningham, Duffy, & Perry, 1992; Wilson, 1999). An example of congruence is the inclusion of scaffolding strategies in constructivist-based instruction, or the use of prescriptive strategies associated with cognitive theory that aid encoding and retrieval of information (Wilson, 1999).

All this reflection still leaves the designer uninformed on how to proceed. Wilson (1999) suggested a problem or practitioner-centered approach in which theory plays a supporting but non-limiting role. Jonassen (1999) suggested that a designer possess the skills to include multiple perspectives, such as the inclusion of objectivist and constructivist views. Miller and Miller (2000) suggested five variables that need to be considered by a designer of online instruction: (a) theoretical orientation of the instructor and of the students; (b) learning goals, either explicit or implicit; (c) nature of the content, such as well or ill-structured subject matter; (d) learner characteristics including cognitive and motivational characteristics; and (e) technological capabilities including available

infrastructure to support various types of online communication exchanges.

Snelbecker (1984, 1989, 1993) proposed that a designer should keep in mind the concept of *functional relevance* requirements regarding both the subject matter and delivery of that material to the learner. This idea suggests a perspective that addresses and integrates theoretical, technical, and practical context concerns. Functional relevance is congruent with the design considerations mentioned in the previous paragraph. In fact, functional relevance can be used as a conceptual framework to identify and to drive decision-making processes that occur during the design and development of instruction.

This chapter discusses (a) the concept of functional relevance from a design perspective, particularly how it can be applied to online instruction design and other Web-based learning, and (b) the relationship between functional relevance and design issues involved with pedagogical theory, social presence, and learner characteristics. The chapter focuses on these topics:

- Meaning of, and conceptual foundation for, functional relevance as a perspective that can yield fruitful implications for the success of online instruction
- Problems, learner needs, and online issues that are met by the inclusion of functional relevance
- Exploration of functional relevance as it relates to three aspects of online design: theoretical orientation, social presence, and learner characteristics.

CONCEPTS, PROBLEMS, AND SOLUTIONS

Functional Relevance

The concept of functional relevance can be depicted as the extent to which technology applica-

tions, including online learning environments, are actually supportive of learner activities and are perceived as such by learners as being relevant for how they function in a particular context (Snelbecker, 1989, 1991, 1993). The assumption is that it is only the degree to which technology is seen as potentially helpful that it will actually foster and support educational achievement and its use.

The importance of functional relevance for technology applications became apparent during the first author's (GES) work with various technology projects starting in the 1970s (e.g., Aiken & Snelbecker, 1991; Ball & Snelbecker 1982a, 1982b, 1983; Ball, Snelbecker, & Schechte, 1985; Roszkowski, Devlin, Snelbecker, Aiken, & Jacobsohn, 1988; Snelbecker, 1986; Snelbecker, Bhote-Edjulee, Aiken & Wilson, 1992; Snelbecker, Bhote, Wilson, & Aiken, 1995). Participants in these technology training projects initially consisted of nurses and physicians, but later mainly involved K-12 teachers. Many were computer novices who expressed some level of anxiety about using computers. Researchers involved in those projects also observed that teachers' *anxiety* was a barrier or restriction in their effective use of computers and related technology resources.

The solution of choice that emerged from those projects and related research was to focus on how computers can be relevant and useful for what teachers need to do in their work with students. Stated another way, once teachers were shown how computers could help them to function more effectively as teachers, indications of so-called computer anxiety and fear were no longer a major concern. Functional relevance involved providing concrete examples demonstrating how the participants could help their students gain technology mediated content. One method was the use of sample scripts—used first by teachers and then modified for their students. Teachers who previously had only limited computer and Internet experiences were hesitant about using computers. However, once they recognized how they could get useful ideas and activities for their students,

they were much more willing to take cognitive risks and explore technology resources and the Internet by themselves. Quite commonly with the different groups it was found that, even early in the training sessions, teachers and other trainees began to have more confidence, rejecting offers of help even though they initially had regularly sought help.

The initial experiences of these teachers reflect the experiences of many end-users. When computers and other technology resources became more readily available, available instructions and manuals almost exclusively focused on how computers functioned. In contrast, end-users need instructions and examples clearly describing how they could benefit from using computers in their respective learning or work contexts. Unfortunately, the trend to focus on how technology works rather than on its functional relevance continues today. All too often, many user manuals emphasize key-strokes (i.e., push X key followed by Y key) rather than guidelines about how the hardware or software can enhance how people function relevant to their respective learning or work contexts. One key idea derived from functional relevance is that fear of computers is less likely to occur when users recognize clearly how the computer resources can support and enhance their functioning.

During the previously mentioned school-related technology projects, the first author (GES) used his background and experiences as a clinical psychologist and as an educational psychologist to create and develop the concept of functional relevance. A number of theorists' ideas were helpful in developing facets and use of this concept. Carl Rogers (1969) is widely known for his concept of personally relevant learning, that is, students may be apathetic about teachers' comments but will become engaged in learning when students perceive learning to be personally relevant for themselves. This idea stimulated Snelbecker to explore ways that teaching-learning activities might have greater impact if and when students perceive those activities can be relevant for how

they function in personal, work, or other contexts. Concurrently, Heider's pioneering work regarding common sense psychology and interpersonal relationships (Fredenborg, 1995; Harvey, 1989; Heider, 1958; Snelbecker, 1988) provided insights and research methods to discern how people develop beliefs as to what can be functionally relevant for them.

Other theorists' ideas were helpful in developing procedures for selecting and improving interventions related to functional relevance. Many people are familiar with Selye's (1956, 1980) concept of distress, which is stress from highly undesirable or even potentially painful experiences. But, comparatively, few seem aware of Selye's concept of eustress, which is stress in conjunction with highly desirable but challenging experiences, such as getting a job or promotion, getting married, or having other challenging responsibilities. This raised questions about how to cope with challenging experiences during online and other learning activities.

Certain researchers' ideas were helpful in addressing cognitive operations that are regularly used by experts and that could be valuable for novices to learn. Herbert A. Simon and Alan Newell's key work on administrators' and other professionals' approaches to problem solving showed that, quite often, those experts were not aware of the many steps or sequences of actions they use in formulating or solving problems (Simon, 1981; Simon & Newell, 1971). Lev Landa (Landa, 1987; Landa & Kopstein, 1974, 1976; Main, 1987) created procedures (a) to uncover actual procedures used by experts—including logical steps that experts have described and also other cognitive operations that they could not describe, and (b) for teaching novices, effectively and efficiently, how to emulate experts in complex real world problem solving contexts. Those procedures and other ideas from Landa, Newell, and Simon proved to be helpful in designing functional relevance guidelines for teachers and students. Other aspects of functional relevance were influenced by the work

of educational technology leaders and various psychology learning theorists, including the views of scholars about the creation, modification, and use of theories and research findings (Azar, 1999; Oswald, 2002; Snelbecker, 1974, 1985). Thus, functional relevance draws from and is based on a synthesis of observations and ideas from formal theories and research findings, as well as common sense psychology and other so-called real world learning, ideas, and perspectives.

When Design Lacks Functional Relevance

Our premise is that potentially helpful technology applications will foster or support meaningful educational achievement successfully only in the degree to which they are clearly relevant for how students and teachers function. This requires having such helpful resources perceived, respectively, by students and teachers, as being functionally relevant for them in their particular context. Functional relevance overcomes frustration and anxiety, two human emotions that frequently accompany use of technology. We now need to recognize briefly some inherent, potentially problematic, attributes of technology before addressing ways to maximize learning benefits from technology.

It is a mistake to assume that the frustrations encountered by users in the aforementioned technology projects are a thing of the past. There are unending streams of examples about the frustrations people endure when trying to use technology resources. A June 16, 2004 *PC Magazine* article, entitled *Help Us Define PC Ease of Use*, depicted a PC as behaving like a stubborn child, including being obstinate and hard to figure out, much too often taking even simple tasks consume too much time. Also criticized were too frequent occurrences of poor design, inherent incompatibilities, and having things not working the way they should. Advertisements and articles in major IT industry publications (e.g., the June 28, 2004 issue of *ComputerWorld*) contain requests such as, “Can’t

there be a machine that adapts to my business, not the other way around?” More recently some IT industry publications have been proposing that an “IT attitude” (or, “IT” emphasis) should be discarded in favor of focusing on ways in which IT resources can enhance business, professional, or personal productivity. Each of these comments reflects a condition in which technology is *not* functioning in a manner that is recognized by users as being relevant for them. All too often, it seems intended end-users tend to judge that technology resources or ideas offered are so markedly different from their perspective that any benefit from such ideas would be too costly in time, frustration, or effort that they are judged as being simply *not* worth the effort needed to learn and use them.

Unfortunately, one source of frustration stems partly from inherent attributes of modern-day technologies, which constitutes strengths as well as frustration-laden weaknesses. These inherent aspects of technology resources include, but may not be limited to, the following: (a) complex software that can deal with complicated processes, and (b) general purpose software that can be modified for a variety of purposes. These attributes make it difficult for developers to know how and when software may malfunction. For example, once we know that a board can support 210 pounds we also know that the board can support objects weighing less than 210 pounds. Unfortunately, the same *may not* be true for many technology resources. Even if we know that software can handle complicated tasks, we cannot safely say that this software can separately handle all simpler tasks. That gap could exist even when those same simple tasks are being addressed successfully in the process of handling more complicated tasks. An example would be to create a universal design compatible website. It is believed that by adding technical features such as ALT tags for web graphics and enclosed captions for streaming videos, we are able to create a website that would address the needs for all people. Such an assumption may not be warranted. Even though the website is designed

based on the principles of universal design, it still lacks the capability to address the specific needs for all people who use the website.

A second source of frustration is the apparent tendency of designers to forget or ignore the fact that the main goal of online instruction is to facilitate learning that will be beneficial for learners. Instead, too often, designers apparently see a project from their own perspective, perhaps focusing on the technological “bells and whistles” and not through the eyes of the users who want to achieve or complete successfully a particular task. Some designers seem to think that their real goal is to convince others that only the best technology and technical details have been incorporated in their online instruction. It is very easy for online designers to get excited about some new gadget, device, or technology with many new features. Designers and developers of online instruction must be extremely cautious and sensitive about the selection and deployment of appropriate online instruction resources and become aware of the design related issues in online learning. Studies have shown that educators and designers tend to focus more on the technical aspects than the relevant functions in online learning (Baer, 2000; Carr, 2000; Tu & McIsaac, 2002). For example, many online instructional designers are fascinated by the nonlinear, associative nature of the Web and assume that learning will occur when such features are built into instructional Websites. However, physical connection between concepts in online courses does not necessarily guarantee the types of cognitive connections that occur during learning. According to Perkins (1990), “... ‘Connections’ is an effort to try to confront the need for conceptual understanding of subject matter on one hand and the need for general thinking skills on the other” (p. 53). Oftentimes, designers are overly concerned with the physical aspects of a connection, that is, how many links are needed and where to insert them, and so forth, leaving little room for examining the cognitive connections that are needed to support learning.

Some technology designers, developers, and vendors seem to misunderstand why technology resources are not readily usable. That reaction is evident each time designers assert that the solution to end-user problems is to make the software simpler (less capable) or watered down (i.e., providing less information rather than providing the valuable information more clearly). Instead, the designers should be trying to find out how their technology resources, whether intended for experts or novices, can be relevant to the ways that their target group functions. This means that the added value of the online learning for the user’s productivity or other aspects of work is effectively and explicitly provided. Adding value or getting a return on one’s investment (ROI)—time as well as monetary, personal, or business investment—is routinely expected by end-users, (but not necessarily recognized by designers) much of the time in business and professional contexts. Recognizing the perspectives of targeted end-users—during needs assessment and identification of purposes for the instruction and throughout the development process and follow-up evaluations—rather than depending so much on how designers perceive things is very important. Involvement of potential end-users can benefit the ultimate end—and also can help improve the productivity and positive impact of applications designers and developers in online learning.

What is needed is to have designers of online learning focus more on the learning benefits that can be derived from online learning, rather than only or mainly on the subject matter and technical aspects of the technology resources. Of course, all three of these plus practical and other matters must be considered. Online resources should be designed so that they provide students with learning experiences of relevance to the ways that they function in their educational program, personal lives, and/or work.

In the next sections we will offer some examples of how a functional relevance perspective can be useful in addressing online learning instruction

issues and problems. We'll offer some suggestions from a functional relevance standpoint regarding three online learning matters: theoretical orientation, social presence, and learner characteristics.

Functional Relevance and Design

Functional relevance is proposed here as an approach that can help improve and enhance the quality of online instruction. Although functional relevance can *not* be expected to solve all online instructional design problems, it can help the designer make decisions about students' likely reactions to online instruction and thus possibly avoid some problems. Here are some general guidelines to consider:

1. Before starting any design or development activities, get as much information as is feasible about the nature and attributes of learning that is desired and likely to be successful.
2. In addition to discerning what instructors, subject matter experts, and administrators consider to be important attributes and learning outcomes of the online instruction, also get the views and expectations of people who are presumed to be potential students. Where feasible, also be attentive to ideas from students who completed previous relevant instruction.
3. Online instruction quite commonly involves potential students who are not in the same geographical area. However, to the fullest extent that is feasible, seek information from those potential students. Identify similarities as well as differences among those students and note patterns that may have design implications. Use technology resources to communicate with geographically remote potential students.
4. Do *not* wait until you have set the final design of the instruction before getting potential students' views. Instead, as much as

possible, have representatives of potential students somehow involved in providing relevant ideas prior to, during, and after the actual design and development of the online instruction. Be especially attentive to their views and expectations, concerns they may have, and any special accommodations or other issues that might impact on their access to and active participation in the online instruction.

5. As you should do regarding your reactions to ideas from theories, professionals, and other resources, consider the ideas you gain from potential students in the context of all other ideas you're using to design and develop the online instruction.

Theoretical Orientation

One rather common question occurs when designing online instruction: Should a particular theory guide design and implementation? Many different views have been expressed, ranging from those who think that theories are quite useful to those who think that theories are not helpful because they do not take into account practical realities of online learning contexts. Based on our functional relevance standpoint, we offer ideas for you to consider, but we will not pretend that there is one correct position about the use of theories. In brief, we will propose that it could be appropriate to use theories in some contexts more than other contexts or with some facets of instruction without relying on theories for other facets. Theories, research findings, practical information, and so-called wisdom of the profession (e.g., knowing previous customary ways of doing things) all can be very helpful in organizing online instructional design plans. For example, theories can stimulate or facilitate insights and variations in ways to think about online learning.

At the core of instructional theories are their respective epistemologies (or, philosophies about the nature of knowledge). Various frameworks

have been used to describe how respective theories compare regarding epistemology, with some people suggesting that they might be both complementary and competitive while others contend that there exists a continuum from objectivist to constructivist views. The objectivist perspective is that knowledge is observable and measurable. Instructional theories based on this assumption tend to be prescriptive, that is, the theory specifies particular strategies to help the instructor transmit knowledge to the novice learner and strategies that aid the learner in acquiring this knowledge. The assumption of constructivism is that knowledge is the making of meaning about a phenomenon and this meaning-making involves either personal or social agreement. The constructivist approach to instruction uses strategies such as collaboration, authentic context, and diverse perspectives to aid the learner's understanding (Bednar, et al., 1992; Cronin, 1997; Jonassen, 1999; Wilson, Jonassen, & Cole, 1993).

In a sense, we need to consider both the potential value that we might derive from theories and research findings and any costs (time, frustration, incompatibility) involved—particularly any costs that may be imposed on our student end-users. We should not do so simply to proclaim that our design is based on good theory. Using good theory can obviously be a good idea when it is reasonably clear that theories we have selected enhance learning. But, theories collectively cannot address all aspects and attributes that exist in practical situations. Functional relevance can serve as a framework within which to decide whether particular theories or research findings support the design and development of training for the types of skills desired for a particular situation.

One can make the case that applying learning theories to online design after judicious consideration of costs and benefits constitutes a value-added decision. For example, by identifying constructivism with online design, we recognize that constructivist approach in teaching fits with the unique characteristics of online learning en-

vironments which promote positive and active student learning. Head, Lockee, and Oliver (2002) described the facilitating functions of the nonlinear, associative structure of the Web in promoting learners' knowledge association. According to Miller and Miller (1999, 2000), the nonlinear, associative structure can be used to provide more accurate representations of experts' knowledge structures or to permit learners to build their own representations of knowledge (Ayersman, 1995; Wilson & Jonassen, 1989; Yang, 1996).

Discussions about the relative merits of different theories, and sharply different views about whether instruction should or should not be driven by theories, have occupied the attention and interest of researchers and practitioners. Thus, this chapter can not address all issues involved in such matters. However, from the standpoint of functional relevance, we propose that one or more theories should be applied to online instruction depending on the extent to which such theories offer some added value for the online instruction of interest. It may be possible, and even desirable in some situations, to apply so-called competitive approaches in our online instruction.

Previously, in this chapter, it was acknowledged that some designers consider objectivist and constructivist approaches to be incompatible with each other, often asserting that you have to choose one approach or the other. But, with careful attention to overall design requirements, it is plausible that certain aspects of our online instruction could benefit from applying objectivist procedures and other aspects could benefit from constructivist procedures. This can be accomplished successfully by observing that different components of online instruction can be identified and that those components may have contrasting design requirements. Moreover, it seems unlikely that any one theory will address all aspects of our instruction. A functional relevance perspective could be helpful for designers in identifying and making decisions about such responsibilities as the following: (a) make reasonably certain that

procedures within each component make sense to students, (b) provide students with transition instructions and support so that they can move successfully from one component to another, and (c) help instructors and students to recognize how the various online instruction components “fit together” and collectively have been designed to enable students to attain the respective purposes, goals, and benefits to be derived from that online instruction.

Social Presence

Social presence is an important concept for on-line instruction, but too often its significance and impact seem to be ignored or minimized. *Social presence* refers to the extent to which one feels that certain other persons are either both physically and psychologically present or feels the sensation of their being “socially present,” even though said persons are not with us physically. Connectedness is one term that sometimes is used in discussions about social presence. Think for a moment when you were in the same room with another person but the other person seemed to be oblivious to the fact that you were in that same room. That is the kind of situation where you most likely felt that you were not at all connected with this person, and you may even have wondered whether there was any social presence between you and this person. If this person is an instructor of a face-to-face classroom course you are taking, your feelings probably would depend on the size of the class or on other factors. As one member of a class with several hundred students you might have mixed feelings, but as one of only five students, you probably would not feel very happy.

How we perceive other people, and how they perceive us, has been of interest in psychology and other disciplines for at least half a century. Earlier terms for this area include personal perception, interpersonal perception, social perception, and other terms related to communications theory. Some of the earlier work focused on implications

when people do not have accurate perceptions of each other. However, for several decades it has been recognized that how one perceives another person may be more important than whether or not such a perception is accurate. For example, Sundland (1960) found that patients’ outcomes were correlated with their person-perceptions of their psychotherapists along relevant dimensions; however, the extent to which those person-perceptions were accurate was not correlated with their outcome. Snelbecker (1967) found that college students’ perceptions of psychotherapists in a laboratory analog were correlated with their perceptions of two therapists. Both of those studies used Barrett-Leonard’s (1959) idea of Relationship, which was based on Carl Rogers’ theory concerning person-perceptions of patients.

Online instruction designers might want to examine contemporary instruments and research findings both to inform their practice. At least with instructional design of some online courses, it may be important for designers to examine the extent to which students’ views regarding social presence could help identify what students expect with regard to social presence. It is important to note that the studies previously mentioned were conducted in psychotherapy relationships decades ago. However, lessons from studies of those relationships do raise some possibilities today. First, how students perceive social presence matters in online instruction may be important, no matter how accurate they are. Second, it seems plausible that online students’ personal attributes might influence their perceptions and feelings regarding social presence and also influence designers’ plans for creating instruction that is functionally relevant.

Although the term social presence is not always used, there is growing concern that increasing use of automated resources generally in society might be having an adverse impact, partly because of reduced interactions with an actual person. This concern has been expressed about various instances in society today where people are using technology resources as a replacement of person-

to-person interactions. For example, James (2006) suggested that the automated systems that make banking activities readily available as needed may actually be creating emotionally detached customers. One recent major study (Katz, 2006) suggests that, despite their proficiency with technology, today's college students do not necessarily prefer to have more than moderate levels of technology in their college courses. More directly related to online instruction, Reio and Crim (2006) expressed their concern about the lack of personal connection among learners while engaging in asynchronous online learning. They pointed out that the online educators were overly enthusiastic about the features of asynchronous learning and overlooked the factor of social presence, which may result in overall learner dissatisfaction with online learning.

These contemporary observations, along with earlier views, suggest that there may be insufficient attention given to social presence (Baer, 2000; Hill, Raven, & Han, 2002). Hill et al., pointed out that "explanation for high dropout rates and dissatisfaction with distance delivered courses may relate to a lack of a perception of community in courses" (p. 384). Tu and McIsaac (2002) emphasized that it is essential to explore the social presence in online classes, the relationship between media and the social-cultural construction of knowledge. Many commercial Web systems like Web CT and Blackboard include built-in tools to accommodate and facilitate education-related communication—such as synchronous and asynchronous online chat rooms. However, many online courses continue to create "cyber cubicles," where learners are separated from each other and where the level of communication is limited to "logon" without meaningful social communication among learners. Good quality effective online instruction involves more than introducing cutting edge technology. It involves building functionally relevant components such as those that address social presence issues, meaningful communication, and so forth, to create a

positive and socially supportive environment for learning. A recent effort in this direction is Yang's (2007) STEP model, which includes scaffolding, transaction, evaluation, and presentation. The STEP model underscores the importance of establishing social presence in online learning. It reflects the effort of designers and practitioners to build functionally relevant components in online learning by enhancing learner self-awareness in online learning environment, facilitating social comfort of expressing and sensing affect, and providing effective social navigation.

Learner Characteristics

Students who engage in online instruction often come with different motivational demands. Carr (2000) pointed out that some students attended the online courses because of external motivation such as job promotion, while others attended the online courses for internal motivational reasons such as self-improvement. Thus, online instructional design should attend to both external and internal motivation demands. Some students enrolled in online courses became very frustrated because the courses were poorly designed and failed to address students' internal and external motivational demands associated with the online courses (Carr, 2000; Hill et al., 2002). A design issue in online learning is how to address the differing motivational demands that each learner brings to a learning experience.

In most real life situations, people may share a common interest in some event (e.g., an observation or activity) while concurrently having considerable differences in the perspective they bring to that event. Despite such common interest, it does not necessarily mean that all of these people will have similar perspectives about that particular event. This same co-occurrence of shared common interest along with diverse perspectives can involve (a) preparing good online instruction, (b) writing a good book chapter, (c) designing good research studies, (d) practical application of some

theory, or (e) even attending a sporting event. Thus it is not unreasonable to expect diversity and common interests among students who are intended recipients of the online instruction.

Similarly, students enrolled in online courses or some role in making decisions about online learning can be expected to share some common interest but also have co-occurring perspectives with very different views about what constitutes quality of online learning. In addition to the intended beneficiaries of this online instruction, other people with some interest in and views about the topics addressed in the online instruction could include: the authors and designers of the topics, instructors or employers of potential recipients, and various theorists or researchers who focus on online learning.

We suggest that, of all these potential perspectives, too often the intended beneficiaries' perspectives about the online instruction are not adequately considered. More often, it seems that the designers' and other professionals' perspectives predominate. This is not surprising because designers and developers are so busy dealing with their online instruction responsibilities and pressures—typically also while wondering about potential critics' views about the technical standards that are supposed to be met in good quality online instruction.

Why is it important to place the emphasis on clients' or learners' perspectives (instead of mainly designers' perspectives)? Simply stated, if the needs and expectations of those intended beneficiaries are not met in a reasonable manner, it is quite likely that this online instruction will be judged to be either deficient or even a failure. Functional relevance suggests that we need to maintain our focus on the intended beneficiaries of the online instruction from inception of the idea, iterative tests and revisions of the online instruction. That includes not only design and development processes but also follow-up evaluations and implications for making any changes in this present offering or in future online instruction.

In recent years, certain commercial design firms regularly involve intended learner groups or other targeted end-users throughout the design and development process. Although such firms recognize that additional costs are involved, this practice is accepted because it can help ensure that online learning will have higher prospects for success. A key question is: By what cost-effective ways can we obtain reasonably valid information about potential students' characteristics? As a start, let us acknowledge that designers should not be expected to recognize all possible motivations and expectations of students. Available funds, time-frames, and administrative requirements need to be considered when making design plans. Although a first inclination might be to survey potential students, it is usually best to start with pertinent existing information. Such available information could be valuable in designing, conducting, and analyzing surveys of potential students.

In established institutions with ongoing classroom courses and online courses, some useful information may be readily available. Reviews of literature about distance learning for the particular subject matter area may yield some other helpful insights about matters that should be considered for our online course. In the case of a new course, at many institutions this information about students would be required and carefully reviewed before the new course proposal was approved. Thus, it would be very important to obtain all pertinent documents about the new online course. When an online course is replacing or extending an established classroom course, helpful ideas could be obtained from current students or accessible students who previously completed this or similar courses.

Along with these ways for seeking information about learner characteristics, at some point it may be advisable to use a combination of procedures for collecting new information. One approach is to alternate between using interviews or focus groups and surveys. For example, one possibility would be this: (a) after having reviewed available

information, formulate a series of questions and interview or hold group discussions with potential students. A goal here would be to ensure that we're asking reasonably appropriate questions. These interviews and focus group discussions could help guide identification and formatting of appropriate questions; (b) conduct surveys (in class, mailed surveys, or online surveys) of potential students; (c) conduct interviews or focus groups to help clarify and interpret survey results as well as to get answers to questions that only emerged during or after the surveys were conducted.

This information about potential students can be compared and integrated with ideas expressed by the experts. This should result in making decisions so that our resulting online instruction can be more relevant to how our intended online students function.

CONCLUSION

The chapter calls attention to an important aspect in the design of online instruction: that online instructional process will more likely be effective if and when they fit with and are perceived by students as being functionally relevant for their education, work, or other personal contexts. Designers typically must cope with many different—and sometimes competing—responsibilities. They must address subject matter requirements and expected outcomes, provide effective and efficient means for attaining designated educational standards, make professional decisions about cost-effective means for using technology resources, and comply with numerous other conceptual, administrative and practical matters. However, it is a key thesis of this chapter that those efforts may not be so successful if intended students ultimately do not recognize that the resultant online instruction is consistent with their needs and expectations.

It is suggested that unnecessary deficits may exist in online instruction causing students to have unanticipated problems that may cause serious

downtime in learning. For example, problems may occur when technology resource instructions are confusing or not clear, when incompatibilities exist between technology resource requirements and students' available equipment or software, with subject matter content that is different from what students had expected, or when students are not familiar with some particular pedagogical procedures.

The concept of functional relevance focuses on learners' perspectives and perceptions as to whether instruction might be relevant for and fit with the way(s) that students function in their work, studies, personal lives, and so forth. It is proposed that teachers, trainers, and other educators become aware of the functional relevance aspect of their designs and programs. Doing so could help improve and enhance the design and development of successful online instruction. In particular, such efforts can lead to online learning outcomes that intended learners will view as being more relevant to their prior knowledge and as being compatible with they function in their studies, work and personal lives. Those efforts may facilitate students' application and extension of their online learning.

FUTURE RESEARCH DIRECTIONS

Two general directions can enhance our ability to design and provide better online learning: (1) study and classify the nature of respective approaches to designing online learning, (2) create ways to incorporate learners' perspectives throughout the design-development-dissemination process.

1. For good reasons, novices initially are encouraged to focus on only one or a few approaches because trying to learn too many different approaches could be counterproductive. But, with greater knowledge and experience, they will learn about "new" approaches and wonder if some might be

preferable in certain situations. Snelbecker (1999) suggested that facilitating such advanced proficiency in design might benefit from psychotherapists' experiences with their Society for the Exploration of Psychotherapy Integration (SEPI). SEPI helps psychotherapists learn psychotherapy approaches' strengths, weaknesses, and situations where each can be especially helpful. A SEPI-type group could help instructional designers study and discuss merits of design approaches.

2. To create functionally relevant online learning, it is important that intended learners' perspectives be considered throughout the design-development process — from initial ideas through design-development-evaluation-revision, and during follow-up studies in various settings.

Of course, some of this work already is included in most (if not all) instructional design-development approaches, such as doing needs assessments of intended students, and getting reactions of students at various stages. Research could help clarify cost-effective ways (a) for identifying the nature of potential constituent groups, (b) detecting the range of views within each group, (c) discerning similarities and differences in perspectives of constituent groups, and (d) most importantly, research especially is needed to identify cost-effective means whereby we can integrate these groups' perspectives *throughout* the instructional design-development process.

Snelbecker, Miller, and Zheng (2004 & 2006) have reported ways that two commercial design groups began incorporating intended end-users' perspectives throughout the design process from conception of products and continuing throughout development and release of the new products. For example, end-users participate along with graphic designers, information scientists, and other professionals who traditionally designed and

developed such products and services. Instead of waiting until products are ready for "Beta testing" the trend now for some design companies is to have end-users' views made a part of the entire design-development process.

There is need for studies on: identifying the kinds of people who might benefit from proposed online learning, obtaining and understanding the perspectives of constituent groups, clarifying similarities/differences among constituent groups, and indicating ways potential students' perspectives can be *synthesized* with information more conventionally used during design-development of online instruction.

There is long-term and continuing need for this research. Snelbecker (1974) described the need to synthesize information from various resources to design effective instruction, and proposed the importance of focusing on practical matters along with theory. Milsum (1966) explained: "When the biologist, social scientist, and indeed natural scientist collaborate with the engineer on these large new system's problems, their classical roles as analyzers of existing systems in contrast to the engineer's role as the synthesizer of previously non-existing 'hardware' systems needs reappraisal" (Milsum, 1966, p. vii).

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Chapter 2.11

Self-Regulated Learning: Issues and Challenges for Initial Teacher Training

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ABSTRACT

This chapter assumes the importance of developing Self-Regulated Learning (SRL) competences in students in order to cope with the challenges of today's and tomorrow's society. To achieve this, it is claimed that it is crucial to train teachers who are aware of what SRL is and are able to support their students in developing these abilities. This chapter proposes examples drawn from a course in Educational Technology where SRL competence has been promoted through reflection on cognitive, meta-cognitive, emotional and motivational aspects of learning, as well as through modelling teaching practices that tend to shift the locus of control from trainers to trainees.

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INTRODUCTION

Teaching is a very hard job. It has always been hard, but it has become even more difficult and crucial in the so called knowledge society, where the major assets of its citizens do not lie in the amount of information and skills they possess, but in their ability to acquire knowledge and competence and in the way they can make use of both.

In this view, the aim of education is not to make learners know all there is to know about a given subject, but rather to make them able to build, enrich and nurture their own knowledge. Hence, what teachers should do is provide their students with some very basic and carefully chosen notions and concepts and with the ability, the will, the conceptual and technological tools needed to elaborate on them. This is why teach-

ing is so difficult: because it is about empowering people, putting them in charge of their learning and teaching them how to control it by making them aware of how to choose the best learning strategies. But there is even more. Today we do not want to leave anybody behind, neither do we wish to mortify talents or betray excellence. This entails achieving personalised learning, thereby giving each learner the chance to fully exploit their potential. And this makes teaching even more difficult, in that it requires decisions about how to foster learning for each student, by adapting, controlling and assessing the effectiveness of the teaching and learning process.

However, there is some good news: learners can, and should, help in the realization of this process. They can, and should, become aware of their learning styles, learn to evaluate their results, exploit ICT to acquire, evaluate and elaborate knowledge. Teachers will have to provide scaffolds for learning by modelling how to carry out authentic tasks, by offering situated learning opportunities; by providing chances for learners to collaborate and therefore support each other in this process.

But how can we train teachers for such a hard job?

According to Paris and Winograd (2001) the best way is by using, with trainee teachers, the same approach we expect them to use with their students. They claim that it is a frequent paradox that teachers are often trained with methods that contradict the principles they are being taught. Teachers naturally tend to replicate the same teaching approach they have experienced. This accounts for their resistance to the educational use of technology, their tendency to engage in perfunctory curriculum delivery, their focus on contents rather than on learning methods.

In this paper, we will use the case of a course in Educational Technology run by the Institute for Educational Technology of the Italian National Research Council for the Post-Graduate School

in Secondary Teaching of the University of Genoa to discuss and exemplify the following points:

- If the aim is to train teachers about Educational Technology, then Educational Technology must be used to do so;
- It is impossible to teach future teachers all there is to know about Educational Technology: a much more sensible approach is to identify some basic concepts and to lay the bases for further autonomous professional development;
- Awareness about the importance of self-regulation in the teaching profession should also be promoted, because instructional design in education cannot be reduced to rigid decision making procedures;
- If teachers must empower their students and make them able to become better and more autonomous learners, they will first need to learn to self regulate their own learning. To this end, they should receive explicit training on what self-regulated learning is, how it can be promoted and what its relationships with the use of Educational Technology and with the most popular learning theories are.

THEORETICAL FRAMEWORK

The theoretical framework of this chapter lies at the crossroads between two fields: the psychological theories of Self-Regulated Learning (SRL) and the interdisciplinary sector of Networked Learning (NL).

When we talk about the importance of developing a learner's ability to successfully cope with the challenges of today's and tomorrow's society, we acknowledge that this ability involves cognitive, meta-cognitive, emotional and motivational aspects. The theory of SRL subsumes research on these aspects in one coherent construct emphasising

ing the interplay taking place among them when learning is the focus.

NL, on the other hand, is the term we will use to refer to learning on the Web and with the Web, that is by using both its online resources and its interpersonal communication facilities. In the following we will set the scene for this paper by discussing the respective contributions of research in SRL and NL to the field of teacher training. We will also focus on the interplay between these two fields, with emphasis on those aspects that are relevant to the aim of the paper, that is, advocate the importance of SRL in teacher training, both as an aim and as a content, and provide examples of how theory can be bridged into praxis, as well as of the role that can be played by NL in this process.

Self-Regulated Teachers for Self-Regulated Learners

SRL takes place when learners are in full control of their own learning, that is they plan, monitor and evaluate their own learning processes, from a cognitive, meta-cognitive, emotional and motivational point of view (Zimmerman & Schunk, 2001; Boekaerts, Pintrich & Zeidner, 2000; Schunk & Zimmerman, 1998). In principle, this entails learners being able to set their own learning objectives and pursue them by choosing optimal learning strategies and suitable media, according to their learning styles and pre-existing knowledge. They will also be able to regulate the whole process, possibly re-adjusting their own decisions based on effective self-evaluation strategies.

SRL is therefore a very desirable set of competences for students who are to become autonomous citizens, and educators should pursue its development.

SRL competences develop through practice, and teachers can support such development by modelling effective behaviour and by planning the teaching and learning process in such a way that SRL strategies are increasingly adopted by students while teachers' support decreases accord-

ing to scaffolding and fading techniques (Collins, Brown & Newman, 1989).

Obviously, teacher training programmes should aim to raise awareness of the need to nurture students SRL and to develop such competences among teachers. The case of pre-service teacher training is particularly interesting and critical because trainees' SRL competences may be quite well developed in connection with their own disciplines, but some important components are often lacking: the awareness of the importance of supporting their development among their students, the teaching skills needed to do so and the competences required to self-regulate their own learning in a technology rich environment. While the first two points should be among the aims of any teacher training programme, the third point is one of the primary aims of teacher training in Educational Technology.

Networked Learning and Teacher Training

NL is used here to identify "the use of internet-based information and communication technologies to promote collaborative and co-operative connections: between one learner and other learners; between learners and tutors; between a learning community and its learning resources, so that participants can extend and develop their understanding and capabilities in ways that are important to them, and over which they have significant control" (de Laat, Lally, Simons & Wenger, 2006).

According to the aforementioned definition, NL comprises both learning through Information Problem Solving tasks and Computer-Supported Collaborative Learning (CSCL). The distinction between these two areas is quite blurred, the difference lying mainly in the fact that the first appears to focus more on use of the Web and its online resources to retrieve, evaluate and reuse information in a critical way (Brand-Gruwel & Gerjets, 2008; Walraven, Brand-Gruwel &

Boshuizen, 2008), while the second is mostly inspired by socio-constructivist views of learning, and concerns the way people learn together with the help of computers (Stahl, Koschmann & Suthers, 2006; Koschmann, Hall & Miyake, 2002; Koschmann, 1996). CSCL enables, on the one hand, distance learning students to participate in collective activities and achieve shared goals, and, on the other hand, tutors and teachers to effectively scaffold and support students in learning together (Strijbos, Kirschner & Martens, 2004). In this field, written asynchronous interactions are central, since they have the potential to activate collaboration and meta-cognitive processes.

In spite of the strong resistance initially shown by trainees (Wood, Mueller, Willoughby, Specht & Deyoung, 2005; Uzunboylu, 2007), NL is being increasingly used in teacher training, and there are many reasons for this. One is that the large cohorts of trainee teachers are often characterised by very different backgrounds and expectations, so they need to be addressed with a very flexible and personalised approach, which cannot easily be done face-to-face, let alone in a transmissive way. Another is that teacher training is mostly about problem solving in instructional design, and therefore requires reflective practice and the possibility of looking at problems from several perspectives, which is better done through discussion among peers and with experts (Gray, Ryan & Coulon, 2004; da Ponte, Oliveira, Varandas, Oliveira & Fonseca, 2007).

The Interplay between SRL and NL in Teacher Training

SRL in NL contexts imposes demands that are peculiar to this kind of environment (Whipp & Chiarelli, 2004) and have to do with the ability to strike a balance between individual and social aspects of knowledge construction. For example, in CSCL learners should be pro-active and goal orientated without disregarding the importance of peer contribution to the discussion, they should

be able to control emotions but also disclose them to contribute to the formation of a pleasant social climate, they should seek support and feedback but also provide it when needed and they should negotiate decisions and share achievements.

Networked learners, especially novices, should not be left alone in such a powerful but complex and unfamiliar world. To this end, the figure of the online tutor is of crucial importance. The roles of the online tutor have been widely investigated (de Laat, Lally, Lipponen & Simons, 2007; Conrad, 2004; Salmon, 2004; Berge & Collins, 1996) and include, among others: providing guidance and support to participants, especially at the beginning of a new learning experience; facilitating access to the learning environment and providing help with its use; mediating between the instructional design decisions and the spontaneous dynamics of the learning group; helping individuals to work collaboratively towards the achievement of common goals; stimulating discussion on specific contents; promoting cohesion and favouring a positive social climate among students.

As Goodyear, de Laat and Lally (2006) put it, learners, on their side, have to (re)learn “to become active learners, need time to develop confidence to act as constructive learners, and exercise autonomy. [...] Students also need to act as a community, where they take on active responsibility for educational processes as well as managing cohesion, well-being, trust, emotion, spirit and motivation within the group” (p. 216).

The design, investigation and evaluation of NL environments as well as the way they support the development of SRL among trainees can be made more systematic if we refer to an adaptation (Delfino, Manca & Persico, 2007) of the Community of Inquiry model (Garrison, Anderson & Archer, 2000). The original, well known model was based on three dimensions (i.e., the *cognitive*, *social* and *teaching presence*): through these components the model aims to provide a way to understand and analyse the intertwining of several factors in a Community of Inquiry. Enriched

by a fourth element, *meta-cognition*, the model was used to design our courses in Educational Technology. The four components of the learning experience - the cognitive, the social, the teaching and the meta-cognitive – also provide a structure to discuss, in this paper, the choices made by the course designers. In particular, we will discuss the decisions made about the learning objectives, the contents and learning styles (the cognitive dimension); the course structure and the teaching/learning strategies adopted (the teaching dimension); the participants' interactions and the emotional/motivational factors involved in building the online community (the social dimension); the reflection on the learning process and on its effects (the meta-cognitive dimension).

INSTRUCTIONAL DESIGN CHOICES TO TRAIN TEACHERS ABOUT EDUCATIONAL TECHNOLOGY AND SRL

The course in Educational Technology was addressed to trainee teachers and run yearly from 2001 to 2006, involving a total of more than 600 trainees. The objective of the course was promoting the development of educational design competences, with special focus on the evaluation and selection of learning strategies, techniques, tools, and on the infusion of Educational Technology in the school context. Even though some of the contextual constraints remained the same every year (e.g., number of participants; short duration of the course; limited amount of resources available; great differences among trainees as regards expectations, interests and background), the course design changed according to the changing needs and features of the target population, and to the experience gained during the previous versions (Delfino & Persico, 2007). For this reason, in the following, we will refer to the different “versions” of the course, meaning the various formats it took in the six years of delivery.

The instructional design choices made for this course are discussed in the next sections, with particular reference to those aimed at the development of SRL and collaborative abilities. We will start with our view on how the subject can be dealt with, bearing in mind that it is a large and fast moving field. Then we summarise the delivery modes adopted in the various versions of the course. The subsequent sections are devoted to the cognitive, teaching, social and meta-cognitive components according to which the course was designed.

Training Teachers in Educational Technology

“Educational Technology is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources” (AECT, 2004, p. 3). This is the latest definition of *Educational Technology* diffused by the Association for Educational Communications and Technology (AECT). It emphasizes different aspects of educational practice (through the verbs *facilitating, improving, creating, using, managing*) without disregarding the role of theory and research in the field (concepts summarized in the word *study*).

The double nature of this subject entails that the course programme should strike a balance between opportunities for the development of operative abilities (i.e., knowing how to do things, using and managing processes and resources) and for reflective practice, performance improvement and competence building. The key role of practice in Educational Technology is emphasized in all versions of our course by including extensive hands-on experience in their programmes. This choice also derived from the belief that Educational Technology cannot be taught without using Educational Technology, because future teachers should be trained with methods and tools that are

similar to those they are expected to use with their own students.

Furthermore, to develop know-how about what kinds of technology suit different contexts, trainee teachers should be given the opportunity to become acquainted with different forms of technology and to reflect on their educational limits and potentials (Cox, Preston & Cox, 1999; Pope, Hare & Howard, 2002; Brush, Glazewski, Rutowski, Berg, Stromfors, Van-Nest, Stock & Sutton, 2003; Dawson, Pringle & Adams, 2003; Ertmer, 2003). This can be done by emphasising the importance and the nature of the educational processes triggered by technology and by focusing on methodological and educational aspects rather than analysing in detail specific tools, that are likely to become outdated in a short time.

Delivery Mode

In accordance with the earlier considerations, CSCL was included among the training methods of our course, for a number of reasons. Firstly, CSCL competences are highly valued for technology integration in schools. Secondly, collaborative forms of Computer-Mediated Communication (CMC) are capable of fundamentally reshaping teachers' professional development (Pachler & Daly, 2006) since they increase teachers' acquaintance with the different Web services and hopefully encourage their future participation in communities of practice, one of the most promising means of Teacher Professional Development (Fusco, Gehlbach & Schlager, 2000). Lastly, very few of our trainees had experienced CSCL before and they therefore needed to try it out first hand to become aware of the pros and cons of its use in education.

While the first version of the course, held in 2001, was entirely face-to-face, with lessons alternated with laboratory activities, from the second year the course included a distance learning component based on a socio-constructivist approach and therefore it relied heavily on task-based group

work. The distance learning component gained importance with time: in the second year it was an optional three-week online module; in the third and fourth years it was a ten-week online course that students could choose as an alternative to the face-to-face one; in the last two years there was no option but a blended course. The blended scheme chosen for the final versions of the course entailed, for the first time in the course history, that all students had to take part in online activities.

Distance communication among participants - students, tutors and experts - took place within a special configuration of the Centrinity First Class[®] CMC environment. Interactions were mostly asynchronous, though synchronous communication in the form of chat was occasionally used.

The Cognitive Dimension: Learning Objectives, Contents and Learning Styles

Instructional design techniques suggest that decisions concerning the learning objectives of a course, in an academic context, should derive from the learning needs and take into consideration both the features of the target population (size, age, motivation, prerequisites, etc.) and the requirements and constraints imposed by the context in which the training is to take place (times and settings, tools and resources available, etc.).

The nature of the subject matter also influences the design of the course. Educational Technology, in fact, is a wide and complex domain, hard to cover in short courses like the one in question. According to Issroff and Scanlon (2002), it includes a set of pedagogical and methodological skills needed for a competent use of the various strategies, techniques and media in teaching. It was therefore necessary to provide a general idea of the field and its contents, but also to identify some infeasible concepts to be dealt with in greater detail than others, posing the basis for subsequent autonomous learning.

When learners are adults, or graduates as in the case of our trainee teachers, it is desirable that they have a say in the overall objectives of the courses they take, even if their lack of competence in the domain might limit their ability to do so. In our case, to find a good balance between the institutional aims of the course and the students' expectations, interests and desires, we found it very useful to:

- Provide students with a course guide, sent by e-mail a few weeks before the beginning of the course and containing information about the course (its objectives, structure, contents, method and the assessment criteria). This helps students to plan their learning and arrange the environment;
- Monitor students' expectations towards the course and their previous knowledge/experience in the field of Educational Technology year by year, by using ad hoc questionnaires and informal interviews. This also helps students to become aware of their expectations, recollect ideas about previous learning experiences, and activate prior content knowledge;
- Devote some time, at the beginning of the course, to discuss these expectations and competences and negotiate the course objectives and approach with the students;
- Offer the trainees a number of options as to sub-objectives and topics to be dealt with, and differentiate the activities proposed (e.g., individual vs. group work; compulsory vs. optional; based on discussion and knowledge building vs. based on tasks; etc.), so as to give them the chance to identify those that best match their personal goals within the course general aims;
- Provide different ways to achieve similar or alternative learning objectives, so that learners can choose the learning strategies according to their favourite learning styles.

Nevertheless, some types of choices should not be left to the students at the beginning of the course but postponed to a later phase.

First of all, high level choices concerning learning objectives and contents require some competence on the subject, so they can only be made by people with previous knowledge of the domain. This does not mean that the students will never be able to make them but rather that they need to be gradually guided towards this aim. To this end, students can be supported through tools such as advance organisers in fully fledged online courses (McManus, 2000) or face-to-face sessions in blended courses. The role of these tools is to provide an overall picture of the content so that students can make informed choices as to what and how they would like to learn in more detail. This is particularly helpful when there is not enough time for the lecturer to completely cover a subject and the domain is a rapidly changing one. In the online versions of our course, the overall theoretical introduction was taken care of through readings and discussions moderated by competent tutors. In the blended versions, the face-to-face lectures provided the general picture of the topics covered in the online modules, while these served the purpose of carrying out in-depth analysis of one or more examples.

Secondly, choices regarding learning strategies, methods and tools require awareness of one's own favourite learning styles and of the pros and cons of each option. Among our trainee teachers, this awareness is unlikely to be well developed, at least in connection with technology use. However, since Educational Technology is the topic of the course, the ability to make informed choices in this respect is also one of the aims of the course. In particular, among the various possible methods, we wished them to appreciate the pros and cons of online collaboration. This is why we concluded that all our students should try online learning at least once, and specifically CSCL.

The Teaching Dimension: Course Structure, Social Structures, Tutors' Roles, Learning Evaluation

While deciding the activities to be carried out online, many decisions about the course structure, the social structures, the tutors' roles and the evaluation criteria must be taken, being aware of their reciprocal influences.

The balance between the institutional aims of the course, its method and the students' expectations, interests and desires can be achieved by giving the course a modular and flexible structure, where different modules pursue different objectives and students can choose which topics to investigate, with what methods, as well as how deeply they want to investigate them. While this is hardly feasible face-to-face, especially with a large audience, it can be done online, by proposing open learning tasks (i.e., tasks that can be further specified by the students themselves) and by splitting the whole cohort of students into small groups, working under the guidance of experienced tutors.

In our course, for three years, even the choice between the online and the face-to-face mode was left to the students. However, there are drawbacks concerning the management of such options. On the one hand, the more freedom of choice the students have, the more the design and the tutors should be flexible and considering the investment required to design learning activities, especially online, it is desirable to limit the effects of these fluctuations. On the other hand, the students' choices are not necessarily the best ones from the point of view of the learning outcomes (e.g., extrinsic motivation can prevail over intrinsic motivation, and the easiest option is likely to be chosen instead of one that is perhaps more promising but more demanding).

In addition, the balance between choice and imposition changed in time, during each course. The initial activities were, in fact, carefully planned and pre-defined: start date, end date, who does what, by when, with whom, were decisions taken

by the course designers. As the course progressed, though, more freedom was granted and the activity structure was more flexible. The learning materials changed too: during the scaffolding activities tutors provided students with analytical grids and detailed worksheets, aiming to show a possible way to accomplish tasks, as the course progressed, however, they granted learners more and more responsibility, letting them decide how to organize their documents and what to produce in the reification phase.

Since our students had to learn how to handle group dynamics and to experiment their future teaching role, they were encouraged to practice different roles, and in particular to act as moderators and facilitators of online activities. This was achieved through role-play techniques where students were invited to take up various types of pro-active roles in a group, such as strongly characterised teachers (e.g., the technology enthusiast, the technology detractor, the bureaucrat, etc.) while discussing strengths and weaknesses of an online resource. Previous research seems to support the hypothesis that role playing fosters SRL fairly well, compared to other strategies (Dettori, Giannetti & Persico, 2005). However, it was felt that facilitation roles should be first modelled by the tutors before asking students to do the same.

Designing the teaching dimension also entails decisions aiming to define the social structure of the community, including the size and composition of groups as well as their reciprocal interactions. In order to obtain a lively exchange, heterogeneous groups of seven/eight people were established and different learning strategies were adopted in each module. Among these, an alternation of individual and group work was aimed to consolidate and assess specific topics dealt with during face-to-face sessions or covered in educational materials; dialogical, argumentative and peer review strategies were adopted to carry out critical analysis of different learning resources; the collaborative production of artefacts within the framework of the role-play activity was chosen

to achieve thorough understanding of different technology enhanced learning methods.

Most of these decisions were taken during the instructional design of the course, while others were left to the tutors. These were choices that had to be taken on the basis of the information that tutors constantly receive from the monitoring process. Examples of these decisions are those depending on the tutors' sensibility to the students' emotional and cognitive status. The consequence is a need for close orchestration between the work of the instructional designers and the tutors: a lack of understanding of the course design principles by the tutors might, in fact, endanger the whole design effort. It is no coincidence that in our courses the tutors often took part in the design of the course. In this way, not only did we take advantage of their invaluable contribution to the course set up, but we also made sure they really shared its design principles.

Finally, methods and criteria for learning evaluation should be mentioned. The central issue pertains the need to harmonize the socio-constructivist approach with the requirement of a summative evaluation of learning which is peculiar to the academic context. In the solution adopted for our courses the final summative evaluation took into consideration both qualitative and quantitative elements related to participation to each online activity (Anderson 2004a; Benigno & Trentin 2000). The criteria informing learning assessment were made clear from the beginning of the course. Although this point is a general principle in education, it is particularly important in online collaborative learning. Usually the quality and regularity of participation in the collaborative activities is assessed by the online tutors and informs the final assessment, together with the calibre of the products of the working groups. In our course, this type of assessment, based on the individual contribution to the group work process (MacDonald, 2003) was combined with a more traditional type of assessment, based on the production of an essay or an oral exam.

To some extent, we let students choose on what basis they wanted to be evaluated, hoping that this assumption of responsibility further fostered SRL. Forms of self-evaluation were encouraged as factors belonging to the meta-cognitive dimension but were not taken into account for summative evaluation.

The Social Dimension: Emotional and Motivational Factors

The social dimension "relates to the establishment of a supportive environment such that students feel the necessary degree of comfort and safety to express their ideas in a collaborative context" (Anderson, 2004b, p. 274). To reach this purpose, special attention was given, especially at the beginning of the course, to familiarization and socialization activities, considering them as crucial components, able (a) to increase the sense of togetherness among participants and, consequently, to increase the quality of learning and the achievement of instructional objectives (Rovai & Jordan, 2004; Aspden & Helm, 2004); (b) to establish a suitable social climate; and (c) to develop the emotional and motivational aspects of SRL (Delfino, Dettori & Persico, 2008). Although much of the responsibility concerning the regulation of social dynamics is entrusted to the tutors' sensibility, the importance of keeping in mind the social aspects when designing online courses should not be underestimated (Anderson & Elloumi, 2004).

The measures taken to foster social presence were deemed particularly important due to the high number of participants and to the fact that only some of the participants had met before the course. In particular, the sense of belonging developed in the blended versions of the course seemed stronger than in the online versions, perhaps because face-to-face meetings allowed its strengthening by acting on participants' identity, recognisability and participation. This was achieved, for example, by allowing identification of colleagues through

the use of badges, by inviting students to sit in the classroom according to areas corresponding to the online workgroups, etc.

The online activities usually started with some ice-breaking playful tasks, aimed at encouraging students to socialise or at least communicate with colleagues in order to get used to the environment and to familiarize with the basic rules of CMC. Furthermore, they were provided with a common Café area devoted to non-course related discussion. Sometimes, students used this area to talk freely about the course and its components.

An interesting way to encourage socialisation and expression of emotions is the use of metaphoric expressions and figurative language, as a stimulus to manifest and share the emotions involved in any new learning experience. A study based on transcript analysis (Delfino & Manca, 2007) revealed that many of our students made spontaneous use of metaphoric expressions to disclose their feelings and support peers in the emotional control of the learning experience. For this reason, the following years we decided to exploit the potential of metaphors more systematically by adopting an explicit spatial metaphor as a way to foster the students' sense of belonging to a community, to provide a framework for role assignment, identity, and responsibility and as an encouragement to manifest and share emotions (de Simone, Lou & Schmid, 2001). The activity proposed was based on the metaphor of navigation. Participants were invited to choose the kind of boat they wanted to use for their metaphorical voyage (the course), to say why they had chosen that particular kind of boat and their feelings and their expectations about the trip. Afterwards, each group of sailors had three weeks to negotiate and decide on a name for their boat, a motto and a symbol, thus practicing in a simple way methods of online collaboration. In the conclusive activity, they were required to say if they had changed their mind about the original choice, if they wanted to join another boat and another crew, and why.

The Meta-Cognitive Dimension: Reflective Practice

The meta-cognitive dimension deserves special attention when SRL is one of the training objectives (Dettori & Forcheri, 2004; Paris & Winograd, 2001). In particular, in our course, it was regarded as an essential element and therefore made explicit in the design principles because the course was addressed to trainee teachers, and the very nature of their future work requires the acquisition of critical thinking skills in the field of education through in-depth analysis and reflection on learning processes (Parsons & Stephenson, 2005), including their own.

The meta-cognitive component of the course consisted of critical discussions on the approach adopted in the course, on its contents, on the students' expectations, on the relevance of Educational Technology within their training. Furthermore, the fact that for the majority of our trainees (about 90% per year) this was the first exposure to CMC in formal learning activities made it advisable to focus on the peculiarities of this type of learning process.

In parallel with the contents-related main stream tasks, another activity was devoted to the analysis of "what" and "how" participants were learning. Since they were generally free to choose the topics of conversation, some of them gave their feedback on the course method, others focused on the concept of online social presence, yet others gave their opinion on the development of pragmatic and rhetorical skills.

The conclusive phase of the meta-cognitive reflection process took place during the final part of the course and was aimed at reflecting on acquired skills, difficulties, satisfaction or dissatisfaction as to expectations and commitments for the future.

The importance given to the discussion within the group and to the collaborative approach is the consequence of the belief that the teaching skills to be developed within the course are complex,

demanding, and may be best acquired through experience and reflection on it. The tutors, recruited from researchers in the field of Educational Technology and in-service teachers, proposed discussion topics based on authentic or realistic learning situations (van Weert & Pilot, 2003). For example, regarding topics such as instructional design, trainee teachers need to become aware that there is not one right-or-wrong choice since each decision is characterized by pros and cons that a good teacher should be able to detect and evaluate. To this purpose, both self-evaluation and peer interaction are more effective than listening to or reading the expert's opinion, whose point of view is too often assumed as correct.

At the meta-cognitive level, even if face-to-face sessions can be very useful (especially to solve latent conflicts or uncertainties about the method), online discussion is often even more effective, possibly because so many participants, overcoming the distance in space and time, could reflect on and react to each others' postings. The storage of postings in the form of a threaded discussion developed over time, also provided a useful support for reflection (Åhlberg, Kaasinen, Kaivola & Houtsonen, 2001; Thomas, 2002; Macdonald & Twining, 2002; Meyer, 2003). It was mostly through these meta-cognitive activities that participants become aware of what SRL is, how it can be promoted and what its relationships with the use of Educational Technology and constructivist learning theories are.

LESSONS LEARNT

The experience gained throughout the six years of this course, has provided us with a better insight, though not with clear-cut solutions, concerning teacher training in Educational Technology and the way it can be brought to enhance trainees' SRL competences.

We started from the assumption of the importance of first hand experience and reflective practice, in both areas. In addition, we realised that creating and managing a positive social environment in the learning community is a necessary condition for any learning to occur. There is no learning for pupils without an adequate process of socialization behind it, both with the teacher and among themselves. The same applies when collaborative technologies are introduced, and teachers must be prepared for that. A theoretical understanding of pros and cons of given educational software is not enough for teachers to feel at ease in using it in the classroom, they must also know what happens to someone to whom such an activity is proposed.

The changes made to the course aimed to offer flexibility and freedom without making the course too hard to run. Trainee teachers were given the opportunity to focus on the importance of social relations, on meta-reflection; to emphasize the chance to express feelings, moods, states of mind towards the learning processes; to play different roles within a community of learners; to reflect on the potential of language in social interactions, to learn how to self-regulate in order to promote effective self-regulation processes. While the course was in progress, we found that informal interaction among participants (e.g., that occurring in the Café area) via the online platform was as important as the formal learning activities. They were learning something meaningful even (and perhaps especially) when they were not working on a given assignment, but rather making use of the online platform for personal communications of various nature. In the context of a post-graduate training programme for teachers, some of their postings could be considered quite weird or out of place. However, they were not, because ultimately what participants were doing was just experimenting the potentialities of a Web-based collaborative environment, and that was among the objectives of the online course.

CONCLUSION

Technology is changing the way we work and the way we learn. In particular, at the same time NL requires us to become more autonomous in learning and more open to collaboration with peers. These two needs may appear to be contradictory, but they are not. More autonomy is needed because learning on the Web entails personal commitment, personalised goal-setting, ability to manage time and resources, successfully handle emotions and motivation, constructively deal with failures and self-assess achievements while facing information problem solving tasks. Better abilities to collaborate are needed because professional life is increasingly based on communities of practice, virtual or face-to-face, and teachers professional lives are perhaps even more dependent on this way of learning than others. In many countries, the problems teachers face in their work include isolation, lack of preparation to work with colleagues - especially those with different backgrounds, difficulties in dealing with students with different needs and learning styles, and last but not least, insufficient time, competence and disposition to use ICT effectively in their profession.

The educational polices of many countries are, at least in principle, already directing schools and individual teachers to a way of teaching that is more relevant to the outside world, but in many cases this is not enough. Filling the gap from theory to praxis is the difficult part, and teachers should not be left alone in doing it. Actually, in many cases good policy indications are interpreted by the establishment and translated into rigid rules, which are passively, and often reluctantly applied by teachers who do not share their final aim and their real sense.

Teacher training programmes should therefore become a priority and should generally invest a lot in SRL development of trainees, in particular when pedagogical and technological aspects are concerned. These objectives should of course go hand in hand with polices concerning teachers'

enrolment, investments in their preparation and support building among parents, legislators and institutions. The organisation of work in schools should favour, and not hinder, the achievement of these objectives, providing time, space and resources that can be used freely to these ends. If it is true that teaching is a hard job - but very crucial for any society, then consensus should be built around its role and recognition for it should be granted in all senses.

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KEY TERMS AND DEFINITIONS

Computer-Mediated Communication: Communication process between humans through ICT.

Community of Inquiry: Virtual community for inquiry learning.

Educational Technology: Theory and practice of systematic design of learning processes and resources.

Instructional Design: Systematic approach to the design of learning processes and environments.

Networked Learning: Learning on the Web and with the Web.

Self-Regulated Learning: Learning process controlled by the learner from the cognitive, meta-cognitive, emotional and motivational points of view.

Teacher Training: Process aimed at making teachers more competent for their work.

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Chapter 2.12

Individualized Web-Based Instructional Design

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ABSTRACT

Adaptive (individualized) Web-based instruction provides mechanisms to individualize instruction for learners based on their individual needs. This chapter will discuss adaptive Web-based instruction, paying particular attention to (1) the implications of individual differences to Web-based instruction, (2) the adaptive methods that are available to designers and developers, and (3) the considerations for instruction design and development with adaptive Web-based instruction. The primary purpose of this chapter is to provide a framework to shape the development of future individualized Web-based instruction.

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INTRODUCTION: STRATEGIES AND GUIDELINES FOR INSTRUCTIONAL DESIGNERS

Web-based learning environments have unlimited opportunities for educational uses, but there are numerous implementation challenges. Significantly, Web-based learning systems' content presentations, navigational methods, and instructional strategies may not be suited to all users (Brusilovsky, 1998; Song, 2002). Most Web-based instruction provides what the designers/developers consider to be the optimal interface and content presentation, expecting learners to fit into the system (Brusilovsky, 2001; Chen, Czerwinski, & Macredie, 2000; McLoughlin, 1999). Since Web-based learners typically work

alone and asynchronously, instructors/trainers are unable to provide the just-in-time modifications afforded in face-to-face sessions. If the user is not comfortable with the Web-based learning system, many instructional advantages can be lost (Metros & Hedberg, 2002; Oliver & Herrington, 1995).

While many challenges affect all learners, there is also a need for physically and visually challenged students to be appropriately accommodated and successfully integrated into the learning environment. Web-based instructional applications often neglect impaired learners. Through the use of assistive and adaptive technologies, impaired students could leave their isolation and become an important part of the learning community (Cavanaugh, 2002; Fink, Kobsa, & Nill, 1998). To overcome these barriers, an online learning system should be designed such that each individual's needs are identified, and appropriate guidance and support are provided during the learning process (De Bra, Brusilovsky, & Houben, 1999; Papanikolaou & Grigoriadou, 2004; Triantafillou, Pomportsis, & Demetriadis, 2003).

ADAPTIVE WEB-BASED INSTRUCTION AND INDIVIDUAL CHARACTERISTICS

Adaptive instruction means creating a learning environment and finding instructional approaches and techniques that conform to meet students' individual needs (Park & Lee, 2003). Adaptive Web-based learning environments (A-WBLEs) are one form of adaptive instruction that tailor individual differences in the online environment (Inan & Grant, 2004, 2005). In A-WBLEs, the fundamental focus is the individual differences of learners, because individual differences such as gender, prior knowledge, and learning styles have demonstrated significant effects on student learning (e.g., Chen & Paul, 2003). To provide a guiding framework, A-WBLEs (1) gather a learner's information and preferences, (2) build

an individual model based on the learner's preferences and knowledge, (3) apply adaptive methods to accommodate the learner based on the developed model, and (4) monitor the learner's actions and learning processes to provide new information to update the learner's model, granting a more effective and efficient system (Inan & Grant, 2004).

Although researchers agree on the influential effects of individual differences during learning, the question remains as to which variables should be considered when designing an A-WBLE. Many researchers consider learning style and cognitive style to be important characteristics to take into consideration when developing adaptive web-based instruction (Gilbert & Han, 1999; Magoulas, Chen, & Dimakopoulos, 2004; Papanikolaou, Grigoriadou, Kornilakis, & Magoulas, 2003). Brickell (1993) suggested the more enriched learning experiences occurred when the materials developed considered students' learning styles. Furthermore, Triantafillou et al. (2003) reported the majority of students were satisfied with the adaptations of learning strategies in relationship to their cognitive styles.

Another trait, students' prior knowledge and experiences, is also popular in designing adaptive systems (Brusilovsky, 2003; Foster & Lin, 2003; Weber & Brusilovsky, 2001). Students' prior knowledge contains their previous understanding of the content area and level of readiness for learning new content. Many studies have considered prior knowledge in Web-based instruction (e.g., Chen & Paul, 2003; Milne, Cook, Shiu, & McFadyen, 1997). Foster and Lin (2003) found students' acquisition of knowledge and skills were not just related to the presentation of the instructional tasks, but their prior knowledge and cultural background also played an important role. Similarly, Far and Hashimoto (2000) found a student's background knowledge and motivational state had a strong influence on learning outcomes. Moreover, prior technical knowledge may have an effect as well. Learners have different degrees of familiarity with Web browsers and communication tools,

which can affect their learning in an online setting (Magoulas, Papanikolaou, & Grigoriadou, 2003; Muir, 2001).

Additionally, a number of other variables have been considered in the design, development and implementation processes of adaptive Web-based instruction. These have included type of discipline (Chen & Paul, 2003), goals (Brusilovsky, 1998; Magoulas et al., 2003), affective and belief states (Hudlicka & McNeese, 2002), motivations (Far & Hashimoto, 2000), attitudes (Fink, Kobsa, & Nill, 1996), multiple intelligences (Kelly & Tangney, 2004), information seeking preferences (Stelmaszewska, Blandford, & Buchanan, 2005), media preferences (Carro, 2002; Danielson, 1997), language (Carro, 2002), gender (Milne et al., 1997), and disabilities (Fink et al., 1996, 1998).

ADAPTIVE METHODS

As suggested previously adaptive methods are techniques, treatments, and strategies used to make adjustments and variations in various components of Web-based instructional systems to accommodate individual needs and preferences that are stored in a student model. There

are several common adaptive technologies (i.e., adaptive interface, content and navigation) used by adaptive instructional systems, but all adaptation technologies are adopted from intelligent tutoring systems and adaptive hypermedia (Brusilovsky, 1996, 1998). Unfortunately, these methods limit adaptations to the Web-based environment, rather than instructional aspects (Carro, 2002). Inan and Grant (2004) proposed a broad range of adaptive technologies to improve the educational facets of adaptive Web-based instruction. Table 1 provides a summary of adaptive technologies with their educational implications.

Adaptive Content

Adaptive content is changing the contents of the Web page to a learner's goals, prior knowledge, and other personal information stored in the adaptive system (Brusilovsky, 1998, 2001). The contents of the page can be modified to better suit the needs of the learners based on diagnostic assessment of the individual (De Bra, 2000; Fletcher, 1992). There are many ways the same data can be presented to the learner. For example, the amount of the content (e.g., condensed, summarized, extended) or format of the content (e.g., audio, video, text)

Table 1. Summary of adaptive methods

Methods	Description
Adaptive content	Adjusting the organization, format, or amount of content
Adaptive sequencing	Ordering content in the most suitable way
Adaptive navigation and orientation	Changing the appearance and structure of navigations, for example, direct guidance, link annotation, or hiding links
Adaptive support and feedback	Providing intelligent help and feedback during the learning process regarding student actions
Adaptive learning activities	Providing a different instructional treatment for each user
Adaptive interaction	Adjusting interactions with content, learners, instructor, and interface to increase learner engagement
Adaptive assessment and grading	Applying different types of assessment procedures and grading options
Adaptive collaboration	Using system knowledge about different users to form collaboration groups
Adaptive interface	Changing the visual interface of the pages according to individual preferences
Adaptive social context	To maintain interest or user appeal by providing an adjusted social context
Adaptive learner control	Giving options to each individual to decide the system adaptation level

can be adjusted. Adaptation of content depends on several variables such as age, prior knowledge, study discipline, and learning styles. For example, a system could provide supplementary information if the student does not possess specific knowledge or interest. Comparative explanations may be presented to students who want to gain a different perspective (De Bra et al., 1999).

Adaptive Sequencing

Adaptive sequencing is ordering content effectively to provide a learner with the most suitable way to acquire knowledge or skills (Brusilovsky, 2003). Sequencing can be at a high level, that is, determining the order of topics or content to be presented, or at a low level, such as determining the order of learning tasks with examples and problems (Fletcher, 1992). Adaptive sequencing of the content can be arranged according to instructional strategies, a student's goals and preferences, or a student's observed actions and performances. Sequence of the content is mostly affected by the student's prior knowledge and nature of the content (Morrison, Ross, & Kemp, 2004; Wiley, 2001). For example, based on prior knowledge, rules or algorithms may be followed by examples (rule/e.g.) or the reverse (e.g./rule).

Adaptive Navigation and Orientation

Adaptive navigation supports the learner in cyberspace with orientation and navigation by changing the appearance of visible links (Brusilovsky, 1999). Adaptive orientation helps students to locate their current position and how to move to the next or previous position (Oliver & Herrington, 1995). Users with different knowledge levels of the content may appreciate different adaptive navigational support (Brickell, 1993; Weber & Brusilovsky, 2001). Navigational methods with restrictive approaches like direct guidance or hiding links are appropriate for learners with novice

knowledge or no knowledge of a subject. However, the most appropriate approaches for learners with reasonable knowledge are rich associative linking technologies, such as multiple link generations and link annotations to extend learner's options (Brusilovsky, 2003). Options such as site mapping menus, bread-crumb menu details, graphic organizers, and system feedback help to orient the learner within the learning environment, as well as guide the learner in negotiating the learning environment.

Adaptive Support and Feedback

Adaptive support is providing intelligent help during the learning process and giving extensive and creative feedback regarding the learner's actions and answers to questions (Brusilovsky, 2003). Pedagogical agents and intelligent feedback systems within instruction, as well as error recovery within the learning environment, can coach the learner. Although feedback can play an important role in a student's learning and attitudes, providing the same level and type of feedback to each student may not be as effective as adjusting help according to their individual needs. Some learners need to be encouraged or directed; some may only need approval to continue. Some students may perform better when their self-confidence increases. For example, to increase less confident and less motivated students, the system can provide simple and similar tasks that are likely to be solved correctly. When this type of student makes a mistake, instead of providing the correct answer, informative feedback or retry opportunities may be appropriate (Far & Hashimoto, 2000).

Adaptive Learning Activities

Adaptive learning activities include providing different instructional and motivational strategies to support learners and increase engagement in the learning process (Inan & Grant, 2004). In-

Instructional strategies are often selected based on content characteristics, available resources, and class size (Reigeluth & Curtis, 1987). Therefore, one instructional strategy may facilitate learning for one student but may inhibit learning for another (Jonassen & Grabowski, 1993; Triantafyllou, Pomportsis, Demetriadis, & Georgiadou, 2004). For example, several studies on cognitive style indicated that field dependent students learn better with group-based or collaborative learning activities, whereas field-independent learners do better with individualized learning activities (Chen, 2002; Liu & Reed, 1994). Similarly, the need for motivational strategies changes according to individuals. For example, allowing each learner to select and work on projects or tasks relevant to his/her expertise and interest can increase motivation and engagement to the learning process. On the other hand, if motivational strategies are not personalized and chosen carefully, these can even de-motivate learners (Song & Keller, 2001).

Adaptive Assessment

Adaptive formative and summative assessments provide learners with exposure to different types of learning tasks and problems in addition to targeting weaker skills. Furthermore, different assignment types can be applied to different users, such as individual assignments and group assignments (Muir, 2001). The type of testing can be adapted because some students are successful with objective testing. However, only providing objective test items does not ensure these students can express themselves with more open-ended assignments. Other attributes of testing, such as order and difficulty level of items, can also be adjusted (Weber & Brusilovsky, 2001). Traditional adaptive testing is applied in several familiar tests such as the GRE and TOEFL: If a student answers a question correctly, his score increases and receives a slightly harder question, whereas his score will decrease and receive a slightly

easier question next when he answers a question incorrectly (Schaeffer et al., 1998).

Adaptive Collaboration

Group-based or cooperative learning activities are appealing among educators due to their well-established benefits. Basically, these activities help students to create, learn, construct, and develop knowledge, attitudes, and values through interaction with others while developing interpersonal skills (Butzin, 2001; Hancock, 2004; Jonassen, 1995; Roschelle, Pea, Hoadley, Gordin, & Means, 2000). However, one of the challenges of collaborative learning is building the groups meaningfully. Adaptive collaboration can help instructors during generation of groups by making use of the system knowledge about students (Brusilovsky, 1999). This allows forming better matching groups where students have better chances to learn from each other. Other challenges to collaborative learning, such as group decision making (Socha & Socha, 1994) and group formations (Tuckman, 1965), still must be integrated within the instruction.

Adaptive Interface

Adaptive interface is changing the visual interface of the pages according to the individual's preferences (e.g., color, font style, font size, and scrolling) (Inan & Grant, 2004). The appearance of the text and images on the computer screen influences readability (Metros & Hedberg, 2002; Smaldino, Russell, Heinich, & Molenda, 2005). There are many ways in which the same data can be presented to the learner. A variation in information presentation includes items such as layout, organization, structure, appearance, and format (Magoulas et al., 2004; Oliver & Herrington, 1995). Furthermore, adaptive interfaces could be useful for exceptional learners, such as visually impaired students who may need magnification

of the text size or English language learners who may need translations into native languages. Technologies, such as cascading style sheets (CSS) and content management systems, allow for variations in control of Web page structures and content display. So, these may offer easier methods for development with multiple audiences.

Adaptive Interaction

Adaptive interaction is adjusting the type of interaction that is more suitable to the learner's model. Interactions can include: (1) learner-content, (2) learner-learner, (3) learner-instructor, and (4) learner-interface (Hillman, Willis, & Gunawardena, 1994; Moore & Kearsley, 1996). All types of interactions are critical in online learning (Shortridge, 2001), but each individual can have his/her own interaction preferences (Sabry & Baldwin, 2003). Sabry and Baldwin (2003) observed variation between learning styles and types of interaction used in the Web-based instruction. Furthermore, variations were revealed between communication preferences and the gender of students. Bostock and Lizhi (2005) reported females wrote more messages than males in discussion boards, showing more connected communication patterns and a concern for a greater sense of community (Rovai, 2001). Another serious concern involves non-traditional students. By examining use of a discussion board, Jun and Park (2003) indicated international students far less frequently initiated discussions or posted messages compared to American students.

Adaptive Social Context

Like adaptive interactions, adaptive social context can provide options for reducing transactional distance (Moore, 1993) and isolation within Web-based learning environments. A learning environment's convenience and climate helps students in developing a positive attitude toward the system

(Inan, Yildirim, & Kiraz, 2004; King, 2002). Therefore, besides providing content and information, some social activities could be provided according to user preferences. For example, some students enjoy publishing a personal home page. The Web-based learning environments can create a home page or blog space for each learner and allow them to enable or disable publishing or modifying their pages. In combination with adaptive social context, the system may also suggest study groups.

Adaptive Learner Control

One of the most appreciated features of Web-based instruction is its non-linear structure, where learners select content and move around by their own decisions and control (Chen & Paul, 2003; Federico, 1999; Khan, 1997). However, previous studies indicated that some learners may have problems taking control of their learning in an open learning environment (Chen, 2002; Song, 2002; Weber & Brusilovsky, 2001). For example, Ford and Chen (2000) indicated field dependent learners are more comfortable with the system having control, whereas field independent learners prefer to have control over the system. Similarly, McManus (2000) revealed that highly self-regulating learners perform poorly in most linear Web-based learning environments, where limited choices were available. These findings suggest that some learners might be able to decide which adaptive methods and level of adaptation is appropriate for their learning. Therefore, the level of control could be shared among the learner, instructor/trainer, and the system (Papanikolaou et al., 2003; Tsandilas & Schraefel, 2004). Adaptive learner control offers learners and instructors/trainers opportunities to individually or cooperatively decide the level of system adaptation (Inan & Grant, 2004).

INSTRUCTIONAL DESIGN CONSIDERATIONS FOR INDIVIDUALIZED WEB- BASED INSTRUCTION

When designing and developing individualized Web-based instruction, instructional design and development must consider two implementations:

1. The development of new adaptive systems
2. The updating or retrofitting of existing systems; each of these are discussed next.

Development of New Adaptive Systems

Following systematic guidelines or models throughout instructional systems development makes the system more reliable and effective (Briggs, Gustafson, & Tillman, 1991; Gustafson & Branch, 1997; Zheng & Smaldino, 2003). There are numerous instructional design models (e.g., Dick, Carey, & Carey, 2005; Morrison et al., 2004; Smith & Ragan, 2005). Although these models have been developed for different purposes, serve different populations, and describe different steps to achieve instructional products, they all include five core elements: (1) analysis, (2) design, (3) development, (4) implementation, and (5) evaluation (ADDIE).

Unquestionably, designing an adaptive instruction requires following an established model or process. We believe that the ADDIE framework can provide guidelines for development of adaptive Web-based instruction with revising and supplementing necessary steps. The central change in the framework is moving its focus from developing and providing a high quality instruction that “fits all learners” to one that “fits each learner.”

In addition to typical ADDIE processes, the *analysis phase* should include a collection of students’ individual characteristics, which would include elements of typical learning analysis but

may include more specifics, such as assessment scores, communication preferences, and collaboration skills (Aroyo, Bra, Houben, & Vdovjak, 2004; Brusilovsky, 2001; Foster & Lin, 2003; Gilbert & Han, 1999). The *design phase* now adds specifying adaptive methods, assigning roles to students and teachers, plus matching adaptive and instructional strategies to learner characteristics (Inan & Grant, 2005; Triantafillou et al., 2004). The *development process* incorporates generating a user model, content structure and prototypes of the adaptive system (De Bra, 1999; Magoulas et al., 2003; Papanikolaou et al., 2003). *Implementation processes* must include application of the system in the real environment, where instruction is adjusted to meet learner needs (Magoulas et al., 2003; Papanikolaou et al., 2003). Finally, *evaluation* brings in assessment of student learning, observations of student actions, formative evaluation of the system before it is completed, summative assessment of the system efficiency, and updates to the student model (Federico, 1999; Lee, 2001; Triantafillou et al., 2004; Weibelzahl, 2005). Table 2 summarizes the ADDIE framework for the development of A-WBLEs.

Updating or Retrofitting Existing Systems

The second type of implementation is updating or retrofitting an existing system. Today, almost all universities have one of the common course management systems. Similarly, corporate Web-based training has been dominated by learning management systems and learning content management systems. It would be overly optimistic to suggest that these non-adaptive systems will be replaced with adaptive ones soon. Therefore, if there is an opportunity to use an adaptive approach within these systems, there is a need to determine how to integrate adaptive functions with the existing systems. Two methods for integrating an existing system are described below.

Table 2. ADDIE framework for development of A-WBLEs (Note: ADDIE = analysis, design, development, implementation, and evaluation)

ADDIE Components	Strategies for adaptive system development
Analysis	Gathering: Collecting students' prior preferences, knowledge, skills, and attitudes, which are important factors in student learning in a Web-based learning environment
Design	Inference: Inferring and predicting what these collected data tell about student and parameters Matching: Specifying adaptive methods, assigning roles to students and teachers, matching adaptive and instructional strategies to learner characteristics
Development	Building: Generating a user model, content structure, and prototypes of the adaptive system
Implementation	Accommodation: Making adjustment on the system based on collected and inferred data Updating: Altering student model continuously according to collected and monitored data throughout the learning process
Evaluation	Monitoring: Observing student sequence, interaction, errors, pace Assessment: Formative and summative evaluation of system efficiency and student learning

- Patching adaptive functions:** Through a patching method, a new module with adaptive functions can be developed and linked to the old system by managing the systems on different Web servers (Richard & Tchounikine, 2004). This approach helps developers to maintain the existing course/learning management system functions, while incorporating new adaptive functions. This process may augment the existing instruction, but integrating two different Web-based systems under one interface may be too difficult or too costly.

One of the rare examples of this approach, experimental learning management system's (eLMS), Building Block aimed to interoperate with commonly available course management systems, developed by the VaNTH ERC project of Vanderbilt University and collaborating universities (Howard, Remenyi, Pap, & Garay, n.d.). Currently, the Building Block for Blackboard was developed to provide an interface that allows Blackboard users to access services provided by the A-WBLE (Howard, 2006)

- Implementation modification:** The other model for updating or retrofitting existing

systems—implementation modification—can be done by using the existing system's functions in a novel manner or by utilizing some functions and features of the system for a particular group of students to accommodate individual differences. For example, WebCT's selective release function allows instructors to modify instructional components based on student test scores and/or other student characteristics. Additionally, other popular encapsulated instructional modules, such as Macromedia Flash movies and Camtasia simulations, can build in adaptive methods for learners. But these modules require sophisticated programming to connect with the course/learning management system to report and update the student model.

CONCLUSION

The Web has become a widely available and used platform for educational purposes. Adaptive (individualized) Web-based instruction can provide a mechanism to understand each individual's learning styles, preferences, prior knowledge, and learning goals and provide different treatments for each learner based on their individual

needs (Brusilovsky, 2001; Inan & Grant, 2004). If implemented correctly, an adaptive Web-based instruction can improve student performance, as well as decrease learning time and usability problems (Gilbert & Han, 1999; Papanikolaou et al., 2003; Triantafyllou et al., 2003; Tsandilas & Schraefel, 2004; Weber & Brusilovsky, 2001). So the promise of A-WBLEs is attractive.

Developing and implementing adaptive Web-based instruction is a complex process, though. In addition to development costs and time, adaptive instruction has limitations and concerns, including instructor skills preparation, ethical concerns, development and update time, as well as costs (Brusilovsky, 1996; De Bra, 2000; Federico, 1999; Karagiannidis, Sampson, & Cardinali, 2001; Magoulas et al., 2003). Moreover, many adaptive educational applications have failed to incorporate valuable learning principles and instructional strategies (Carro, 2002; Park & Lee, 2003). In order for A-WBLEs to become viable, sustainable options to university faculty and corporate trainers, these issues must be considered in light of the various adaptive methods discussed previously.

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KEY TERMS AND DEFINITIONS

Adaptive Assessment: Adaptive assessment offers different types of assessment procedures and grading options that provide learners with exposure to different types of learning tasks and problems.

Adaptive Collaboration: Adaptive collaboration means using system knowledge about different users to form collaboration groups.

Adaptive Content: Adaptive content means adjusting the organization, format, or amount of content based on learner's goals, prior knowledge, and other personal information stored in the learner model.

Adaptive Instruction: Adaptive instruction means creating a learning environment and finding instructional approaches and techniques that conform to meet students' individual needs.

Adaptive (Individualized) Web-Based Learning Environment: Adaptive Web-based learning environment provides mechanisms to individualize instruction (e.g., content, strategies, assessment) for learners based on their individual needs and preferences in the online environment.

Adaptive Interface: Adaptive interface is changing the visual interface of the Web pages according to individual preferences such as color, font style, font size, and scrolling.

Adaptive Learner Control: Adaptive learner control gives each learner the option to decide the system adaptation level and adaptive methods individually or cooperatively.

Adaptive Navigation: Adaptive navigation supports learner orientation in the online environment by changing the appearance and structure of navigations.

Adaptive Social Context: Adaptive social context means maintaining interest or user appeal by providing an adjusted social context and activities.

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Chapter 2.13

The Virtue of Paper: Drawing as a Means to Innovation in Instructional Design

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ABSTRACT

This chapter presents an argument in favor of using paper to conceive, plan, and describe instructional design projects. Such a simple medium has great capability and, as is well known, a tenacious ubiquity; our offices, practices, and lives are filled with paper. We will see how the attributes of paper help us in both social and cognitive ways, particularly as a medium for drawing.

PROLOGUE

It was a peculiarly beautiful book. Its smooth creamy paper, a little yellowed by age, was of a kind that had not been manufactured for at least

forty years past. He could guess, however, that the book was much older than that. He had seen it lying in the window of a frowsy little junk-shop in a slummy quarter of the town (just what quarter he did not now remember) and had been stricken immediately by an overwhelming desire to possess it.... Winston fitted a nib into the penholder and sucked it to get the grease off. The pen was an archaic instrument, seldom used even for signatures, and he had procured one, furtively and with some difficulty, simply because of a feeling that the beautiful creamy paper deserved to be written on with a real nib instead of being scratched with an ink-pencil. Actually he was not used to writing by hand.... He dipped the pen into the ink and then faltered for just a second. A tremor had gone through his bowels. To mark the paper was the decisive act (Orwell, 1948, p. 23).

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In this passage, Winston is about to engage the simplest, most immediate medium—pen and paper. His creative process will be unencumbered by layers of technology involving complex skill sets, which, even when mastered, place their own restrictions on their user and become to some extent autonomous. Central to this act is his own intellect, and he recognizes the danger and importance, the intent of the mark, and its ability to connect with others.

INTRODUCTION

However we use a notation system, a visible language must build on our human experiences. We choose the media and which technologies we work with, and we make those choices based on our social and cognitive practices. Winston Smith's use of paper embodies human attributes that are politically rebellious: the capacities for private notation and independent thought.

Our current challenges are not so much in the technological systems we use, but in how people conceive, develop, and disseminate ideas through media. The choice is not how to use a new technology or software to visually notate our process of instructional design, but rather how to use visual notation to innovate and improve instructional design and education. Communication, creative thought, and interaction in complex processes must be addressed by meeting the needs of the human element of design.

KNOWLEDGE WORK AND VISUAL NOTATION

The focus of our effort is instructional design, the creation of materials for and the structuring of instruction itself. For our purposes here, instructional design is the knowing use of technology for the assistance of learning, and more recently,

specifically the use of computer- and Internet-based technologies in the service of learning.

Instructional design can be described as “knowledge work” as described by Peter Drucker (1999) and others, and this description may help us understand the use of paper in the field by comparison with other professions. Knowledge work is a classification of work that involves the generation, development, and implementation of ideas. It can be described as work where the true means of production is the knowledge of the worker. Other fields engaged in knowledge work include the law, surgery, and architecture. Knowledge work is generally complex, quite often socially grounded, and involves complicated technical issues. Knowledge work often requires significant education or training, and the work is generally done in organizations and/or teams. Designing, including instructional design, is knowledge work.

Many of the activities of knowledge work are verbal and visual. They involve sharing, recording, notating, and creating ideas—most supported by some technology, the most ubiquitous being paper. There remains, as we shall see later, a continued use of paper in this electronic age. Knowledge work, particularly design, is tied to the use of paper because paper allows visual notations more easily than other media. It is faster, simpler, more immediate, and less separated (or mediated) from our thoughts.

Later in this chapter, architecture will provide a good comparison to instructional design for its use of notation systems: it has similarly complex technical issues (of building and construction); it is socially based, often practiced within a firm and with clients; and it addresses theoretical and philosophical issues in application. While architecture may result in visual form more than most instructional design, it still provides a strong analogy for an examination of design methods and tools as applied to instructional design.

The general field of design can be said to have evolved from craft when need arose to separate the work of creation from the work of production. Within design, visual notation is needed to create, direct, and communicate. “It is, above all else, the separation of designing from making and the increased importance of the drawing which characterizes the modern design process” (Lawson, 2000, p. 241). Drawing, what first developed as a means to direct others in the making of the end product, has also evolved other purposes, notably to support the imagination. The word design, of course, derives from a Latin word meaning “to mark” or draw.

Design as a profession and as a practice is methodological, purposeful, and goal oriented. It examines the entire problem, seeking a broader understanding, rather than small improvements addressing known problems, as does craft. Both craft and design seek applied solutions; the crafts person creates the result, while the designer directs others in doing so generally through visual means. Advances through craft will be incremental, i.e. minor continued improvements in efficiency or detail; advances in design work may be significant changes or substantial improvements. Currently, much instructional design is craft based, seeking detailed changes in the end product, and often building from existing models of instruction. For greater innovation and invention to occur, however, changes in the design process are necessary.

PAPER

Throughout history, visual notation systems for information recording, conveyance, and investigation have been tied to various media, most frequently paper. Since its broad production and use, paper has helped fuel the development and communication of the world’s knowledge.

Over the past twenty years, electronic communications methods and media have rapidly developed—newspapers, books, and whole librar-

ies are now accessible online, and many people work using computers, particularly in knowledge and information fields, while management, communication, and production in instructional design is done principally on computers.

THE GOAL OF THE PAPERLESS OFFICE

The computer and information revolution have significantly changed our work habits and our understanding of information. The concept of “atoms vs. bits” (Negroponte, 1999), of analog vs. digital, and advanced vs. appropriate technology all pressed us forward to embrace computer technology. Not using the latest technology in the workplace is considered laggard or Luddite. As knowledge workers, we are centered in the use of computers, and paper is *passé*. The conversion, quasi-religious, is not complete:

Yes, I’ve been to the crossroads and I’ve met the devil, and he’s sleek and confident, ever so much more “with it” than the nearest archangel. He is casual and irreverent, wears jeans and running shoes and maybe even an earring, and the pointing prong of his tail is artfully concealed. He is the sorcerer of binary order, jacking in and out of terminals, booting up, flaming, commanding vast systems and networks with an ease that steals my breath away. ... Do we know what we’re doing? Do people understand that there might be consequences, possibly dire, to our embrace of these technologies, and that the myth of the Faustian bargain has not become irrelevant just because we studied it in school? (Birkerts, 1994, p. 211)

The “paperless office” remains as a broadly held belief; however, in real life, the use of paper remains important in the workplace.

Computer technology was supposed to replace paper. But that hasn’t happened. Every country

in the Western world uses more paper today, on a per-capita basis, than it did ten years ago. The consumption of uncoated free-sheet paper, for instance—the most common kind of office paper—rose almost fifteen per cent in the United States between 1995 and 2000. (Gladwell, 2002)

If we examine our own work experience through reflection and the work habits of others through research, we can see the continuing use of paper for knowledge work and the reasons for its persistence. For example, while we use e-mail constantly, the promise of paperless communication has not been achieved. In truth, as organizations install e-mail systems, paper use increases on average by 40% (Sellen & Harper, 1997). With e-mail, we use *more* paper. Why?

WE KNOW HOW PAPER IS USED IN OUR OWN EXPERIENCES

Our own work experience can provide a base for understanding the role of paper in the knowledge workplace. We understand first hand the use, ubiquity, and commonality of paper. The management of “paper” is considered a hallmark of modern professional travail; the clutter of our homes comes significantly from paper; organizations seek to decrease the use of paper and encourage its recycling. We print documents to read and edit, guilty about our use of the world’s resources, and about our failure to fully achieve digital literacy.

In general, knowledge workers make a series of choices that take advantage of how to use media. More often than not, we make rational and understandable choices to use paper. For example, we print out e-mail to have a handy record of a communication. We write numbers, names or ideas on available pieces of paper. The grocery list is put on the back of an envelope, a phone number on a sticky note, and contact information is embellished on the back of a business card. We print out docu-

ments to read and annotate; our well-read books are marked up and personalized, the notations becoming part of the cognitive record of reading.

Some of these choices are due to the simple physical attributes of paper that are easily recognized. Paper is (among other characteristics) generally inexpensive, lightweight, light in color, translucent, durable in most situations, easy to use, easy to mark, and readily available. These physical attributes help determine for what it can be used, i.e. its capabilities or *affordances*.

Affordances, per Gibson, are those capabilities, properties, and attributes of a tool or medium that “...make possible different functions for the person perceiving or using that object” (Gibson, 1979, p. 24). We often make choices about media use by weighing various affordances, choosing media with a perceived relative advantage for our own use.

For example, we chose to write the grocery list by hand on a used envelope instead of on the laptop because it is lighter and more transportable, more easily carried to the grocery store. While it is possible to carry the laptop to the store, we quickly understand that it would be easier to use a lighter weight scrap of paper to help remember grocery items. We mentally and often unconsciously weigh these attributes when we pick up a piece of paper.

Imagine the process of writing the list on one’s laptop to illustrate an alternative choice: go to the laptop, start the laptop, start the word processing program, write the list, visit the refrigerator to check current supplies, start the printer, print the list, close the program and laptop. One could chose to carry the laptop to the grocery store in lieu of printing the list, but that would raise additional difficulties.

We often know it is much easier to use paper without going through a conscious decision making process. We use paper because it has the capabilities we need for the tasks we are performing. It does what we need it to do simply.

AFFORDANCES OF PAPER FOR KNOWLEDGE WORK/DESIGN

Within the scope of simpler tasks, we understand what works well, knowing needed skills and effort. We use what is easy and cheap, paper, the affordances of which stand well apart from our digital tools. There also are more complex or sophisticated affordances of paper that are tied to knowledge work, particularly is how we use paper as individuals and within groups to understand and think.

- **Navigation:** The tangibility, the physicality, of paper helps one navigate and understand a document. Through spatial understanding, through representation of (textual) location, and through a physical gauging of location, we understand the structure of a document. One can understand, visually and haptically, progress in reading a large document or the ease with which one could read a thin children's book. We can find summarizing arguments in many books at the end, and the initial challenge of the author at the beginning. We know the main body of the book contains supporting information in greater detail.
- **Cross referencing:** Spatial flexibility allows the easy comparison of multiple documents, cross referencing between multiple pieces of paper. Multiple documents can be arrayed on a surface and easily cross-referenced, even between paper and electronic sources.
- **Annotation:** Paper based documents can easily be annotated using textual or symbolic notation, using pen or pencil. These marks vary from structural reorganizations to textual comments to visual representations, often all within the same document and using the same marking system.

- **Manipulation:** Paper allows for the multi-dimensional display and reorganization of documents. For example, paragraph five can be physically put at the end of the report, or an image can be located for connection to the text. The manipulation of paper materials is grounded and first hand. For example, we can examine the difference between paper collage and digital collage. There are real limits to a paper collage. One must budget unique resources, and creation is tied to real constraints of paper, cutting, shaping, and gluing. This is contrasted to the weightless world of the digital creation, which is unlimited and, in the end, without gravity. The paper collage is, however, immediate, personal, and unique.
- **Placeholding:** Paper documents serve as cognitive aids to memory; they remain as left until addressed. They are a constant reminder of tasks undone.
- **Portability:** Paper is portable and can be carried to various locations untethered to one's workplace, e.g. away from one's computer. It can be read in the park, handed to an airline ticket agent, or presented to a flight attendant when "all electronic devices must be turned off". Is it not place bound, tied, at the least to an Ethernet wire or a battery pack.

These capabilities of paper do not mean that other digital systems are not useful; these observations mean that the use of paper is often part of the complete process of idea and document development: a document may be initialized and finalized on the computer, but in the process, it may be converted back and forth to paper many times.

Yet, if the computer is the canvas on which documents are created, the top of the desk is the palette on which bits of paper are spread in preparation

for the job of writing. Without these bits of paper ready to hand, it is as if the writing, and more especially the thinking [italics in original], could not take place in earnest. (Sellen & Harper, 2002, p.1)

These affordances can be contrasted to computer-based electronic systems; all of the tasks could be accomplished using a computer. But all would require substantial investment in technology, skills, and cognitive effort. The tasks would be divorced from direct human intervention and not grounded in the real world. Computers and most software packages separate users—through interfacia such as keyboards, mice, screens, and requirements to learn and often extensively develop skills—from the act of creation.

While paper has substantial value for text-based communication and notation, it is also well suited to use to convey visual images or notation. Paper, broadly defined, is a surface for making marks that require little experience; a separate program or marking tool is not required. Most people have sufficient skill in non-textual visual representation, i.e. drawing, to accomplish rudimentary representations and to decode visual images (Goldschmidt, 1999). This is often more efficient than text alone. The hand, unlike computer programs, has never had a significant division between writing and drawing, between textual notation and visual notation. While skills may vary, the medium is not forcing the use of word or image on the page; a mark is a mark, whether text or image, or visual notation.

EMPIRICAL EVIDENCE OF PAPER SUPPORTED KNOWLEDGE WORK

Sellen and Harper (2002) found that knowledge workers employed paper in ways that were complex and sophisticated, and which also illustrated some of the nature of knowledge work. Their research involved observing work in air traffic control, financial management, and policing.

Authoring, reviewing, collaborating, and interacting socially were all supported through the use of paper, even when electronic media for communication were available and well understood.

Authoring, an important component of knowledge work, is well supported by paper. As noted, digital technologies may be used for the finished product, but the actual composition of ideas is done through a combination of paper and digital technologies. We write, compose, draw, and create on paper. We may implement those ideas through other media—digital software, oil paint, buildings, and sculpture—but we make our initial authoring choices generally on paper. Even authors who extensively used word processing software move back and forth between print and electronic versions of their work.

Knowledge workers also tend to review the work of others on paper, both for approval and for their own understanding. We understand information through the formation of our own knowledge, and part of the formation of our knowledge often occurs by marking written text.

Similarly, knowledge workers often plan their work using paper, where a lack of imposed structure affords ease and flexibility in jotting down notations, making diagrams, marking emphasis, or connecting ideas. Word processing, by comparison, focuses one type of information and is structured for written documents on a page. The diagram sketched by hand into the paper document is easy; that same diagram in an electronic document requires many additional steps and substantially more skill in software use.

Collaborative activities are also often more easily undertaken through the use of paper. Paper allows the sharing of a common document and making of multiple and diverse marks on it. Knowledge workers can pass around a draft, or even copies of a draft, for annotation and review. Paper often provides the media to record ideas, plans and discussion for working groups. Examples of collaborative paper or paper-based activity in the workplace include the large paper

easel pads used to record and archive ideas in team brainstorming sessions, or sticky notes used to plan staffing or procedures.

Finally, paper is often used as a reason for added, informal interpersonal meetings, greasing the wheels for further creativity. Written documents, such as a report or a memo, are often delivered in person. This provides an opportunity to review the materials with the intended audience and to increase creative social interaction in the workplace. Such documents could often be sent by other means, such as e-mail, but the personal meeting is valued more highly than electronic expediency.

One of the most developed paper-based collaborative systems is the A3 Report used by Toyota. “These single page data-dense reports are used as part of a process to gather information, share information, make comments, track progress and graphically represent the improvement process” (Liker and Meier, 2006, p. 201). The A3 Report method involves using one side of an A3 sized piece of paper. “It allows only the most critical information to be shared with others for careful evaluation of the thought process used, as a means of requesting support or advice, and for arriving at a consensus.”

Initially, A3 Reports were developed as a standardization choice allowing worldwide communication through a single, simple format: “... this was the largest size paper that could fit in a fax machine: 11 × 17 inches” (Liker & Meier, 2006, p. 203). While the documents could be done in electronic form, the use of paper allows for easy distribution, broadly distributed use, and allows input from all. They are dynamic and collaborative documents, not frozen and uni-directional Power-Point presentations (Sobek & Jimmerson, 2004).

A3 reports are a hallmark of the “lean” management movement. These single pages of A3 sized paper are used for planning, communicating, generating new ideas, and resolving problems. Use of the single sheet for planning reports forces conciseness, summarization, and organization

of thought. The reports, consistent with Toyota management principles, are highly structured, yet created to encourage ongoing input, including editing and marking, by others.

The value of the A3 report is that it ensures communication, either formalized or incidental. Reports are duplicated and presented to others for input. The development of the A3 document is often done in teams or collaboratively; reports can be printed or posted for review, and are easily folded for inclusion in a notebook. Informal annotation of the A3 reports by others, including on the factory or shop floor is encouraged as part of the ongoing process.

DRAWING AS A MEANS TO DESIGN

Much of our understanding and use of paper is for text; most of our communications efforts are centered around words and writing. However, beyond the linear use of one symbol system, writing is an entire array of ways to communicate more effectively and expressively. Drawing, a visual notation system, is central... and common to all design fields. Historically, humans have relied on drawing to communicate.

Drawing is a kind of Universal Language, understood by all Nations. A Man may often express his Ideas, even to his own Countrymen, more clearly with a Lead Pencil, or Bit of Chalk, than with his Tongue. And many can understand a Figure, that do not comprehend a Description in Words, tho' ever so properly chosen. (Benjamin Franklin, 1749)

Central to the use of paper is the ability to generate graphic images or diagrams easily. For the architect or artist, these images are essential to their creation: Drawing, or “making marks,” is an act of decision and exploration. Designers make marks, adjust symbols, manipulate forms, and from that manipulation and iterative design

process develop new and better ideas (see for example, Waters & Gibbons, 2004).

How we view visual notation, drawing, is an important key to advancing instructional design. If we use it solely to communicate, we will limit its effective use. Communication with colleagues and clients is an important use of visual notation, to be sure, but more importantly, drawing can serve other functions in our design process. It is where we can generate ideas, its principle role in many other design fields.

Why is drawing effective in the development of ideas? Visual form is instantly recognizable, and at the same time encourages interpretation. The generation of visual forms allows the abstraction of ideas and the summarization of complex concepts. One can scribble a drawing, change it, and reinforce one's thoughts. It is "media-as-environment," a place for the development of ideas (Meyrowitz, 1999, p. 45).

REASONS FOR DRAWING

In the design fields, drawing or visual notation is central to the design process and is used for a variety of purposes, ranging from the presentations to the public and reviewers, to the cognitive efforts of individual practitioners.

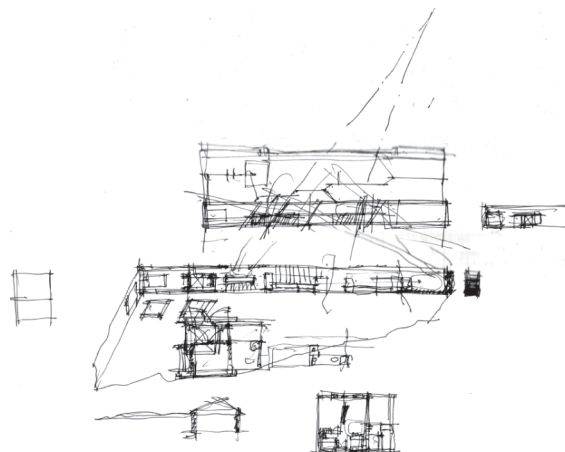
A drawing is like a theatrical scrim, a gauzelike screen whose properties change dependent on lighting conditions. Like a scrim, a drawing is both opaque and translucent, a filter between the drawer and viewer; drawer and object, between ideas conceived and their two-dimensional manifestation. A scrim and a drawing both prevent as well as allow view, asserting their presence with varying authority and in different ways. When the back light turns on, the scrim disappears. In a similar way, drawings dissolve and open a world of rich possibilities. (Fraser & Hemni, 2000, p. 18)

Both Lawson (2004) and Fraser and Hemni (2000) describe multiple functions for drawing in the architectural design process; drawing is used to plan, to communicate, to convince, and most importantly, to ideate (See Figures 1-3). Each of these modes of drawing can be applied to use in the field of instructional design. These types of drawings include:

- **Public communication:** Most design work in architecture is very public; public reviews are common. Many drawings in the design fields are used to present work and communicate intent to outside parties. In architecture, plans are reviewed by government agencies, clients, and communities. These drawings can be described as presenting a positive and finished image to the public (Lawson, 2004). Drawings may be used to support marketing of buildings, securing public approvals, or in convincing a client of the project's value.

Within instructional design, there currently is less use for representation of design work, as often the preference is to have non-working digital models for presentation of early stages. In architecture though, the economics of physical

Figure 1. Thinking drawings by the author



construction compared to the cost of producing a digital prototype encourages visual and often animated representations.

One other comparison for the field of instructional design would be movie production. The development of movies is based on an extensive series of drawn visual representations, story boards, and iterative representations as the cost of final production is quite high. Most animated movies such as Disney/Pixar's *The Incredibles* (Walker, 2005) are extensively developed on paper in hand drawn form prior to the computer-based rendering of the final product.

- **Work communication:** Drawings are extensively used to communicate within the field of architecture. These may take the form of diagrams, representations of data, or representations of ideas. The value of this type of drawing or visual notation is beginning to be well understood in the field of instructional design (cf. Botturi, 2006). Design teams in all areas need to communicate structure, sequence, and organization of their work; visual representation and notation can provide a better understanding than by text alone.
- **Vendor communication:** Drawings are commonly used to communicate directly with those providing services or products; within architecture, some drawings have the legal force of contract and are literally called "Contract Documents." As more of the actual production work in instruction design is done by outside vendors, communication will become a higher priority. Much of this communication will be verbal, but visual notation and communication will also be increasingly valuable.
- **Development testing:** Many ideas cannot be fully understood unless represented visually and those ideas are often explored through drawings. Understanding complex and intricate technologies can be assisted

through the use of drawing. For example, the efficient layout of clothing patterns on milled fabric is important for cost effective production; developing hypothetical layouts of furniture in visual form by interior designers helps to understand room use; and urban designers use visual models to understand the ramifications of zoning laws. If verbal annotation is helpful, diagrams, visual representations, or mapping is more so.

In the virtual world of technology-rich instructional design, the real world limits of room layout, fabric width, and neighborhood density are not immediate concerns. However, early development of screen designs could benefit from rapid visualization through hand-based drawings, and hand drawn maps are a good starting method for Web site design.

- **Research drawing:** Architects and others also use drawing as a means to understand observed phenomena. The "grand tour" of Europe, undertaken as part of formal studies in architecture, is often documented with drawings in a sketchbook. Not mere drawing practice, this custom helps the architecture students cognitively engage and internalize what they see.

Most travelers today carry a camera and forsake the personal time and engagement of drawing what they see, yet for most the cognitive residue of taking a photograph is minimal while the understanding gained by drawing one's observation is long lasting. In Japan, hikers still climb Mount Fuji to paint the sunrise. Again, the reflective experience is of considerably greater value.

Drawing as a tool to research and understanding is not limited to architects and tourists. Early scientists, including Sigmund Freud, used drawing as a means to understand and develop ideas.

In the latter part of the 19th century, German researchers considered drawing to be instrumental to scientific discovery, both as a way to capture the microscopic detail of nerve cells, for example, and to illustrate theories of how the brain might work. (Gamwell, in Carey, 2006)

For example, Darwin's drawings were essential to his seminal work in *The Origin of Species*. And the recorded anatomical observations of Leonardo da Vinci are early examples of the use of drawings for research. Mechanical or electronic reproduction of visual images does not require the same cognitive effect as the engaged and personal representation.

- **Sketching as visual thinking:** The most important aspect of drawing is its ability to help create and develop new ideas. This type of drawing, called "study sketching" by Goldschmidt (1999), and "design drawings" by Fraser and Hemni (2000), occurs in many fields. It is finding answers to complex problems through visual representation, and is "...practiced by individuals who attempt to conceive of a new entity, be it a work of art, a building, a technically-oriented invention or novel artifact, or a scientific concept" (Goldschmidt, 1999, unnumbered). Many design fields such as architecture, graphic design, and industrial design have active histories of design sketching. This process is drawing to invent, to generate the new, drawing to create.

This type of drawing is often intensely personal. It is a one-to-one visual conversation with oneself through the medium of drawing, and it is generally not meant for extensive communication. Such sketches can be decoded, understood, and valued by knowledgeable others, but their primary purpose is one of supporting thought.

The imperfect feedback (or "backtalk" per Goldschmidt, 1999) of media is an important component of the design process. Representing an idea through drawing is not always an exact science; through the vagaries of the media, the roughness of the paper or bleed of ink, or even through the inaccuracy of the hand, differences and changes occur. This can be a conversation as challenging as an engaging argument with a peer, and it is where ideas develop. Lawson (2004) calls these drawings "proposition drawings." "These are drawings where a designer makes a 'move,' or proposes a possible design outcome" (p. 45).

Designing, particularly within architecture, is often iterative, making a series of choices within a larger conceptual goal. This type of drawing becomes game-like, combative, an interactive argument, and, as often described, conversational. It is an interaction with a sheet of paper, akin to "thinking out loud," helping ideas and decisions emerge from the page, away from the brain, in a two dimensional use of symbols comparable to the leap to writing envisioned by Ong: Thought requires some sort of continuity. Writing establishes in the text a 'line' of continuity outside the mind" (Ong, 1982, p. 39). Drawing expands this capability in multiple dimensions.

This method of drawing is closely related to the concept of cognitive tools developed by Jonassen and others to describe the use of computer-based tools to investigate various hypotheses and directions. A spreadsheet, for example, can be used as a cognitive tool to define, structure quantitative relationships, and to iteratively advance various numerical scenarios. The use of drawing in design can easily fit within Jonassen's (1996) description of cognitive tools as "...readily available, generic applications; they are affordable; they are used to represent knowledge in content domains; they are applicable across different subject domains; they engage critical thinking in learners; they facilitate transfer of learning; they are simple, powerful formalisms; and they are reasonably easy to learn"

(p. 709). How parallel is Goldschmidt's description of the cognitive mechanism of drawing: "... this is a 'front edge' process in which partial and rudimentary representations are produced, evaluated, replaced by others if need be, transformed, modified and refined, until their maker is satisfied with the result" (1999).

As we have seen, the visual notation of architecture, drawing, serves a wide variety of needs, which can be compared to the work in instructional design. Drawing, i.e. paper-based, free flowing visual notation, has value on many levels, from public communication to private cognition. In both fields, ideas and concepts need to be explored and described in ways beyond simple text. Similarly to architecture, the drawing of instructional design must be free flowing, inventive, both personal and public, and easily used.

Visual notation must have both a cognitive and practitioner base in drawing, a basis gained by making marks *by hand* on surfaces, which occurs most easily and commonly on paper.

DRAWING ON PAPER

Media, of course, are needed to communicate and to support thought. The use of some technology is necessary to extend our thoughts to others. But the type and extent of media technology imposes change on the message and change on the process. Two things stand out: first, the cognitive load and communication skill required to use more complex technologies detracts from the capacity for thought. Using simple media allows greater concentration on the task at hand – design, information, communication, or invention.

Simpler media also impose less of their own structure on the interchange and allow a freer form of idea development. Software is an indispensable tool of instructional design, but any software, as a medium, structures the results, "perfecting" ill-formed ideas in its own likeness (Drucker, 1999).

Figure 2. Thinking drawings by the author

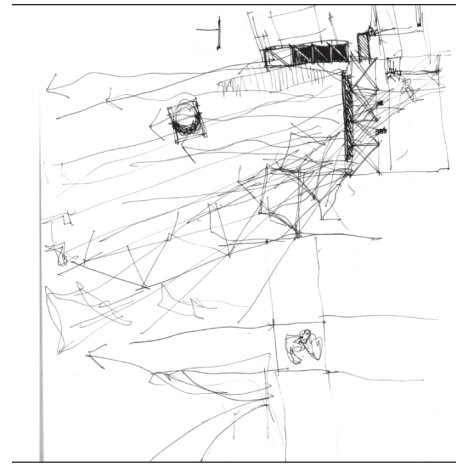
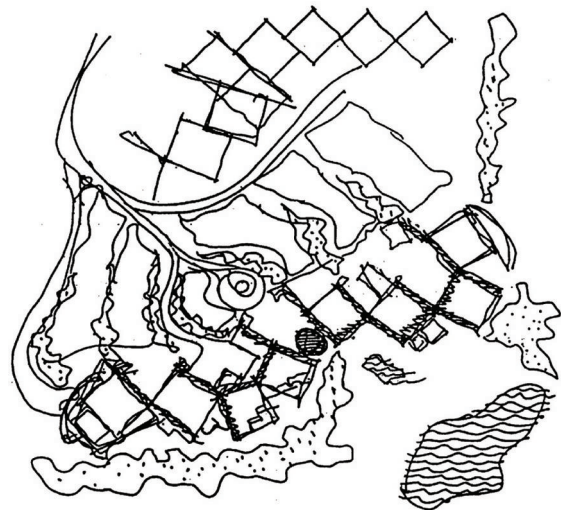


Figure 3. Preliminary site concept drawing for Cambridge Community College, Minnesota, USA. Courtesy Hokanson/Lunning Associates, Inc., architects.



For example, a word processor often completes or re-spells words; presentation programs such as PowerPoint utilize wizards to summarize presentations, limiting expression and communication (Tufte, 2003), and desktop publishing programs make some layouts easier to use than others, encouraging their use.

If the meaning of Goethe's Faust, of Van Gogh's Landscapes, or Bach's Art of the Fugue could be transmitted in discursive terms, their authors should and would not have bothered to write poems, paint, or compose, but rather have written scientific treatises. (Von Bertalanffy, 1965, p.44)

Media biases communication, whether the media is computer-based software or oral speech (Innis, 1951). The clearest, easiest, and least biased use of visual notation (for the foreseeable future) will occur through the use of drawing directly on paper.

CONCLUSION

We have seen, through both our own experiences and through research, that paper continues to be an important component in knowledge work, the work of thinking, invention, design, and innovation. This will be the important work of the coming century, and it also includes instructional design. Paper will continue to be used for a number of reasons, both common and complex. In modern society, it is always present, inexpensive, light weight, flexible, and relatively stable. We note things on scraps of paper or in more developed notebooks, on agendas, on programs, and on napkins and note cards. It also has value in more complex ways; it remains less mediated than computer-based communication as fewer processes are needed to use and understand it. Further, paper provides abilities in the areas of editing, annotation, collaboration, and manipulation that remain more difficult on the computer; and it supports close interpersonal contact in meetings, conveyance, and personal delivery, i.e. it encourages face-to-face social interaction.

Our ideas come from our use of media. While the other tasks of visual notation or drawing that are primarily representational are important to the process, the generational aspects of any notation, whether drawing or writing are paramount;

drawing is a cognitive tool, unmediated through a computer.

Perhaps the most critical element in the use of drawing or visual notation is the ability to generate ideas, to create within this simple medium. Ideas are created through various processes, through thinking, working, communicating, and experimenting. They are not birthed fully formed. Highly developed programs and media short-circuit the process and pre-structure the results. Ideas need an environment, a medium that allows their formation like a cloud of matter coalesces into a planet; an environment for the growth of ideas.

While Einstein was able to mentally generate images, most mortals require some sort of cognitive assistance and some exploration with an external medium. Few humans can completely envision the results of their ideas, whether that is quantum physics, mathematical examples, or designing a new bathroom. This envisioning must occur with ease, with the tools at hand, with the least mediation. That is why Sellen and Harper (2003, p. 185) have written that "the reality [is] that the workplace of the future [is] full of paper." And it's marked with the results of our thinking.

As we develop a common symbolic language for instructional design, we may learn from the work of Christopher Alexander, architect, and author of *Pattern Language* (1971). The book extensively explores hundreds of architectural elements in diagrammatic and photographic form. Ideas for houses, cities, rooms, and spaces are examined and diagrammed as a means to understand the richness of architecture. Far from a template for design, it can be better used as a descriptive observation of the built environment, an artifact from Alexander's own observations. What was most important was the making, not as a product for codified reuse

While there are a number of computer-based notational systems in use, there remains no common system for instructional design. The development of any notational system must be more than a one-off program; it must be based in the human

process of design and development, and its use must be easy, inexpensive, shared, and widespread to be of value. Designers will need to use the system on an informal and unmediated manner. They have to be able to use it without a computer, anytime, anywhere, and at a moment's notice.

Such a system will evolve bottom up, through usage by drawing, much as the rules of writing have evolved from informal oral speech: "The rules of grammar in natural human languages are used first and can be abstracted from usage and stated explicitly in words only with difficulty and never completely" (Ong, 1982, p. 7).

Visual notation in design must encompass many tasks. It will be used for communicating with other team members, but will also be used to plan out tactics and set goals as a decision recording method, to define components created by others, to present ideas and progress to clients, or to develop ideas for the invention of new forms of instructional design. What is not needed is a canned set of symbols, like logos, icons, templates, or emoticons, but a broad-based development of representational or generational skills: skills at conceptualizing, summarizing, editing, communicating, organizing, ordering, and structuring for instructional designers. In simpler terms, instructional designers need to draw to plan, to conceive, and to communicate.

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Chapter 2.14

LDL for Collaborative Activities

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ABSTRACT

LDL (learning design language) is an educational modeling language which was conceived to model collaborative activities. It has roots in social sciences, mainly linguistics, sociology and ethnomethodology. It proposes seven concepts that allow instructional designers to build the model of a collaborative learning activity. It has both a visual and a textual notation, the latter being computer-readable. This means that the produced models can be easily operationalized and executed in an existing virtual learning environment. This chapter introduces LDL, its concepts and the graphical notations associated with each of them. The methodology proposed to

facilitate the modeling is also presented. Its use is illustrated by the example of the planet game, which was practically tested with other research teams as a benchmark/competition during the ICALT 2006 conference.

INTRODUCTION

Learning design language (LDL) is a language intended for use by instructional designers. It has been created to allow them to describe and specify learning activities on the Internet. Lots of activities may take place on the Internet—like a treasure hunt between groups of children, a training session to improve reading, a discussion between a teacher and students, an examination, etc. So, the focus is placed on collaborative activities, as the LDL

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authors are convinced that learning can no longer take place without considering and enhancing the interactions between the learners.

The ambition of the LDL authors is twofold: on the one hand, we want to provide instructional designers with simple means to build the formal description of whatever kind of learning activities (such as the ones previously mentioned, for example) and to combine them. On the other hand, we want the teachers to be able to transform easily these formal descriptions into effective online activities, without any intervention from computer science specialists. These activities will involve services and digital resources available on the teachers' school network and on the Internet.

We did not take into account the division of labor that usually occurs between the instructional designer and the teacher. On the contrary, we have considered that, in order to be exploited by an instructional designer, the language should allow the designer to describe activities as if she or he were a teacher and had to solve some of the problems encountered by teachers preparing lessons. Examples of these problems include determining the theme of the activity, gathering adequate documentation, defining some attainable learning objectives, evaluating the duration of the activity, proposing a division of the activity into sessions, indicating the way students will be arranged during learning sessions, defining individual work sequences and positioning them in the overall activity, defining the way and the means to measure the students' progress. They concern learning and pedagogy, of course, but also logistics, organization and evaluation.

This is an important preparatory task, which may be more or less precise, more or less detailed. It guarantees the teacher being able to conduct the activity once it has begun while keeping control of his or her objectives. Improvisation, on the other hand, is more risky. It is probably limited to the best teachers, in the same way that rally-style driving is restricted to the best drivers. It supposes a complete mastery of pedagogy.

After this preparatory phase, the teacher will be in charge of adapting the activity designed by the instructional designer. The teacher will consider the following:

- The students to be involved in the future activity, because the teacher knows their skills and their work practices,
- The personal objectives defined for each of these students,
- The technical context in which the teacher is operating.

Using LDL during the preparation phase leads the instructional designer to create a *scenario*. A scenario is a codified and formal description of a future activity. It can be considered as a specification of this activity. Designing a scenario to specify an activity consists in describing:

- Where the activity will take place,
- Who the participants in the activity will be,
- What the participants' interventions will be,
- How and when these interventions will be connected throughout the activity,
- The rules the participants will have to comply with,
- What the consequences of the participants' reactions, actions and points of view on the activity will be and how they will be able to express these points of view.

The distinction between a scenario and the activity modeled by this scenario is the same as the difference between a recipe and the future dish whose preparation is described by this recipe. If the ingredients used by the cook are actually the ones mentioned in the recipe, and if the way the dish is prepared is in conformity with the instructions in the recipe, then the tasting of the dish should go off well. In particular, if the codification proposed by LDL is respected, then a computer will be able to interpret a scenario. Thus the teacher will be

able to operationalize it in a technical computer environment.

To support the description of a scenario, a graphical notation was defined. This enables the instructional designer or teacher to represent the scenarios produced more easily and comprehensibly. Once these representations have been produced, they are translated into a corresponding XML binding in conformity with the LDL syntax. (These bindings are not provided here as they are of no use in helping the reader understand the models or the notation.) They are the computer-readable representations of the scenarios. They are also a way of representing the scenarios in a normalized format suitable for exchanges and operationalization.

LDL does not describe the actual nature of the services and resources used by the learners and teachers during the ongoing activity. Neither does it describe the functionalities of these services. The transformation of a scenario, in which services and resources are described in an abstract way, into an actual online activity, in which actual services and resources are involved, is carried out during the operationalization phase. It is supported by learning design infrastructure (LDI), a global infrastructure which has been developed in relation with LDL to deal with both the operationalization and the execution of scenarios.

The authors of LDL think that teachers and instructional designers, who design activities for the teachers, should not have to concern themselves with the technical features of the computer tools they use. That is not their problem. They should be allowed to forget about it so that they can concentrate on the specification of the activities they intend to carry out with students. They have to suppose that the technical environment will be able to adapt to their needs. This is a strongly-held position of the LDL authors, which has had a huge impact in defining LDL and developing LDI. Indeed, LDI is in charge of seeking, finding, and building the technical environment best adapted to the teachers' needs.

What follows is a description of LDL. Before the description, the background of the language will be presented. This will explain the origin of the language and will position it in the field of VIDLs. We will then categorize the language according to Botturi et al. (2006) classification. Next, a detailed description of LDL concepts will be given. For each of them, a definition will be provided together with some examples and the notation proposed to instructional designers to represent the concept in the activity modeling process. After that, the methodology defined to model learning activities with LDL will be described. The use of this methodology will then be exemplified in the planet game example. This example is a case study which was proposed as a modeling and implementing challenge during the last International Conference on Advanced Learning Technologies (ICALT) (Vignollet et al., 2006). It will be introduced just before describing how LDL was used to model it within the LDL methodology. Finally we will present the first results obtained, the strengths and the limitations of LDL and the future work.

THE ORIGIN AND BACKGROUND OF LDL

Modeling Collaborative Activities

The definition of LDL follows upon research we conducted in the domain of CSCW (computer support for collaborative work). Such research works asked the following questions: What are the essential properties of a groupware so that it effectively supports group activities while taking into account the social aspects of these activities? On which model should these tools be built?

The answer was to propose a model for group activities: the participation model (Martel, 1998; Ferraris et al., 2002). This model is grounded on properties that are inherent in the nature of collaborative activities. These properties were analyzed

and revealed by research in social sciences. We have considered the following ones:

- Activities are *situated* in various contexts (social, cultural, technical, geographical, etc.) (see Suchman, 1987; Fitzpatrick et al., 1995; Garfinkel & Sacks, 1972). Thus it is necessary to consider both the *places* of the activity and the *roles* the participants will have in these places. Roles are relative to the location of participants: i.e., they are also situated (see Chapter XIII).
- Activities are *unforeseeable*. They are built gradually as they proceed (see the works on activity theory by Vygotsky and Leontiev). So it is impossible to produce an *a priori* description of what an activity will be. Such a description can nevertheless be useful to support collaboration in CSCW tools but *if and only if* it can be revised *in situ*, according to what actually happens in the ongoing activity (Suchman, 1987).
- Collaborative activities suppose the existence of a *compromise* between the interests of the group and those of the individuals, between the dependencies that stem from relationships among individuals and their autonomy. Each individual must be able to negotiate her or his commitment to the activity (Martel, 1998). This was inspired by Goffman's theory (Goffman, 1981).

In addition, we were inspired by works in linguistics, mainly the dialogue models of the University of Geneva (Roulet et al., 1985) that attempt to explain the succession and the interweaving of conversational exchanges. Indeed, we have drawn a parallel between a teaching activity and a conversation. In a conversation, locutors speak to their interlocutors, who make an interpretation of what is said and may react in turn (Austin, 1955). Just like a conversation,

we consider an activity as *a set of exchanges and interactions* between the users involved (the participants). As in a conversation, the exchanges are *structured* and *scaffolded* by rules. And as in a conversation, every exchange involves at least two participants: an *addresser* who acts and whose actions are aimed at an *addressee*.

A Socio-Constructivist View of Learning

Contemporary pedagogical movements attach great importance to socio-constructivism, a learning theory developed by Lev Vygotsky at the beginning of the 20th century (Vygotsky, 1934). This theory rests on the idea that knowledge acquisition is facilitated by the various social interactions a learner may have during her or his learning process.

This point of view seems to be shared with problem-based learning proponents such as Savery and Duffy (1996). These researchers also state that cooperation influences learning. Indeed, generally in their approach, learners, grouped in teams, are expected to collaborate, helped by their teacher, to explain phenomena underlying a problem.

Both theories thus state that learning activities are intrinsically cooperative: they are based on interactions which are richer and more complex than the traditional face-to-face exchanges between a teacher and her or his learners.

THE IMS-LD PROPOSAL

The main proposal in the domain of learning design languages is IMS-LD, which was a result of the work conducted at OUNL (Koper, 2002). It is based on a theatrical metaphor. Indeed, it considers a learning activity as being a succession of "acts" (in the theatrical meaning of that word) that leads to the realization of the "drama" which occurs between learners and teachers. Modeling

such an activity is thus a matter of modeling the alternating or the sequencing of the exchanges that occur in the class.

The main contribution of this approach is to put forward this learning flow modeling, considering that the learning flow reflects the activity in an overall way. However, even though EML has been adopted by IMS, there remain barriers to its adoption. We mention in what follows the barriers which are particularly significant to our purposes. They led us to choose to develop a new LD language instead of using IMS-LD.

A Complex Language

The first barrier is the complexity of the IMS-LD language. Several researchers and end-users (teachers, instructional designers) share the point of view that IMS-LD is complicated, in particular because of its high number of concepts. Consequently, only someone who knows it well can handle it and capture its subtleties. For instance, it is very difficult to define the appropriate properties. Even if the associated best practices try to offer a method, it is still extremely difficult to use for instructional designers, and quite impossible for teachers to use (Le Pallec et al., 2006).

Indeed, as IMS-LD (EML in fact, its ancestor) has been designed to industrialize the creation of distance learning activities, it is not dedicated to teachers organizing learning activities in their classes. It operates as though the modeling phase has to be dealt with by an instructional designer who has a discussion with the teacher and who translates into IMS-LD the informal description of the learning activity the teacher has produced. However, once the modeling has been done, the teacher and the instructional designer have to discuss the formal model produced. This requires the teacher to be able at least to understand, even if she or he cannot produce, the model in a general way. If the language is too complex, this may not be possible

Difficulties in Modeling Collaborative Activities

Miao et al. (2005) have done an interesting and deep analysis of the capacity of IMS-LD for formalizing collaborative learning scenarios. They have pointed out five major difficulties, among which is the difficulty of modeling varied forms of social interactions. They show evidence that by using IMS-LD “it cannot be clearly modelled whether and how people collaborate” (see p.3 of Miao et al.’s paper).

As Hernandez-Leo et al. also noted this problem, they have proposed an extension of IMS-LD (see Chapter XX). But, as Harrer mentions in Chapter XIV, this extension at service level rather than at activity level cannot appropriately capture the characteristics of social interactions.

These difficulties were also reported by Caeiro (see Chapter X). They put forward that the theatrical metaphor is not suitable to model collaborative learning situations when they are not a succession of acts, in the theatrical sense. This led them to propose the poEML language.

No Concept Dedicated to the Activity Observation

All of the actors in the field of education are in agreement about the fact that an educational activity is characterized by its unpredictable nature. Le Pallec et al. (2006) claim that “a large part of scenario can only be defined during runtime” and “in learning science, models are driven by learning events to detect and to react upon” (Le Pallec et al., 2006, p. 2). In fact, teachers are usually able to give prescriptions of an activity, but they know that they will have to take into account the learners’ reactions and what will happen during the activity to adapt it as it proceeds.

IMS-LD does not include a semantically-founded concept which could capture these reactions and the events coming from the ongoing

activity. This is probably due to the theatrical metaphor which intrinsically does not take the reactions of the actors into account. Indeed, actors are supposed to play the part without deviating from the original text. So there is theoretically no need to consider these reactions and what is going on. Everything should go on according to what is written in the author's original text.

The IMS-LD "property" concept could be used to try to capture these reactions. However it has not been defined for that purpose but to be computational. That is probably why it is so difficult to use it to capture reactions and points of view of the participants. Moreover, it cannot be used to capture what is going on in the activity.

Learning Tools Confronted with Virtual Learning Environments

Learning tool designers were concerned very early on by the modeling, or, more exactly, the orchestration of these tools. They tried to describe and formalize the ways of interacting with them, taking into account the specificity of the learning activities they wanted to plan. This is true in all learning contexts: lifelong learning, school-based instruction, etc. This is for instance what Gueraud and her colleagues propose in FORMID (Gueraud et al., 2004), which implements learning activities that include the use of simulations in the electricity field.

However, the deployment of virtual learning environments (VLE) leads one to reconsider their proposals. Indeed, learning tools are now included in the VLE and can interact with other services (Durand & Martel, 2006). Then teachers or instructional designers populate the VLE with several resources, including instructions, learning tools, documents, case studies, etc. All these resources can be considered as small pieces of learning scenarios. Only the sequence which orders these elements is missing.

Towards the Creation of a New Language

In 2003, we were facing the following situation:

- We needed a language enabling one to describe collaborative learning activities and their learning flows,
- We wanted the language to take into account the unforeseeable nature of learning activities,
- We wanted the language to consider the situated and interactive nature of collaborative activities,
- We wanted the language to be computer-readable so that it would be possible to automate the construction of an adapted VLE and the delivery of learning activities via this VLE starting from the activities' description,
- The incipient IMS-LD standard language did not meet our requirements.

So we decided to define a new LD language, based on the participation model. As this model had been improved and validated—it had been used to specify and develop successfully one of the very first extant VLE in France, which has been used daily since 1999 at University of Savoie by more than 15,000 users (Martel et al., 2004)—the challenge sounded possible.

LDL was thus created in 2003 by Christian Martel, Laurence Vignollet and Christine Ferraris from "scenario Team" in collaboration with Pentila corporation (<http://www.pentila.com/>) and Jean-Pierre David and Anne Lejeune from LIG-METAH (Laboratoire d'Informatique de Grenoble—METAH Team). The related infrastructure LDI was specified by "scenario team" and Pentila corporation, and developed by Pentila corporation.

POSITIONING LDL TOWARDS BOTTURI ET AL.'S CLASSIFICATION

LDL can be considered as a *finalist communicative* language, in reference to the framework presented in Botturi et al. (2006). In the same paper, they have also defined a classification scheme for ID languages. According to this classification, LDL can be categorized as:

- **Stratification:** (layered) LDL proposes seven different concepts to describe the model of a learning activity. All these concepts are linked with each other in an information model (a meta-model).
- **Formalization:** (formal) LDL combines a graphical notation and a textual one. Indeed, the instructional designer is supposed to use the graphical notation to create a scenario. The resulting diagrams have then to be transformed in a corresponding LDL-XML binding, so that a computer will be able to make the scenario run on an existing VLE. The binding is of course formal as it is expressed in XML according to the LDL grammar. As the transformation is supposed to be carried out automatically in the future (this is not the case currently), the graphical notation requires precise syntactical rules.
- **Elaboration:** (Specification) The language has been primarily defined to build the specification of a learning activity. The specifications built have the particularity of being computer-understandable. They can be transformed automatically into machine-code in order to automate the delivery thanks to technology.
- **Notation:** (Both visual and textual) Initially, there was only a textual notation (an XML binding). We have added a graphical notation, assuming it would help teachers and instructional designers in

building the scenarios. This still has to be validated.

- **Perspective:** (multiple) If we consider only the textual notation of LDL (i.e., the XML binding), the perspective is single. If we consider both the textual and visual notations, it is multiple. In fact, several views are required for some of the LDL concepts, for instance the *position* one (see Figure 13 and supplementary Table 1).

LDL: SEVEN CONCEPTS TO BUILD A SCENARIO

To build a scenario using LDL, the instructional designer has to analyze the activity to identify:

- « Who »: Who takes part in the activity?
- « Where »: Where does the activity take place?
- « What »: What is done during the activity?
- « How » and « When »: In which order do we play and under which constraints (when does it start and when does it stop)?

To those “classical” concepts, LDL adds two other, more original ones (Martel et al., 2006a):

- The « reactions » of the participants: What is the participant’s evaluation of the difficulty of an activity? What is his or her point of view on a document? How does a participant view his or her place in the activity?
- The « rules of the game » of the activity: What is allowed? What is not? How could we take into account the participants’ reactions to adapt the activity?

LDL concepts are detailed below. For each detail, we provide a definition of the concept together with its UML representation (which positions the

concept relative to the others within the LDL meta model), some examples and the corresponding LDL graphical notation. This notation is intended for instructional designers. We have defined it in order to prevent instructional designers from having to use the XML notation. The objective is twofold: (1) to provide instructional designers with a graphical notation which is much easier to handle than XML and (2) to provide both teachers and instructional designers with a more user-friendly means of communication. The reader who is not familiar with UML will be able to find a good UML primer in Chapter IX of this handbook.

The Roles

The roles represent “classes of” participants who take part in the activity. In activities, participants have coherent interactions. A set of interactions reflects a “thematic” role.

Definition

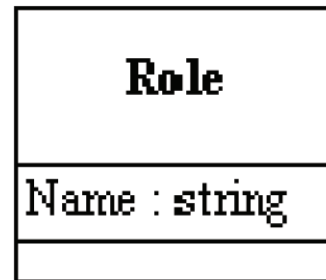
The activity’s participants are represented by the role concept (see Figure 1). A role is the set of interactions a participant can have with others taking part in the activity.

It is characterized by a name (the role’s name), chosen by the instructional designer because of its relevance to the activity to be modeled.

Examples

Participants who write a course for their students, annotate their work and mark their examinations are teachers; participants who read the course, do the exercises and take the examination are the learners; participants who write an article for an online newspaper’s readers are writers.

Figure 1. Role model (UML representation)



Notation

The Figure 2 gives the graphical notation of the roles. This notation is taken from actors’ notation in UML.

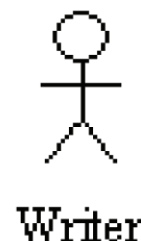
The Arenas

The arena is the place where the activity takes place: a service or a content. A forum, a search engine or a chat room are considered as service arenas. A course, an exercise, a photo album or a Web site are content arenas. This referencing to real space guides the modeling and delimits the interaction perimeter. Participants interact in these arenas through the interactions specified by their roles.

Definition

Places where activities take place are arenas. An arena refers to a service or digital content which supports the participant’s activity. It is defined

Figure 2. Role notation



at least by a name and may contain other arenas (see Figure 3).

Examples

The library is an arena where participants can search for a book; the amphitheater is the place where the teacher gives a lecture: it is the lecture's arena. The usual arena used by participants for asynchronous online discussion is a forum.

Notation

The Figure 4 gives the graphical notation of the arena called "Forum to discuss the lecture."

The Interactions

The interactions represent what is done during the activity. They specify the exchanges the participants will have during the learning activity. They usually consist of verbal communication, document exchange and collaborative productions. They are situated: they occur in contents or via services. So they depend on the capacity of the

places where they occur (for instance, a content can be read, a forum can offer communication functionalities, etc.)

Definition

Any exchanges which take place between the participants during the activity are called interactions.

In its simple form, an interaction is characterized by (see Figure 5):

- An identifier,
- The *action*, which describes what is done during the exchange,
- The roles of the participants involved in the exchange,
- The arena in which the interaction takes place.

An interaction always takes place between at least two participants, represented by their roles. The initiator is called the *addresser*, the one to whom the action is addressed is called the *addressee*. Addresser and addressee represent the respective places of the interaction's participants (here we have transposed the duality that exists in conversations between locutors and interlocutors). The association called "*involves*" which appears in Figure 5 between the "role" and "interaction" concepts thus needs to be divided into two more precise associations which consider these respective places: the ones appearing on Figure 6.

Furthermore, LDL allows the specification of start-up and stopping conditions of interactions, using *rules*. The rules are described further.

Examples

"The teacher provides a document to the learners," "the project leader sends an alert message to the members of her or his working group," "the learners answer a question given by the teacher"

Figure 3. Arena model

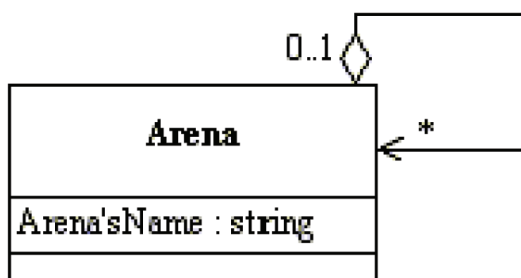


Figure 4. Notation of an arena

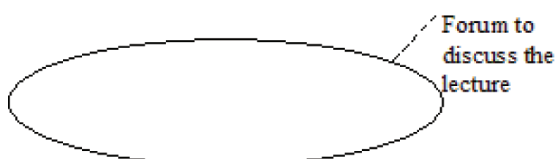


Figure 5. Interaction model

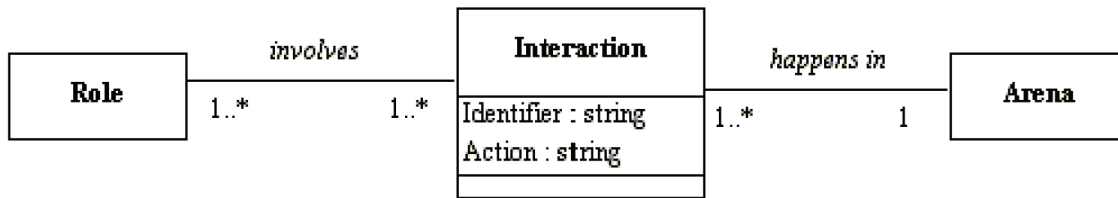
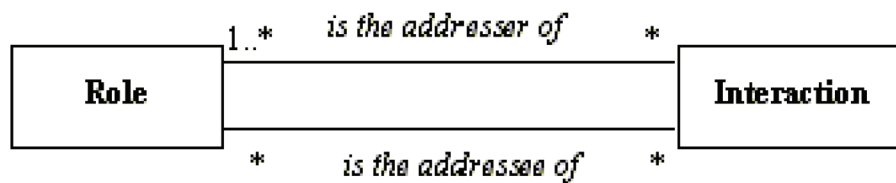


Figure 6. Addressers and addressees during an interaction



are just a few examples of interactions which can happen between an activity's participants.

Students doing an exercise and sending it to their teacher are the addressers and the teacher is the addressee. Sometimes, the addresser and the addressee are identical and correspond to the same participant. It is for instance the case when a learner reads a document for her or his own information. It is also the case when a participant uses a search engine to find information.

Notation

Interaction notation consists of four constituents: its identifier, the action's name, the roles involved and the arena where it takes place. This is expressed by the notation presented in Figure 7 (R1 and R2 correspond to the name of the roles).

This notation has to be completed with the rules that express the start-up and stopping of the interaction. They are referenced by a diamond, which symbolizes a condition, as shown in Figure 8.

Figure 7. Notation of the interaction I

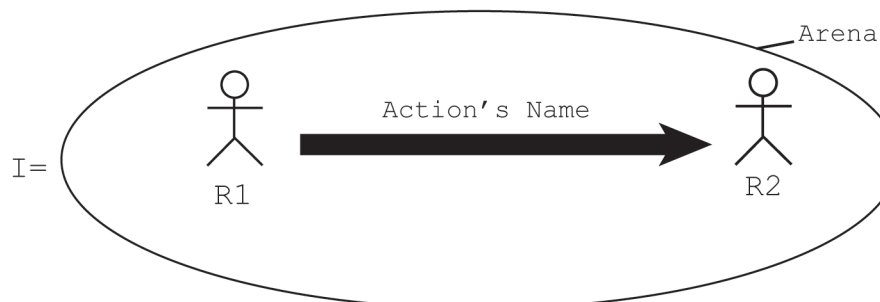
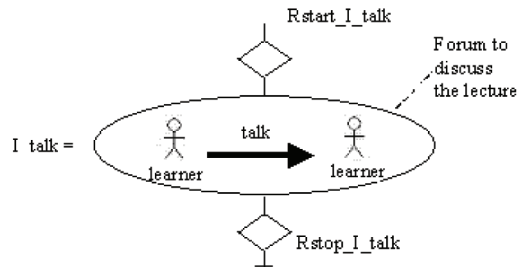


Figure 8. The interaction *I_talk* referencing its start-up and stopping rules.



The Structures

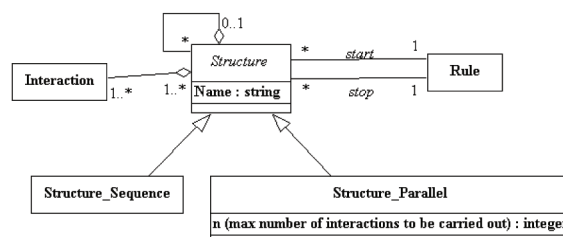
How and when the interactions are connected throughout the activity is captured by the structure concept.

Definition

During the activity, interactions are played either sequentially or in parallel. In LDL, the structures describe these sequences.

A structure is characterized by (see Figure 9) a title, which identifies it in a unique way within a scenario, the list of the interactions, and the type which defines the interactions' organization. LDL distinguishes two types of structure, which correspond to two different manners of linking the interactions:

Figure 9. Structure model (types are represented using sub-class notation)



- A *sequence* structure means that the interactions will be executed one after the other, sequentially;
- A *parallel* structure means that all or some of the interactions will be executed in parallel. With this type of structure, the instructional designer could, if necessary, indicate the maximum number of interactions that the participant has to perform. By default, this number is equal to the total number of interactions which corresponds to the progress in parallel of all the interactions.

Like the interactions, the structures contain information on their conditions of start-up and stopping. These conditions are also expressed by rules. Finally, a structure can include other structures.

Examples

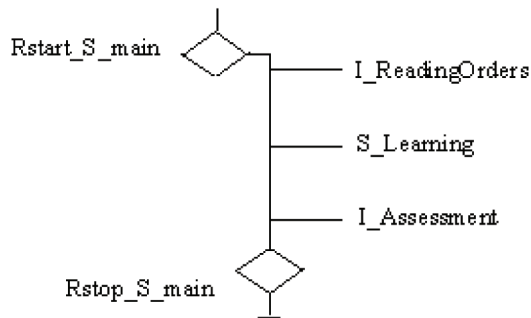
A *sequence* structure will allow one to express that an alert will be sent to tutors as soon as the teacher gives the specified document to learners. A *parallel* structure will make it possible to express that the learners must carry out three exercises, in any order, that they will have to choose from the list of the five proposed.

A more complex structure could be for example: the learners read the instructions, they can then play a learning activity, and finally, they have an assessment to perform. In this example, three steps are sequentially performed. The first one and the last one are simple interactions. The second one corresponds to a more complex activity where, for instance, the learners can, in parallel, read the lesson, discuss with their peers and do exercises.

Notation

The *sequence* structure is represented vertically and the *selection* structure horizontally. If the number of interactions to be performed is limited, this number is mentioned in brackets.

Figure 10. Sequential structure notation



In Figure 10, we represent the main structure of the last example above: a sequential one which starts automatically and specifies that the reading interaction called *I_ReadingOrders* is followed by the learning structure called *S_Learning*, and closed by the assessment interaction called *I_Assessment*.

Figure 11 shows the “*S_Learning*” structure, a structure where three interactions can be played in parallel: the “read the lesson” interaction (*I_ReadingLesson*), “discussion” interaction (*I_Discussing*) and the “exercise” (*I_Exercising*) interaction.

The Rules

The rules correspond to the rules of the game of the activity.

Definition

Rules are used to express the start-up and the stopping of interactions and structures. They are production rules of the form: *If condition Then action*. The conditional part of a rule is a logical expression using the connectors OR, AND and NOT. The action can be the start-up or the stopping of a structure or an interaction.

Examples

Rules make it possible to express for example that a discussion can begin when all the learners have read the instructions and that it will stop when the teacher gives the signal.

Notation

A reference to the rules is added to the structure and interaction notations, as shown in Figures 8 and 10.

The Positions and the Observables

The conditions of the rules depend on the reactions of the participants. LDL includes a concept, that of *position*, which allows one to specify these reactions and thus to adapt the activity according to them. The value of a position is tested in the conditional part of a rule.

Figure 11. The parallel structure called *S_Learning*

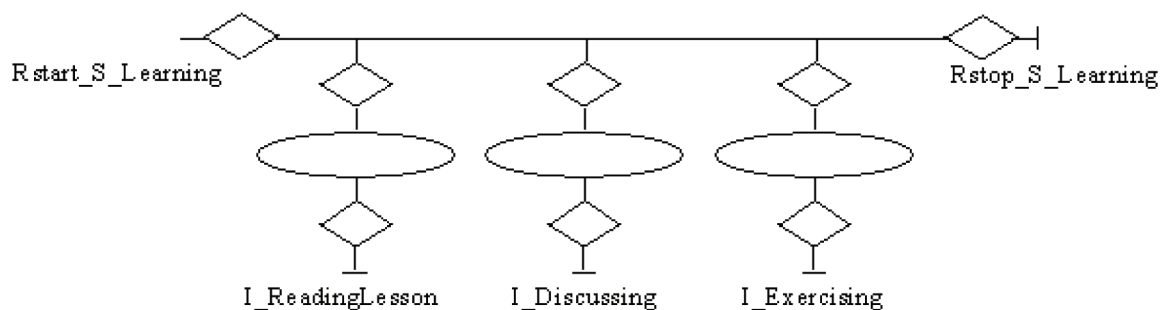


Table 1. Examples of position

Position Id	Title	Value	Type	Taken by	On
P_stop_act	I stop the learning activity	True or false	declared	teacher	The learning activity
P_vote	my evaluation of this work is	an integer between 0 and 20	declared	teacher	The learner work
P_is_inside	I am present	True or false	observed	learner	The group space

Definition

The position of a participant is the means of expressing the participant's reactions, perception and points of view on an ongoing activity. It is characterized by (see Figure 12):

- An identifier,
- A title, which expresses the semantics of the position,
- A value,
- A type: *declared* or *observed*,
- The role of the participant who takes the position,
- The arena on which the position is taken.

Two types of position exist, depending on how the value of the position is obtained. A *declared* position means that its value is given explicitly by the participant involved. The value of an *observed* position is assigned by the system which deduces it from observation data on the activity's

progression. The instructional designer will have to define which aspects are to be observed. These aspects are called the *observables*.

Examples

A teacher can choose to interrupt a working session to allow learners to play games. This is a *declared* position taken *by* the participant having the “teacher” role *on* the “learning activity” arena. Its title may be “I stop the learning activity.” Its value may be “true” or “false” and may vary as the activity proceeds. Another *declared* position allows the teacher to give a mark to the work of the learner. The presence or the absence of the students in the digital space shared by the group is an *observed* position. Table 1 shows the complete descriptions of these three positions.

Notation

Positions are represented by:

- A hand symbol for a *declared* position,
- A magnifying glass symbol for an *observed* position.

The role of the participant who takes the position is specified under the symbol.

In Figure 13, the discussion can begin when all the learners have read the instructions and it will stop when the teacher gives the signal.

When appearing on an interaction representation (such as in Figure 13), positions are not

Figure 12. Position model with the links to other concepts

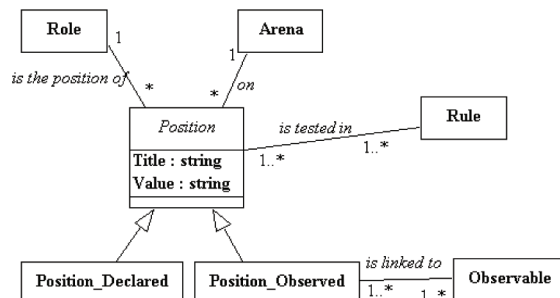
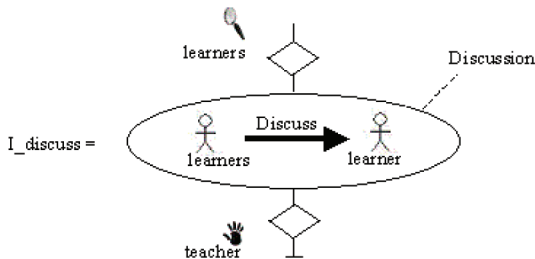


Figure 13. Interaction notation supplemented with positions



completely specified. Thus their definition has to be supplemented by fulfilling a table like the one presented in Table 1.

Please note that the rules are the means to personalize activities. For instance, a rule can be defined to propose complementary lessons to a learner who has declared that she or he is not able to do an exercise (her or his position to the arena “exercise”).

The presentation of LDL and its concepts is now complete. The next three sections are devoted to the presentation of the methodology we have defined to help the instructional designer build a scenario with LDL. The methodology is of course subordinated to the LDL language. After this presentation, we will apply the methodology to an example.

THE METHODOLOGY

The proposed methodology distinguishes two steps clearly. Step 1 aims at building an informal scenario. Step 2 aims at formalizing this informal scenario.

Step 1: Building the Informal Scenario

Usually, a learning design begins with a more or less precise idea of a learning activity described in a narrative way. For instance, the teacher and

the instructional designer could intend to propose an activity on the subject of planets and their organization in the solar system. In this example, the objective could be to enable the learners to discover that the differences between the distances of the planets from the sun can be explained by their properties. Another objective could be to allow the learners to acquire knowledge in the field of astronomy: the difference between a planet and a star, the notion of orbit, physical mass, etc.

To build a scenario, the instructional designer will first of all take into account the learning objectives of the teacher. Existing reference lists of skills will also be taken into account. Then the learning design consists in thinking about how the learners could individually or collectively use the resources during the activity. In other words, it is the construction and the description of interactional arrangements in which resources are used to facilitate effective learning. If possible, this learning has to be assessable.

Step 2: Formalizing the Informal Scenario

One only has to observe a group of learners working to become aware that the slightest educational activity is complex, and that its modeling could be quite difficult to carry out. In fact, a learning activity often conceals a myriad of interwoven activities, whose relationships are confused. Within this myriad of activities, we distinguish four types:

- The first type is obviously the *learning type*. Activities of this type are the heart of the learning. Learners manipulate the resources put at their disposal. They produce contents related to the learning objectives. They work individually or collaboratively.
- The second is the *observation type*. During activities of this type, the teacher observes the ongoing learning activity. The objective of this kind of activity is twofold. First,

they are intended to help the teacher perform a formative assessment of the learning activity, for each participant. Second, they can allow the supervision and the regulation of the progression of the activity. Usually, teachers are the only participants in this kind of activity.

- The third is the *assessment type*. Any learning activity is preceded, associated with or followed by at least one assessment activity. This is the place and time to assess the knowledge of the learners. The place of the assessment activity in the overall learning flow depends on the kind of assessment desired by the designer (diagnostic, formative, summative, etc.) (Durand & Martel, 2006).
- Finally, we consider the *organizational type*. Activities of this kind are dedicated to organization problems. It is usually the time and place where the resources and tools are made accessible, and the orders are given to the learners. If needed, it is also the time and place where groups of learners are created. Finally, it is the time and place in which the other activities are started.

We regard these four kinds of activities as basic elements that constitute every learning activity to model. The overall learning activity results from the combination and the interrelations of these activities. Being activities *per se*, they can be modeled as independent scenarios. Building the formal scenario of a learning activity is thus no longer a matter of defining a unique scenario, which encapsulates everything. It becomes a matter of defining *at least four scenarios*, corresponding to the four different kinds of activities identified. As a consequence, it becomes a matter of describing the relationships between these scenarios. It is also a matter of describing each scenario in terms of the concepts proposed by LDL. Thus the current step of the methodology consists in: (1)

identifying the activities and their relationships and (2) modeling each identified activity. These two phases are presented in the next two sections.

FORMALIZING THE INFORMAL SCENARIO (PART 1): IDENTIFYING THE ACTIVITIES AND THEIR RELATIONSHIPS

At this stage of the methodology, the instructional designer has to:

- Analyze the overall activity to identify the activities that constitute it and that correspond to the four types of activities mentioned above: organization, learning, observation and assessment;
- Define the relationships between these activities.

Identification of the Activities

It is easier to begin with the identification of the learning activities, as most of the time the information provided in the informal scenario concerns learning. The identification of the observation activity is next, followed by the assessment activity. Then comes the identification of the organization scenario, as it may start the other activities. The description of what usually happens in these activities (see previous section) may help.

Identification of the Roles Involved

The “identification” phase has to be completed with a description of who is to be involved in each activity by identifying their *roles*. For each activity, the instructional designer identifies the main roles of the future participants. For instance, the teacher is the role of the observation activity. For each activity, she or he also has to define the *participation modes*.

Identification of the Participation Mode

“Participation mode” is the overall way participants will exchange and interact in an activity. It describes the kind of situation a teacher wants to carry out with his or her students. It allows *individual* participation in an activity to be distinguished from *collaborative* participation.

In individual participation, participants have individual activities and no relationship with each other. This is the case, for example, of an examination in which, by definition, learners have to work on their own. Figure 14 presents the notation proposed to describe individual participation.

On the other hand, in collective participation (see Figure 15), participants work and interact together. They are supposed to act in the activity as interdependent and engaged partners sharing a common goal. For example, teachers may ask students to work in a group of four to read texts about “instructional design,” analyze them and produce a synthesis of their readings. In each group engaged in this activity, members work jointly. They will produce a unique synthesis.

In collaborative participation, we distinguish *frontal* situations from *open* ones. In frontal situations, participants have individual activities but no relationships with the other participants, except with the person having a particular role who oversees, stimulates, coordinates and controls. This person has a central position in the ex-

changes and in communication. This is the case for example of a course at university in a lecture hall: the teacher is in front of the students giving a lecture and the students are allowed to ask questions; to do that, they have to raise their hand to ask to speak. Figure 16 presents the notation proposed to describe such frontal situations.

In open situations (see Figure 17), participants can cooperate freely with their peers or with the teachers. It is the case for example of a panel session in which participants are invited to discuss and express freely their opinions and points of view.

In real educational practices, these various forms can be combined with each other to produce hybrid educational situations that can evolve over time. Figure 18 is an example of such a case. It combines individual participation for participants having a role (represented on Figure 18 with a black head) with open situation for participants having another role (represented on Figure 18 with a white head). It could be the case, for example, of a panel session with attendees. On the one hand, participants having the “attendee” role have an individual activity: they listen to the discussion and may take some personal notes. On the other side, participants having the “speaker” role are involved in an open situation: they are debating on a given subject.

Figure 14. Notation for individual participation in an activity

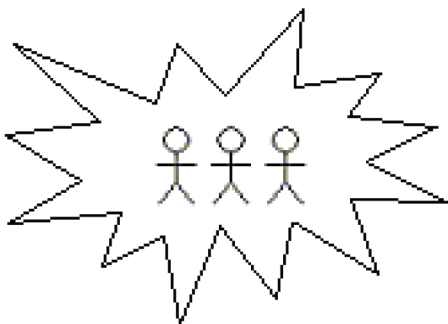


Figure 15. Notation for collective participation in an activity

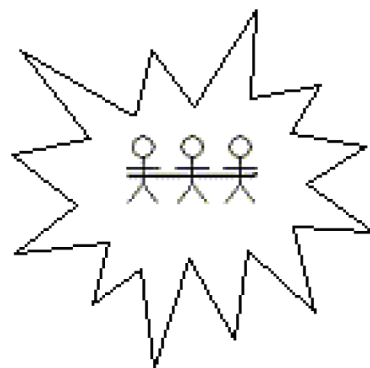


Figure 16. Notation for a frontal situation

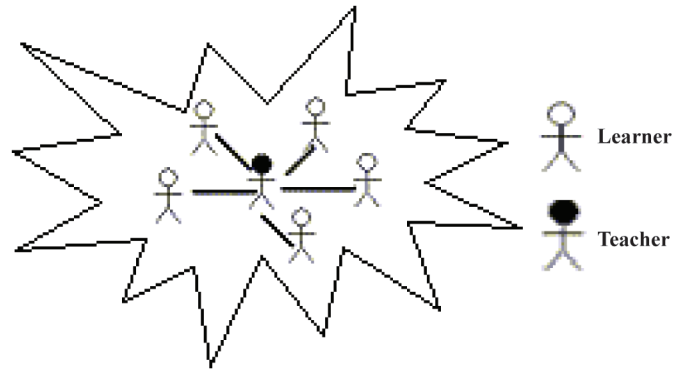
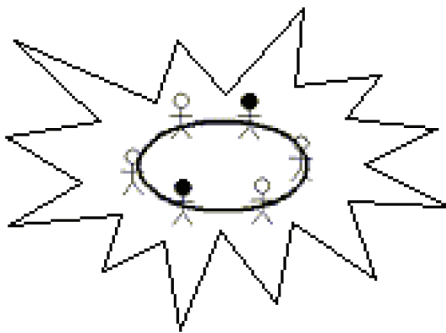


Figure 17. Notation for an open situation

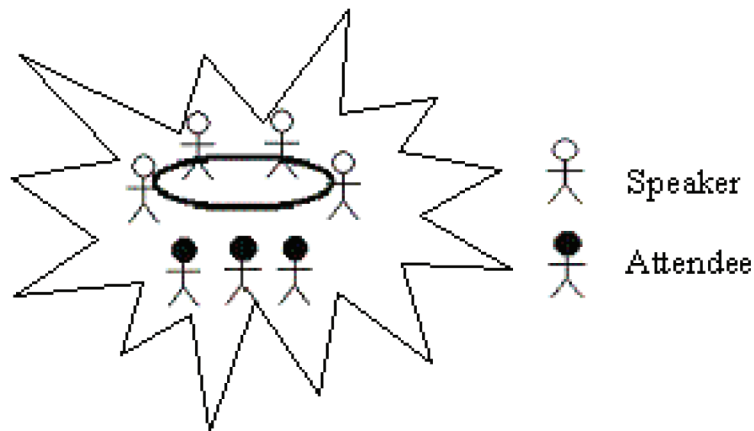


Definition of the Relationships Between the Activities

Once the instructional designer has identified the activities, the roles involved and the participation modes for each of them, these activities have to be positioned by the designer with respect to each other. This means that the designer has to:

- Define the learning flow; and,
- Define the objects the activities may share (arenas and positions).

Figure 18. A hybrid situation.



These elements are presented in what follows, together with the notation proposed to represent them.

Defining the Learning Flow

The definition of the learning flow leads to both the building of the activity schedule (specification of the order according to which activities will have to be performed) and the definition of synchronization points between these activities. We have defined a notation to represent these two dimensions. For the schedule, the instructional designer may use the notation proposed in Figure 19 to represent activities which are connected sequentially. The notation proposed in Figure 20 is for those activities which proceed in parallel.

The synchronization points allow the instructional designer to deal with the start-up and the

stopping of activities. Two activities may start in an asynchronous way. If so, they will have different start-up conditions. This is represented by the notation proposed in Figure 21.

On the other hand, they may start simultaneously. This means that they share the same start-up rules. This is expressed by the notation presented in Figure 22.

Finally, the instructional designer may want to express synchronization at the end of activities. Figure 23 shows the notation proposed to express this in the case of three activities A1, A2 and A3: A3 cannot start until A1 and A2 are over.

Defining Shared Objects

Activities may share some objects. Two kinds of objects can be shared: arenas and positions. Two activities may share an arena if their respective participants need to have interactions in the same arena. Let us consider the example mentioned previously (concerning collective participation) in which groups of students work on the production of a synthesis on instructional design theories.

Figure 19. Activities performed sequentially

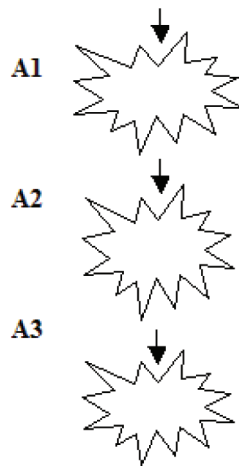


Figure 20. Activities performed in parallel

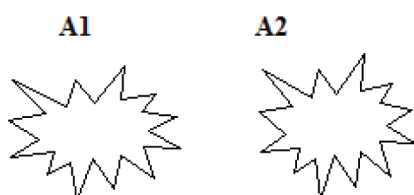


Figure 21. A1 and A2 start asynchronously

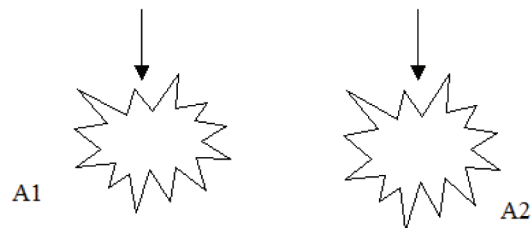


Figure 22. A1 and A2 start synchronously

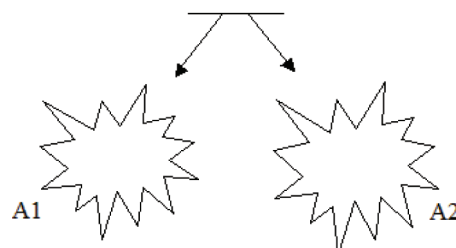
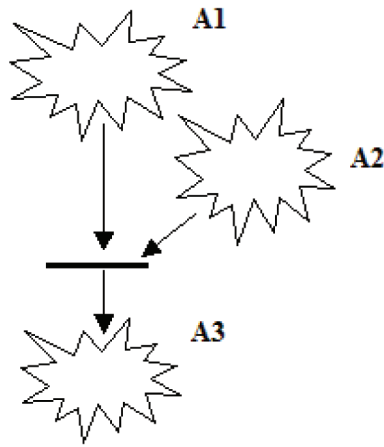


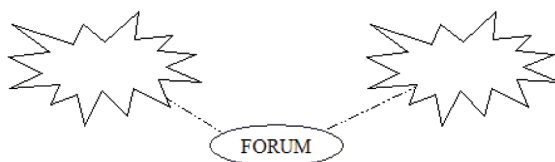
Figure 23. Synchronization between activities



Imagine that in the learning activity, students have at their disposal a forum to support their discussion about the synthesis they have to produce. The observation activity and the learning activity will have to share this forum, as the teacher involved in the observation activity will have to be able to observe it. The notation proposed for the sharing of arenas is given in Figure 24, on the example of a shared forum.

In the same way, activities may share positions. For example, imagine that an assessment activity is going on. The teacher wants to propose an adapted remediation activity to the students whose marks are not as good (this is a learning type activity). To do that and to adapt the remediation to the students according to the obtained mark, the two activities will have to share the marks (see Figure 25). It is an “observed” position given by the teacher in the assessment activity. It will be used in the remediation one.

Figure 24. Two activities sharing a forum



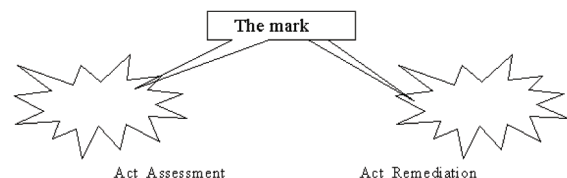
FORMALIZING THE INFORMAL SCENARIO (PART 2): MODELING EACH ACTIVITY

Until now, the instructional designer has focused on the identification of the activities and their relationships. She or he has built an overall view, positioning the activities with respect to each other. It is time now to change the focus and to go deeper into each activity. That means building a model, i.e. a scenario, for each of them.

An LDL scenario needs the definitions of the structures, interactions, roles, arenas, rules, positions and observables suitable to the activity to be modeled. We recommend defining these concepts in the following order:

- First, identify the learning flow of the activity. This leads one to make an inventory of the structures and the interactions they organize. At this stage, the instructional designer only needs to identify the interactions in a general way (only their names). This will give a first, overall view of the expected activity.
- Second, give a more precise specification of each interaction. That means identifying the roles and the arenas involved in each interaction.
- Third, complete the specification of the interactions and structures with the definition of their start-up and stopping conditions. This supposes modeling the corresponding rules.

Figure 25. Notation for two activities sharing a position



- Fourth, define the positions. The conditional part of the rules tests the values of the positions. So, from the exhaustive list of rules, one can obtain an exhaustive list of positions to be defined.
- Last, define the observables. The instructional designer has to define for each “observed” position the associated observables.

The description of the methodology now is completed. With this approach, the instructional designer has all the material required to model a learning activity: a language, allowing a model of the targeted activity to be built, and a methodology for explaining how to handle the language and how to carry out the modeling process. The next section shows an example of how LDL and its associated methodology were used to create the model of the planet game case study.

APPLICATION OF THE METHODOLOGY TO AN EXAMPLE

We have chosen to show the use of LDL and the methodology with the planet game example. This example was proposed as a common case study to work on within the workshop entitled, *Comparing Educational Modeling Languages on a Case Study* (Vignollet et al., 2006) we organized during ICALT’2006. Each research team engaged as a competitor (they were 9) had to study a given real situation (the same for every team: the planet game), had to at least model this situation by using its own models and languages, and was asked to implement it as an activity running in a web learning environment.

The methodology recommends building the informal scenario first. Thus we begin by presenting the informal scenario of the planet game. Note that we will not provide the complete specification, as this would be too long. We will just show a part

of it, which illustrates the approach satisfactorily. Additional information can be found in Martel et al. (2006b) or at <http://ld.pentila.com>.

Step 1: The Planet Game Informal Scenario

The Context

The chosen activity is part of a real lifelong learning scenario in astronomy. The students have the same problem to solve. They are grouped into two teams. Each team has only a part of the knowledge and data required to solve the problem. So, they must collaborate.

The Proposed Activity

The activity objective is for learners to acquire knowledge in the field of astronomy. More precisely, they have to classify the planets with respect to their distance from the Sun (from the nearest to the most distant).

The strategy used by the teacher to reach these objectives is to propose a game for the learners. The latter are grouped into two teams (Team A and Team B). Resources and services will be available to help the learners in acquiring new knowledge, in exchanging with their team members, and in negotiating.

The Game Rules

Clues are distributed among teams. Team A knows some planets’ properties, taken from an expert interview it has at its disposal. Its members can deduce the planets’ order, but not the planets’ names. Team B knows the planets’ names and some properties taken from another expert interview. However, many properties are missing. Each team can use a chat room to enable its members to have discussions (about the problem to solve, the clues they have, etc). Each team also has at its disposal

a shared whiteboard allowing its members to list the already discovered information.

The teams have to cooperate using a forum to negotiate the exchange of clues and information. The teacher has access to the forum, and can participate in the discussions. She or he can also add new clues to either of the expert interviews. When she or he decides, the exchanges are stopped. Then, each learner fills in a questionnaire about the planet classification. The winner is the first who gives the right associations (the planets in order from the sun). The activity finishes when a winner is nominated.

Step 2-Part 1: Identifying the Planet Game Activities and their Relationships

When analyzing the informal scenario above, we notice that the four kinds of activity mentioned in the methodology section (organization, learning, observation, assessment) actually exist in the planet game. For the learning activity, it is obvious. The informal scenario explicitly includes a lot of information about this activity. The learning objectives are listed, together with the way to reach these objectives (analysis of the clues, discussion in the chat room, negotiation with the other team, etc.). The aim is clearly for learners to acquire knowledge about the organization of the solar system.

The informal scenario also mentions the interventions of the teacher in relation with the learning activity. Indeed, the teacher has to observe the teams while the learning activity proceeds. She or he may observe the team members' exchanges, their productions, the way they use the clues, etc. This is an activity *per se*, during which the teacher may identify the difficulties encountered by the learners, may put new clues at their disposal, etc. This is the observation activity.

The assessment activity is also clearly mentioned. It consists in a summative assessment

which occurs at the end of the learning period. It aims at checking the level and the solidity of their knowledge.

Finally, there are some elements which are related to organization which are possibly less explicit. The most evident one is to set up the two teams. To be carried out, the planet game requires this step. It also requires the teacher to prepare some instructions intended for learners, to put them at the learners' disposal, together with the useful resources (interviews, clues, shared whiteboard, chat room, etc.), to organize the course of the activities in time, etc.

These activities are represented graphically in Figure 26, together with the learning flow between them (the schedule and the synchronization points). Note that the learning activity appears twice, once for each team: they correspond to the same scenario.

The description of the relationships between activities has to be supplemented by the definition of the shared objects: arenas and position. The ALearn1 and ALearn2 learning activities share the forum which supports the negotiation of the exchange of clues. This arena is also shared with the AObs observation activity, as the teacher involved in the observation activity has to be able to at least observe what happens in it (see Figure 27).

Furthermore, the two learning activities and the observation one share the "end of the learning activities" position. This position is a decision of the teacher to be made explicitly in the AObs activity. Indeed, the teacher observes the two ongoing learning activities and chooses the time to stop them, when the learners have worked enough and have acquired enough clues and knowledge. Thus the AObs activity has to share this position with the two learning ones. As a consequence, these two activities will be aware of it and will be able to end. Note that it is also shared with the AAssess activity, as the end of

Figure 26. Activities, roles and relations between activities are identified

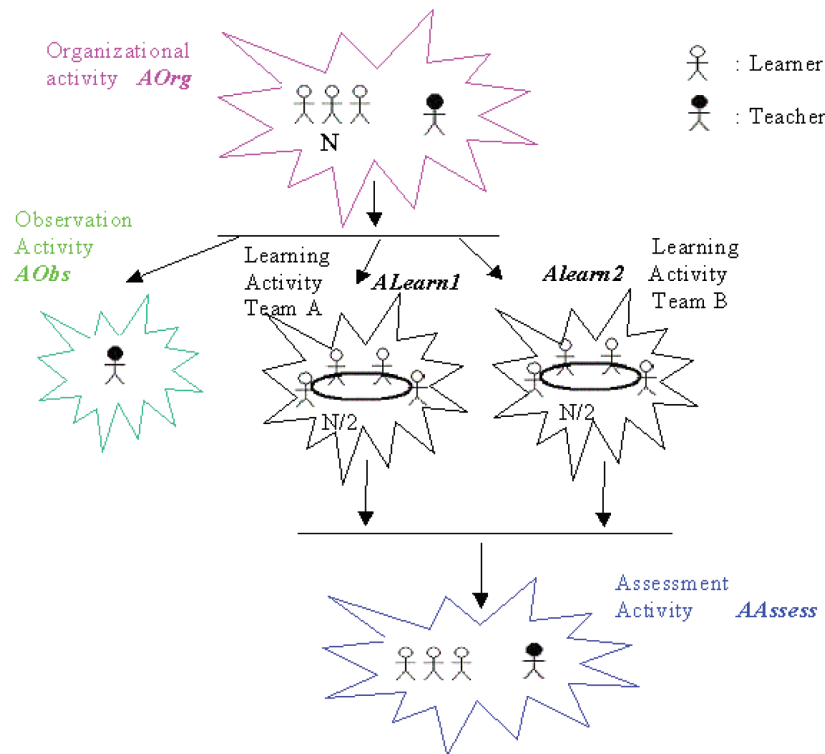
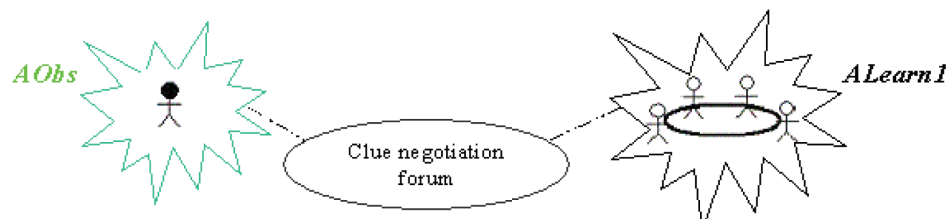


Figure 27. ALearn1 and AObs activities share the “clue negotiation” forum



ALearn1 and ALearn2 coincides with the beginning of AAssess.

Step2-Part 2: Modeling Each Activity of the Planet Game

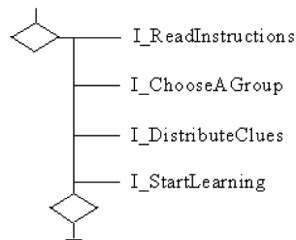
We have chosen to describe the organizational one (though only part of it). It is easy to imagine the design of the others, in the same way. The first step is the identification of the “Learning Flow,” represented by the structures and the interactions.

The Structures and the Interactions

The main structure is a sequential one which combines four interactions:

- Read the instructions, called I_ReadInstructions
- Choose a group, I_ChooseAGroup
- Distribute clues, I_DistributedClues
- Start the learning activity, I_StartLearning.

Figure 28. The main structure with the interactions



This is noted as shown in Figure 28.

This identification leads to the determination of roles.

The Roles

Table 2 places the AOrg activity's roles in relation to the interactions that define them. It also provides the place of the role within the interaction: being an addresser or an addressee.

The Arenas

Now, the places where the activity takes place have to be identified. They can be more or less abstract. To find them, the instructional designer has to answer the following question: Where the interaction from role X to role Y takes place? What is the support of the interaction? In which space does the interaction take place?

In the example, the arenas are:

- I_ReadInstructions is done into the Instructions,
- I_ChooseAGroup is done in a questionnaire,
- I_DistributeClues is done in a group space,
- I_StartLearning is done in an activity.

Rules

The distribution of clues can start when the learners have chosen their group. A rule has to be defined. Let us call this rule R_distrib_start. The conditional part of R_distrib_start checks the

position of each learner. Its action part starts the distribution activity.

Positions

For each rule defined, there are related positions. The ones associated to R_distrib_start is a declared one. It is specified in Table 3.

Observables

The P_Group-Chosen position is an observed one. It is associated to an observable: the response provided by the learner in the questionnaire.

FIRST RESULTS AND CONCLUSION

As mentioned in Botturi et al. (2006), each design language was developed with a specific use framework in mind. For LDL, the use framework is the modeling of learning activities and the execution of the produced models (i.e., the scenarios) on existing VLE. As computer scientists, we have taken an engineering approach, moving toward the constant refinement of the language. We have made the deliberate choice of focusing on the expressiveness of the language and on the development of software tools enabling one to easily transform the models into actual activities running on VLE. Indeed, we think that it is of paramount importance that instructional design-

Table 2. The roles in AOrg and the associated interactions.

The Role	is involved in	as an addresser	as an addressee
Learner	I_ReadInstructions, I_ChooseAGroup I_DistributeClues I_StartLearning	Yes Yes	Yes Yes Yes Yes
Teacher	I_DistributeClues I_StartLearning	Yes Yes	

Table 3. Specification of the P_Group-Chosen position

Position Id	Title	Value	type	shared with	taken by	on
P_Group-Chosen	I have chosen a group	True or false	observed	-	learner	The questionnaire

ers and teachers are able “to see” what happens when a scenario is executed. So they can give some feedback. And this also enables learners to be involved in the evaluation process.

This has an important impact on the results we can present here. We provide results about the modeling capacity of the language and related to the experiments which were conducted with learners. But results related to the actual use of the language by instructional designers or teachers are still missing to date. This is commented on below.

Experiments Conducted

LDL’s maturity can be evaluated by taking into consideration experiments already carried out: the three main ones are described here. They enabled us to improve the expressiveness of the language and to make the infrastructure more robust.

A Famous Scenario of the Internet: The Treasure Hunt

A first experiment took place which brought together 40 participants at a workshop held during the 2005 occurrence of the annual summer school of the French “Technology Enhanced Learning” research community (Lejeune et al., 2005). The chosen activity was an example of a treasure hunt. This type of activity is very widespread and numerous examples can be found on the Internet.

We used LDL to build the scenario and LDI and its associated player to operationalize, execute, play and follow the resulting activity. This experiment enabled us to validate the concepts of the model. It also allowed us to improve the

robustness of the infrastructure, with 40 users playing simultaneously.

The Project “Shared Virtual Laboratory” (SVL) of the Kaleidoscope European Network of Excellence

The objective of this project was to provide researchers in ICT in Education with an integrated environment to collect and share experimental trails. This environment, developed by Pentila corporation, includes:

- Workspaces in which experiments can take place,
- The LDI infrastructure and the associated player,
- A trails repository.

TPELEC (French acronym for “practical work in the domain of electricity”) was one of the experiments conducted to improve the developed environment. It concerns learning in the domain of electricity. The learning scenario’s goal was on the one hand to destabilize the misconceptions and incorrect reasoning of learners, on the other hand to use the detected misconceptions for remediation, progression and building of new knowledge. To carry out the TPELEC experiment, LDL was used to create the scenario and its possible adaptations when misconceptions are detected. LDI was the operationalization, execution and observation infrastructure.

The TPELEC scenario was experimented with in classrooms in 2005-2006 (six experiments in three schools, with a total of 120 learners aged 14

to 16). As the teachers were involved in the experiments and could see the scenarios as they run, they gave some interesting feedback. In particular, they became aware of the modeling capacities of LDL. This stimulated their imagination and led them to produce new, richer scenarios. These scenarios will be formalized, operationalized and experimented within a new project that has been recently funded by the Kaleidoscope Network of Excellence. For a more in-depth description of the TPELEC experiment and its results, you can read the corresponding Kaleidoscope report (Kaleidoscope D7.8.1, 2006).

From a learning design point of view, the purpose of this work was to test the observation points: from their specification in LDL to their implantation and use in LDI.

The Planet Game

The previously presented planet game was tested by researchers during the ICALT 2006 conference. It allowed us to improve the capacity of the language to model different kinds of activities and led to the development of the methodology.

Qualities of LDL

We here want to highlight what constitutes, in our opinion, the main strengths of LDL. To do that, we will refer in particular to some of the “desired properties” proposed by Harrer in Chapter XIV. We also provide some limitations of the language.

A Theory-Based Language

LDL is activity-centered. It was conceived to model collaborative activities. It is grounded on social theories which explain what is inherent in these activities. It thus integrates concepts which enable to take these inherent features into account, mainly their unforeseeable, situated and interactional nature.

Simplicity

LDL comprises a small number of concepts, which facilitates its appropriation. This meets Harrer’s “familiarity / intuitive intelligibility” desired property. One may object that “arena,” “position” or even “interaction” are not that familiar to instructional designers or teachers. That is probably true. But the questions corresponding to the LDL concepts (who? where? what? how? etc.) should compensate for the relative unfamiliarity. And the number of questions should be small, as the number of concepts is. We are currently exploring ways of dealing with this problem through the development of an authoring online tool dedicated to instructional designers and teachers. In particular, we are considering the possibility of using metaphors to translate LDL concepts into corresponding concepts available in these metaphors. For example, in the “classroom” metaphor, the arenas could be the blackboard, the lesson, the poster, the video projector, the story book, etc., i.e. any resources or objects available in a classroom which are quite familiar to instructional designers and teachers. This should facilitate the use of LDL.

Expressiveness

The experiments conducted have improved LDL expressiveness. We were able to model different learning situations and activities of various kinds (learning, observation, assessment, organization). This is probably due to the neutrality of the underlying metaphor. Indeed conversation perfectly corresponds to activity and has the same inherent properties.

Support of Different Granularity

LDL also meets Harrer’s “support of different granularity” desired property thanks to the activity-centered point of view and to the “arena” concept. Arenas are places where activities take place. An

activity occurring in an arena can be described by means of a single interaction (for example, the interaction “to discuss about the lecture” taking place in a “forum” arena). But it could also be described by a more complex specification defining what may happen in the arena (for example in the forum, there may be a moderator; contributors may add new discussion subjects; a contributor may post something new; etc.). And this is a complete scenario (Martel & Vignollet, 2007). The grain of the activity to model has changed.

Future Works

LDL’s expressiveness has been improved during the conducted experiments. Nevertheless we cannot claim that LDL can be used to model any kind of learning. And this is true for all design languages. To try to obtain evidence to support that claim, it is necessary to continue the improvement with a set of informal scenarios to model, which could be considered as a benchmark. We suggest dividing the effort of the building of this benchmark between LD language designers. The work currently done by the English Joint Information Systems Committee (JISC) on the evaluation of IMS-LD within the IMS Learning Design for Practitioners (LD4P) project could be the basis of this benchmark.

Furthermore, we have not yet considered the evaluation of the perception of LDL’s usefulness and the associated methodology by end-users. This is a very difficult problem to deal with, as there are a lot of elements and variables to consider, which are tightly intertwined (Botturi, 2005). Some promising approaches have begun to clear it up, for examples chapters XVIII, XIX and XXI of this handbook and Botturi (2005). If we want to make such an evaluation, we need to make some experiments with practitioners (instructional designers and teachers), giving them the role of “scenario designer.” If we wish to do that in the best conditions, we in fact have to provide an online authoring tool to support both the design

process and the translation of the diagrams produced into LDL code. This tool has to be simple and intuitive enough to be used by end-users, as the learning activity management system (LAMS, Dalziel, 2003) authoring tool for instance. It has to support the graphical notation that we have proposed and the methodology. We have specified such a tool. It is currently under development and should be operational by summer 2007. This will allow us to start a validation phase, which will be supported by learning scientists, instructional designers and/or teachers.

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Chapter 2.15

Development of Game– Based Training Systems: Lessons Learned in an Inter– Disciplinary Field in the Making

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ABSTRACT

Modern computer gaming technology offers a rich potential as a platform for the creation of compelling immersive training systems, and

there have been a number of game-based training systems developed in recent years. However, the field is still in its infancy. Improved understanding is needed on how to best embed instruction in a game and how to best use gaming features to support different types of instruction. Further, the field is inherently inter-disciplinary, requir-

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ing instructional system designers, software developers, game designers and more, yet there are no established development methodologies to ensure effective coordination and integration across these disciplines. The authors introduce a collaborative effort that is investigating how to improve the craft and science of game-based training. They present their experiences in creating a flooding control training system for the U.S. Navy Recruit Training Command, and discuss the inter-disciplinary development issues that they encountered. They present the lessons they learned and their views on how to advance current methods to support the consistent production of effective game-based training.

INTRODUCTION

Computer games of various kinds have been used for education and training purposes for over two decades with varying degrees of success (O'Neil et al., 2005; O'Neil & Perez, 2008). As computer gaming technology has matured and increased in capability, the opportunities available for delivering immersive learning experiences have increased (Bonk & Dennen, 2005; Hill et al., 2006; Hussain et al., 2008; Johnson et al., 2007; Roberts et al., 2006), and so has the challenge of creating experiences that are pedagogically effective (Diller et al., 2004; Hussain & Ferguson, 2005). A training game is imbued with a purpose - to provide experiences which lead to specific gains in the student's knowledge and/or skills. A good training game will consistently balance the instructional goals with the goal of motivating the player. However, a poorly designed training game will sacrifice one or more fundamental elements of the gaming experience in order to attempt to satisfy the training goals, or will sacrifice effective pedagogy in order to attempt to keep the game compelling. The former may be a great training system, and even a great simulation-based training system, but doesn't pass muster as a game-based

training system since the players don't enjoy it. The latter may be a great game, but doesn't pass muster as a training system since it does not produce the desired learning outcomes. Developers of game-based training systems know this, but achieving this synergy between instruction and engagement is a poorly understood art.

The challenges facing us as a discipline are:

- 1) An enhanced understanding of the elements of game design and pedagogical design that are crucial to game-based training and how to balance those elements effectively,
- 2) An enhanced understanding of how to assess the success of a game-based training application, and
- 3) The creation of development methodologies that lead to repeatable successes, especially for non-commercial training programs that are limited in the scale of effort that can be supported.

We introduce the initial results of a multi-disciplinary effort sponsored by the Office of Naval Research to directly address the issue of how to best create effective educational immersive computer games. The team for our project included researchers and content developers from the fields of instructional design, story-based training and entertainment, movie production, human performance assessment, game engines, commercial games, game-based training systems, simulation and modeling, intelligent tutoring systems, graphic design and modeling, system integration and educational science. As professionals in our respective fields, we each brought different perspectives on the interactions of different aspects of gaming and pedagogy to the table.

Our effort had two mandates. The first was to conduct applied and empirical research on tools and methods for enhancing the art and science of educational games. In particular, our initial focus was on identifying extensible design and development methods that support efficient cre-

ation of training games with strong pedagogy and embedded assessment. The second mandate was to create prototype training systems for the Navy that met real training needs and embodied sound pedagogy. The customer for our first training prototype was the U.S. Naval Service Training Command. The goal of this prototype effort was to provide training on how to perform effective flooding control aboard a simulated naval ship. The Flooding Control Trainer that we developed is intended for use at the Navy's boot camp to augment the classroom-based and hands-on instruction that is currently provided to over 40,000 recruits per year.

In a seven month period, our team members worked closely together, with subject matter experts and with our Navy customer to produce a prototype that met our customer's needs and was effective. We present here a description of the process that we followed, the tensions we encountered during the effort, and the lessons we learned on how to work in an interdisciplinary manner to achieve an instructionally strong and enjoyable outcome. We discuss our next steps in the project to refine and formalize our process, as well as our thoughts on where the field needs to focus going forward to ensure longevity and success as a discipline.

BACKGROUND

From a theoretical perspective, games hold promise as effective teaching devices because they can provide instructional environments that embody key principles derived from learning science. For instance:

- Interactions that facilitate player engagement in a *compelling task environment* should facilitate learning. Practicing in this type of environment is consistent with notions about the development of expertise (Bransford et al., 1999; Chi et al., 1988;

Glaser, 1989) and anchored instruction (e.g., Bransford et al., 1990; CGTV, 1992; CGTV, 1997; CGTV, 2000). The game world provides a context in which appropriate mental models are developed and refined through repeated exposure to important cue patterns.

- Games provide an excellent *model-based world* to foster reasoning. Students are able to manipulate variables, view phenomena from multiple perspectives, observe system behavior over time, draw and test hypotheses and compare their mental models with representations in the external world. These features are consistent with the model-based reasoning concepts advocated by learning researchers (Cartier & Stewart, 2000; Gentner, 1983; Leher & Schauble, 2000; Raghavan et al., 1997; Raghavan et al., 1998; Stewart et al., 2005; Zimmerman et al., 2003).
- Game-based tasks are expressly designed to help players *progress toward goals*. Moreover, the goals are concrete, specific, and timely. The vast literature on goal setting in instruction suggests that this characteristic property of games should enhance learning (Locke et al., 1981; Locke & Latham, 1990; Schunk & Ertmer, 1999).
- Interaction frequency is very high in games. These often require decisions and inputs by players several times a minute. Thus, games provide a *highly active learning* environment, the kind of environment associated with effective instructional system design (Chi, 2000; Mayer, 2001; Rothman, 1999; Vogel et al., in press).
- Well-designed games provide the player with constant successes. Many small tasks are embodied along the way in the pursuit of a greater goal. The result is that the game generates a feeling of constant accomplishment, a feature likely to *enhance self-efficacy*, which has been consistently

shown to improve learning and motivation (Bandura, 1977; 1986; Gist et al., 1989; Gist et al., 1991).

- Games provide a *continuous source of feedback* so that players know where they stand with respect to their goal accomplishment. This is crucial since feedback improves learning through both its informational and motivational qualities (Bransford et al., 1999; Salas & Cannon-Bowers, 2000).
- Game play tends to be *self-regulating*, an important feature of effective learning. Players are motivated to accomplish the next challenge and they know where they stand relative to their goals (Kanfer & Ackerman, 1989; Kanfer & McCombs, 2000; Pintrich & Zusho, 2000; Schunk & Ertmer, 1999; Schunk & Zimmerman, 2003).
- *Engagement and immersion* are high in well-designed games. Literature is beginning to investigate these concepts as psychological states associated with effective performance and learning (Csikszentmihalyi, 1990; Gerhard et al., 2004) and to examine what contributes to them (Baylor, 2001; Gerhard et al., 2004; Moreno & Mayer, 2004).
- *Challenge and competition* are hallmarks of good games. These features have been found to be motivational under certain conditions (Epstein & Harackiewicz, 1992; Reeve & Deci, 1996), and may be useful to motivate learning.
- Perhaps due to factors listed above, *time on task is very high* for games. It is not uncommon for players to spend hours a day on engaging games, and to continue interacting with a single game for years. From a strictly time-on-task perspective, we would expect that learning would be enhanced when trainees engage quality learning content for longer periods of time.

Despite this promise, however, many game-based training applications suffer key deficiencies leading to poor learning outcomes, such as poor instructional design, poor (or no) performance assessment, limited training scope, low levels of reusability, and lack of appeal to students (Hussain et al., 2008; O'Neil & Perez, 2008). These problems are due in part to the limitations of current gaming technology - for example, commercial games typically do not provide the ability to capture the relevant performance data at the right level of detail for tracking and assessment of trainee performance. However, they are also due in large part to the fact that there are no clearly proven methods for the development of effective training games. Further, most organizations and companies developing game-based training systems have only a few years of experience doing so and their experience is usually limited to work on one or two systems. Generally, designers and developers apply methods that have been appropriated from other fields, such as general software development, simulation-based training, computer-based training, commercial game development, and intelligent tutoring systems. The lessons learned from these ad-hoc approaches to game-based training development are rarely shared. Hence, insights are lost, pitfalls are re-encountered, and useful community-wide guidelines are not formed. Further, different development teams contain expertise in different fields, and hence some elements of game-based training design tend to be emphasized at the cost of others.

Our project team was a highly multi-disciplinary set of experts, each with varying degrees of expertise with game-based training, but all with deep knowledge within their core disciplines. The development team included members from seven different organizations that together provided expertise in game-based training, educational science, commercial game development, instructional design, human performance assessment, story-based training, simulation-based training,

computer-based training, military training systems, graphic design and modeling, animated movie development, entertainment and media production, intelligent tutoring systems, game engine development, agile software development methods, and systems integration.

Collectively, these experts brought to bear a rich subset of the practices currently used for developing game-based training. The key practices that we chose to start with based on preliminary discussions included:

- The manner in which the system will be used impacts instructional design choices, so pay close attention to requirements gathering.
- Remain focused upon learning objectives throughout system design and development.
- Develop the story outline early on, base it on the learning objectives, and iterate as system design proceeds. Taken to an extreme, one of the teammates believed that “It all starts with story.” According to Jerome Bruner (1990), plots are a creation of “transactional relationships” between reality, memory, and imaginary/narrative worlds. Transactional connections help learners use what they know in order to contextualize what is unknown, meaning that since the human brain needs story to provide context. An effective story provides a basis for addressing requirements and framing all content development in order to produce a consistent and compelling product.
- Incorporate assessment needs as early as possible during system design and development. Post-development efforts to graft assessment on a system not designed for it lead to significant problems in capturing the type, quality, and quantity of data required for effective assessment.

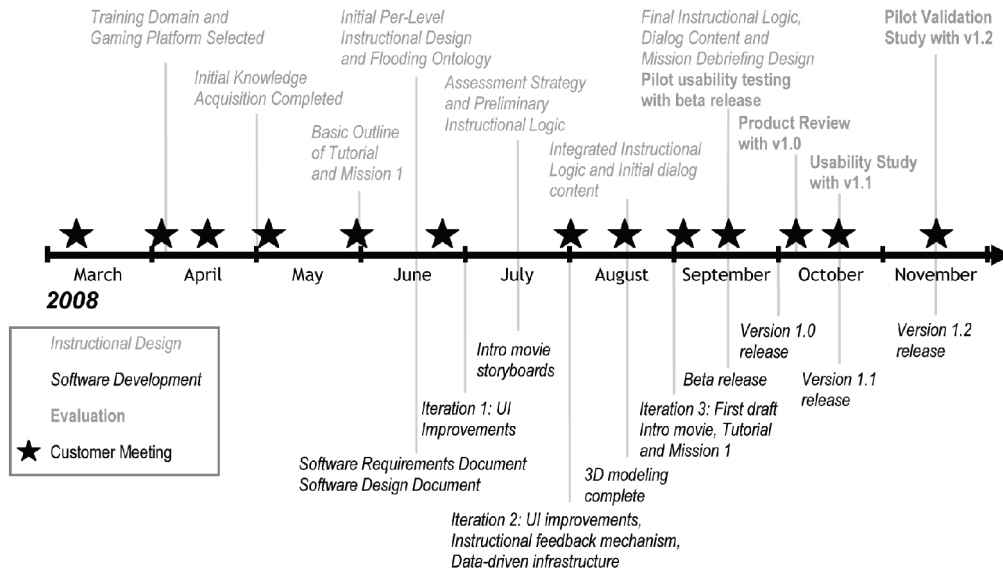
- Agile development methods work very effectively in fast-paced game-based training development efforts.
- Early involvement of all stakeholders in design and ongoing involvement during design and development iterations leads to a more robust product and helps avoid significant pitfalls.
- Keep the customer involved throughout to ensure the product meets stated and unstated requirements (and adapts to meet changing requirements).

DEVELOPMENT PROCESS

In March 2008, our team began the development of a game-based training prototype. Over the course of seven months, we followed an agile development methodology to iteratively create and refine our instructional design, and develop and refine our initial product prototype, which we delivered successfully at the end of September. During our effort, we encountered a number of issues, many of them due to tensions caused by differing perspectives of the project stakeholders based on their backgrounds and relative priorities. All key issues were resolved, practically-speaking, to result in a product that met our customers’ needs and satisfied the immediate goals of the project. However, a number of the tensions remained as background issues and recurring discussion themes. In this section, we summarize the key tasks of the project in a roughly chronological manner, and identify the key tensions that occurred along the way. Figure 1 illustrates the project milestones that are discussed in more detail in this section. The following section expands upon these tensions and identifies the methods used to address them and/or the lessons learned from our experience.

Our project, a three-year effort that started in February 2008, had two mandates - to conduct applied and empirical research into tools and

Figure 1. Timeline of project milestones



methods for enhancing the state of the art and science of educational games, and to ensure that these developments would have long-term value to the Navy. In order to achieve the latter mandate, we created a prototype training system for the Naval Service Training Command (NSTC) to enhance the Navy's Recruit Training Command (RTC) curriculum. Our NSTC customer has a background in educational science and deep knowledge regarding the training needs and culture at RTC. From RTC, we drew upon the training staff as subject matter experts (SMEs). Thus, the stakeholders of our effort included our transition customer (NSTC), our program manager (ONR), the subject matter experts and the members of our team.

To support the first mandate, we identified a need for a game-based training test bed allowing the explicit control of diverse variables in order to empirically study the impact of gaming and instructional features upon learning outcomes. This test bed capability formed an additional requirement for the initial training system we created. The focus of the paper is the process we followed

in developing the training system product and our lessons learned from that effort. We describe certain interim and final elements of the product to support our discussion. However, a complete description of the final product is not given.

Selection of Training Requirements, Domain, and Gaming Platform

In developing our training product for RTC, our initial step was to identify the specific training needs. At RTC, recruits currently undergo six weeks of intensive training on fundamental navy skills and end their training with an intense exercise called Battle Stations 21 (BS21). BS21 is a real-life simulation environment in which recruits are exposed to seventeen simulation scenarios during a single night. The facility is a building designed to give recruits the experience of being aboard a ship, and contains a simulated dock, a simulated exterior of a destroyer, and several floors that simulate different decks of a ship.

The goal of our effort was to provide supplementary training to augment the current classroom-

based and hands-on instruction in order to produce better prepared sailors. While overall performance of recruits in BS21 is excellent, students frequently exhibit key errors in several of the BS21 scenarios due to training gaps on those skills. Our requirement was to provide a compelling virtual training system to address some of those gaps.

At this earliest stage of product development, past experience has shown that it is critical to fully involve the customer. With any training system, the focus of the training must be driven by customer requirements, and the requirements must have a direct relationship to the learning outcomes desired. With any training application, it is important to choose a training domain that is suitable for the type of training possible with the technology used, or, alternatively, to choose the right type of training technology for the type of training desired. In our case, the customer desired an initial product delivery as soon as possible and wanted the product to provide immersive training geared toward single players. The customer desired that the training address a domain that would have high payoff in terms of improving recruit performance in BS21, but also wanted the application to provide familiarization with operating within a (virtual) ship environment. Within those constraints, we had a fair amount of leeway.

In initial discussions with our customer and with SMEs, four key training domains were identified as high benefit: controlling a flooding situation, standing a bridge watch, handling rope and navigating within a ship. Of these, it was determined by all stakeholders that handling rope was the least appropriate for an immersive gaming environment. Navigating within a ship was determined to be of secondary importance in that it could be embedded within training focused on either of the other two domains.

In these early discussions with the customer, it quickly became apparent that the high-level goals of the customer and the project could be best attained by leveraging an existing, open-source

game-based simulation prototype developed for the same customer. That application was based on the game engine Delta3D and contained a high fidelity representation of the ship interior of BS21 with a first-person perspective (see Figure 2). The drawback to the application was that it had minimal pedagogical infrastructure and minimal gaming elements. The advantage of the application was that it would avoid the need for an intensive graphics development process, and, since it was open-source, would allow us to add the pedagogical elements we needed. One of our team members had been the software developer for that application, which also provided us with immediate expertise. From the customer's perspective, reusing the application would justify earlier investments. Further, the customer already knew its strengths and weaknesses and was able to give us specific feedback on what he wanted improved for our product. The earlier application did not, however, contain virtual characters. Preliminary task analysis determined that it would be pedagogically appropriate to provide flooding control training without virtual characters since those skills can be performed by a single individual alone in real-life situations. Bridge watch, in contrast, inherently involves a team of people and thus the application would require augmentation with simulated characters to provide effective training. The bridge watch domain was deemed too risky to meet our aggressive development schedule.

The final choice of training domain for our initial product - flooding control - was made in early April for practical reasons based on the nominal choice of training platform and the customer's view of which domain would have higher product acceptance at RTC. The process of making this decision revealed one of the first key tensions in the project:

- The basis for technology decisions – pedagogical or technological

Figure 2. Available 3D simulation environment of BS-21 interior



Knowledge Acquisition

Once the choice of the flooding control domain was made, we undertook the task of knowledge acquisition for the flooding control domain. The knowledge acquisition methods we employed included a traditional, formal cognitive task analysis (CTA) as well as a subject matter analysis focused upon the potential elements for flooding control game scenarios, termed here a scenario element analysis. The analyses were based upon reviews of training materials in use at RTC, observations of recruits performing the flooding control scenario (and others) in BS21, and discussions with SMEs. In mid-April, a SME session was conducted face-to-face with six trainers from RTC. During this session, the questioning was led by our instructional designers, but representatives of most team members were also present and contributed to the discussions. This session, as well as a couple of follow-up face-to-face and teleconference sessions, provided two initial products.

The first was a traditional breakdown of learning objectives and the identification of expected behaviors, common errors, and consequences. The CTA determined that there were four key categories of learning objectives—those related to communication, situation awareness, appropriate

decision-making, and leadership. The communication learning objectives, for example, included reporting a situation immediately, communicating relevant information, and reporting when an action is completed. Decision-making objectives included maintaining watertight conditions, requesting permission before taking action as appropriate, and performing proper containment procedures. In addition, the CTA determined that there were certain skills that the recruits were expected to know based on the current curriculum, certain skills that it would be desirable for them to know if training could be enhanced, and certain skills that were very important in real-life, but that were beyond what could be expected of a normal recruit.

The second product was a breakdown of the elements of the flooding control mission that suggested the potential structure, actions, and variations for a simulated flooding control scenario. The scenario element analysis determined the typical timeline involved in a flooding control mission and the specific elements of the different phases of the mission that suggested the potential actions and variations to be included in a simulated scenario. These phases were broadly captured as: the discovery phase (the actions surrounding the event that identifies the need for flooding control), the preparation phase (actions in getting assigned

and ready to combat the flood), the transit phase (actions taken en-route to performing flooding control), the casualty combat phase (the procedures and options available while trying to control the flood), and the completion phase (what actions are performed at the end of the situation). These phases summarized the SMEs' views of the typical way in which a flooding mission occurs and what they felt needed to be reinforced with the recruits. Within each phase, a number of activities, possible actions and scene variations were identified. For instance, in the transit phase, additional hazards could be encountered, such as additional leaks, additional flooding locations, unsecured items in hallway, injured personnel and watertight doors not closed appropriately. During different phases, inappropriate setting of a watertight boundary could lead to various complications, including allowing a flood to spread or trapping a shipmate. In addition to multiple phases of a mission, the scenario element analysis identified multiple roles involved in different phases of a flooding control mission, including a first-on-scene sailor, a damage

control (DC) team leader or member, and damage control central (DCC). The SMEs indicated that the recruits should be taught certain skills associated with certain roles, even if they would typically not be in those roles for some time.

The products of the CTA and scenario element analysis were then merged to form a third product that mapped the learning objectives in context across the phases and roles (e.g., Figure 3 shows one of 26 learning objectives mapped). This product was prepared by May 1 and provided inputs to our story development process.

During the knowledge acquisition process, several tensions arose, including:

- Identifying all the learning objectives versus selecting the objectives to be addressed in the first game prototype
- Balancing cognitive elements with experiential elements

Figure 3. Learning objectives and common errors in context of flooding mission phases and roles

Learning Objective	Expected behaviors (enabling objectives)	Discovery Phase	Preparation Phase	Transit Phase	Casualty Combat Phase	Completion Phase
Communication - Demonstrate they know (a) whom to contact and (b) what to say and (c) how to listen and repeat back						
Report situation immediately	Use best available means to communicate Report hazards upon discovery Report new factors in situation immediately	Role: First on scene Specific objective: Notify someone of the flooding situation immediately Expected behavior: Report flooding immediately upon discovery. Use best available means to communicate (phone, yell, send messenger) Common errors: Do not communicate. Ignore problem, isolate location without permission, combat casualty on own. Consequences: No one else knows. Leak/flood progresses quickly and DC has less time to get there. Scenario variations: Individual injured or dies while combating. Individual electrocuted due to unperceived electrical hazard. Ship capability reduced. Ship sinks.		Role: DC team member Specific objective: Report any hazards en route to flooding area. Expected behavior: Report hazards upon discovery Scenario variations: Additional leaks, additional flooding locations, unsecured items in hallway, injured personnel, watertight doors not closed appropriately	Role: DC team member, DC team leader Specific objective: Keep DCC informed of any changes in situation. Expected behavior: Report new factors in situation immediately Scenario variations: Additional leaks, additional flooding locations	

Story Development

Great stories share at least six elements that set them apart from “scenarios” or “case studies”. They are: setting, characters, conflict/resolution, plot, voice, and emotion. Compelling stories, and those experienced in game environments in particular, are often called “immersive.” However, immersion doesn’t just happen; it takes purposeful effort on the part of the storymakers or designers. To achieve a great story, one must be intentional about combining the six elements in a way that will draw the audience (in the case of a game, the players) into the story so that they can see themselves as part of it. To do this, the story must be easy for them to relate to. To be successful as a learning environment, it must also create an “envelope” that will carry the learning tasks so that the learner literally “embodies” them.

Generally, fodder for narrative development in a learning product can be gathered in early conversations with the customer. In our effort, during the knowledge acquisition process, we determined through discussions that the basic objective of our initial product would be to teach recruits the steps required to stop (or mitigate the flow of) a leak on board a ship. We were thus able to begin to zero in on some of the key story elements from the beginning. For instance, from these early discussions, we knew the following about the eventual story:

- The story *setting* would be on (some type of) a ship.
- At least one of the *characters* would need to be a sailor on board that ship.
- The *conflict to resolve* would be a leaky pipe or breach in the ship’s hull that the sailor would need to fix or at least mitigate the effects of.
- The *plot* would need to include some sort of potential flooding scenario.

- We believed that the *emotion* of fear could be used to engage the learner as a crisis ensued. We also believed that the Navy values of “Honor, Courage, and Commitment” that were instilled in recruits during basic training could be used to provide motivation to overcome the fear and lack of initial skills, competence, and confidence to perform the mission.
- Voice, or who the “teller” would be, was not established until later.

On May 6-7, we held a two day story conference. We came together as a team of instructional designers, programmers, writers, and artists to begin to create the metastory for the game. Our customer participated and provided subject matter expertise as well as general guidance. The instructional designers kicked off day one by reviewing the learning objectives with the group so that we would stay focused on those throughout the day. The group was led by experienced story development facilitators through activities chosen to help us experiment and “play” with character development, setting, and plot points that would drive the learning objectives involved with a flooding scenario. It was important to develop a metastory that would be believable and that a new recruit would identify with as well as one that would set us up for the kind of conflict or crisis that could incorporate other possible disaster prevention/recovery scenarios (e.g., fire fighting) over time.

During the discussions, our customer emphasized the need to reinforce the pattern of “look-report-do” when training recruits. This led us to focus upon the situation awareness, communication, and decision-making learning objectives, and to de-emphasize leadership. To further focus the story, our customer in particular and the team in general prioritized all the enabling learning objectives based on training requirements and perceived utility.

After the story conference, the story developers used the notes from the two-day event and developed a draft of the metastory which included several possible game levels. During the first pass at the story, we decided that the background story (“backstory”) would be told in the third person by a narrator that was not a part of the story itself. This backstory eventually became the introductory movie or “intro cut scene” of the game.

During story development, a key tension was:

- Story first versus design first

Game Design

On May 29-30, we held a two-day team meeting to flesh out the specific training scenarios for our product. A representative from the customer attended, but no SMEs did. Using the learning objectives and story construct as a basis, the team brainstormed on how we wanted to provide training within the game. We made the decision to couple a guided discovery instructional strategy with an adventure-style gaming strategy. Following a common gaming approach, we decided to create a game with multiple levels of increasing difficulty. Based on the scenario element analysis, we decided to structure each level as a single mission, possibly with some “twists” to add to the sense of adventure. To support our instructional and gaming objectives, we identified a general mechanism for using dialog and messages from game characters to provide mission objectives, story and adventure elements, and instructional guidance and feedback. To avoid the need for animating the non-player characters, we designed the game in such a way that these characters would be elsewhere in the ship, out of view. Further, we incorporated the capability to provide students with opportunities to fail, possibly catastrophically, depending upon their errors.

Early on, we realized that we would need a tutorial level to train students on how to play

the game. This is a standard mechanism used in commercial games to bring players up to speed. The instructional designers deemed it important that this tutorial level would introduce the basic instructional mechanisms to lay the foundation for how the game would deliver its training. The game designers emphasized that the tutorial level should reinforce the mission metaphor to introduce the gaming strategy and to set student expectations. The story developers encouraged the incremental introduction of story elements throughout all levels, including the tutorial level. We converged on a tutorial level design that met all these goals.

Using the multiple levels of expertise identified in the CTA and our earlier rankings of the relative priorities of different learning objectives, we fleshed out the basic enabling learning objectives for the initial game levels. By the second day, we had designed the outline of tutorial level and three training levels of increasing difficulty. For each level, we identified which behaviors we wanted to assess, the key story developments, potential instructional scaffolding, desired immersive elements (such as sounds, lighting and game objects and effects), and the general flow of the gameplay.

At this point we captured and prioritized all the desired instructional and gaming capabilities. We determined that the initial prototype would focus on the tutorial mission and the first training mission (“Mission 1”). This provided the basis for the software requirements and the launching point for further instructional design.

The tension revealed here was:

- Gaming strategy versus instructional strategy

Initial Instructional Design

Following our May 29-30 meeting, the instructional design process began in earnest. Our instructional designers, assessment experts, and

Figure 4. Potential game levels produced during game design session

Story Development: Approaching area of operation, prepare for underway replenishment (UNREP)
Tutorial Level
Inspection: Inspect and secure repair locker
Objectives: Game mechanics, Communicate using phone.
Assess: Time taken. No failure and no negative feedback. High guidance.
Story Development: Ship collides with oiler during UNREP
Mission 1 Level
Investigate and Repair: Assess and repair leaking pipe
Objectives: Communicate with DCC, Maintain watertight integrity
Assess: Intent and accuracy of actions
Feedback: Guidance primarily in response to errors. Negative feedback and potential catastrophic failure
Mission 2 Level
Repair Complex Flood: Assess and repair multiple leaks
Objectives: Establish boundary, Apply appropriate repair, monitor and report situation, prioritize decisions, dewatering
Assess: Intent, accuracy of actions and effectiveness of decisions
Feedback: Low guidance, multiple ways to fail, complete success possible but order of decisions matters
Mission 3 Level
Rescue: Combat flood and ensure safety of equipment or personnel at risk
Objectives: Maintain safety of ship. Assess and report changes
Assess: Appropriateness of decisions
Feedback: Low guidance, complete success not possible – hard choices necessary, multiple “passing” mission completion states

game developers worked iteratively to identify the specific instructional elements of the proposed “Mission 1” game level based on our cognitive task analysis and our guided discovery instructional strategy.

An initial instructional design was developed by mid-June that elaborated on the learning objectives associated with each level and suggested the general instructional approaches to be used in the product. The guiding principles of this initial design were to:

- Address objectives in story, rules, consequences
- Design consequences to dispel misconceptions
- Provide feedback to promote learning
- Use scaffolding to guide players and allow them to experience actions beyond their level to reinforce learning objectives
- Use gaming technologies to facilitate the development of mental models

The instructional approach was a holistic design for providing part-task training within the context of the whole task. It specified multiple forms of feedback for alerting players to deficiencies and providing opportunities for players to demonstrate skills again in similar but not necessarily identical situations. It attempted to carefully control variations to ensure that the player did not just learn the game mechanics, but also understood the underlying facts, concepts, or principles.

The initial design also identified a general approach for assessment within the game. The types of assessment envisioned included completion of tasks, accuracy, time taken and steps taken. The intent was to assess learning objectives throughout the game by the actions the player would take. These assessments were also expected to affect play. The player’s actions could be limited until he or she demonstrated a predetermined level of mastery. A final performance assessment would be given at the end of the game that would detail strengths and weaknesses. In this final assessment, the player would be informed of how well

Development of Game-Based Training Systems

he or she did on each of the game performance criteria and how to improve performance in the future. Drawing upon the CTA, the scenario event analysis, and the basic game level design, the initial instructional design identified a series of key scenario events, the associated learning objectives and the associated assessment requirements (see Table 1).

The design specified several different types of feedback to be used in the game, such as:

- Natural consequences would be used, when possible, to indicate the effects of the player's action. The player would be made aware of the relationship between their action and the consequence (e.g., the player must know that turning the valve cuts off the water supply for fighting a fire).
- Hints would be given to reinforce or correct declarative knowledge, for example

Table 1. Mission 1 level scenario constraints and learning objectives

EVENT	ENVIRONMENTAL REQUIREMENTS	LEARNING OBJECTIVES	ASSESSMENT REQUIREMENTS
Readiness Set Readiness condition is set as a result of ship-wide "event" –General Quarters	• Alarm sound • Lighting effect • Announcement over the sound system	Decision-Making • Respond to readiness condition Situation Awareness • Report to proper location	Learner immediately leaves for general quarters assignment
Navigate Ship (recurs throughout game) Learner navigates within the ship	• Circle X, Y, & Z doors to open/close • Limit space to task area – Control where they can go. • Phone on wall in destination compartment or passageway	Decision-Making • Comply with restrictions on doors Situation Awareness • Identify location Communication • Ask permission before opening door	• Used phone to ask permission for opening doors • Opened/closed correctly • Path taken • Used phonetic alpha/num • Repeated back instructions • Located the proper compartment, as ordered • Reported location
Detect Flooding Situation Learner encounters flooding situation in a compartment	• Pipe w/ slow, obvious water leak • Other pipes not leaking • Identifier for compartment location	Situation Awareness • Conduct assessment • Recognize flooding cues • Identify location • Identify type of pipe leaking Communication • Ask permission before opening door, entering compartment;	• Asked permission to open door • Did not enter the compartment without permission.
Report to DCC (recurs throughout game) Learner reports to DCC	• Phone to use • Way to conduct two-way communication. Phonetic alpha/num • CCOL that can be read.	Communication • Communicate relevant information • Listen and repeat back instructions • Listen and acknowledge or correct repeat back Situation Awareness • Locate CCOL • Recognize equipment and material settings in CCOL	• Reported correct pipe/liquid type • Reported correct location • Corrected errors from DCC • Repeated back • Look at CCOL and used CCOL information correctly • Reported contents of the room
Minimize/Contain Leak Learner is ordered to repair/contain the leak	• Repair locker (to select & open) • Containment equipment (jubilee, shoring equip) to select from	Situation Awareness • Find repair locker Decision-Making • Perform proper containment procedures • Select appropriate equipment • Use proper technique for attaching patch	• Located repair locker (path taken) • Opened locker • Selected correct equipment (# of attempts, order of selection) • Placed patch and & tightened with wrench

- by telling the player the general rule or protocol.
- Catastrophic failures that immediately stop the game would be used to emphasize critical errors made by the player.
- Game scores would be used to provide feedback on the key behaviors to be developed and to reward the attainment of desired learning outcomes

Finally, the design specified several possible types of scaffolding to consider, including:

- Limiting the play space and/or choices offered to avoid cognitive overload and focus attention on key cues in the environment
- Providing hints that focus on the facts, rules, and or steps in a procedure
- Providing just-in-time information, particularly at novice levels, when the player is not expected to know that information or when that information is not critical to achieving the learning objective
- Modeling or demonstrating procedures using gaming techniques or incorporating embedded videos
- Providing advance organizers, such as a schematic of the ship to aid navigation
- Providing characters to guide the player in decision making when a player has been unsuccessful after several attempts
- Providing access to “mini-games” as needed to increase proficiency in basic skills

Following a traditional game technique, the notion of a “score” was initially suggested as a form of implicit feedback, and the use of specific warning messages in response to student errors was suggested as a form of explicit feedback and guidance.

During this initial instructional design process, two key tensions were revealed:

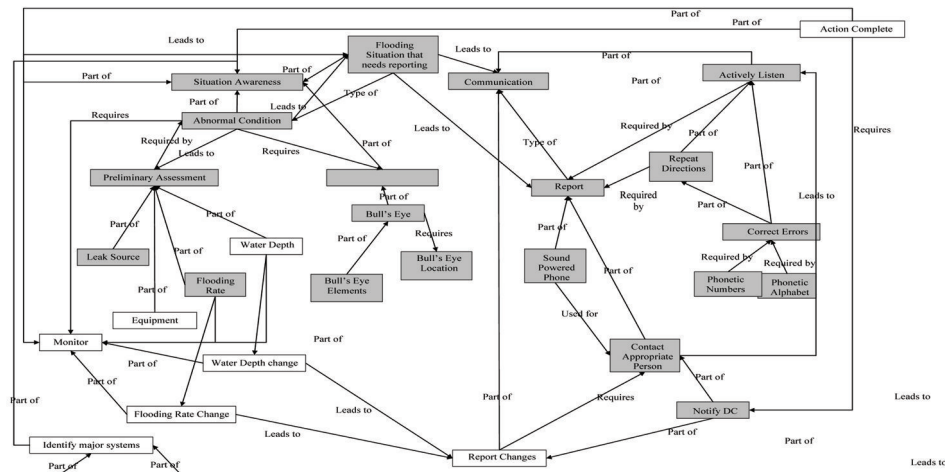
- Directive instruction versus guided discovery
- Feedback for learning versus feedback for motivating gameplay

Assessment Strategy

To accomplish the task of embedding effective assessment in our game, our design process dictated that we begin by examining the damage control domain - a broad class of activities of which flooding control is a part. Working closely with the instructional design team, the assessment experts identified the key constructs and relationships that formed the sub-domain of flooding within the damage control domain and mapped these constructs and relationships into a Flooding Ontology (a visual representation of the constructs and that make up flooding and how those constructs are linked). The ontology was divided into three broad constructs –Situation Awareness, Communications, and Decision Making—as these encapsulated the cognitive and behavioral elements relevant to addressing a damage control situation aboard a ship. The goals and objectives of the training, along with the assessments, would be designed around these core concepts and relationships. Given this general Flooding Ontology, the specific elements relevant to the Mission 1 level were identified based on the initial instructional design (e.g., see Figure 5).

With this ontology completed, we drafted a preliminary set of functional game requirements necessary for player performance to be sufficiently assessed. These requirements were specific features that needed to be represented in the game to serve as indicators of performance. They included elements the player could use to communicate with Damage Control Central (to assess communication skills), opportunities for the player to choose from a variety of apparatus the appropriate one to contain the leak (to assess content knowledge and decision making), and

Figure 5. Partial flooding ontology with mission 1 related elements (in gray)



opportunities for the player to interact with different types of doors under various material readiness conditions (to assess the player's understanding of readiness conditions and adherence to permission protocols).

Based on the initial instructional design and the general approach to gameplay, we proceeded to flesh out the detailed automated assessment strategy to be applied. The key learning objectives were mapped to key assessment requirements. We then identified, for each assessment requirement, the specific metrics that were possible to determine automatically in the game. These were tied as appropriate to specific scoring computations or feedback actions. The final assessment strategy incorporated the pedagogical objectives while respecting the need to have assessment fit in naturally with gameplay. The game score was defined to be monotonically increasing (i.e., total score could only increase in value, and would not decrease due to errors). The second iteration of instructional design, incorporating an assessment and feedback strategy for all learning objectives, was completed in mid-July.

In our assessment strategy, we attempted to identify behaviors that could lead to a failure of the mission. These serious errors would produce

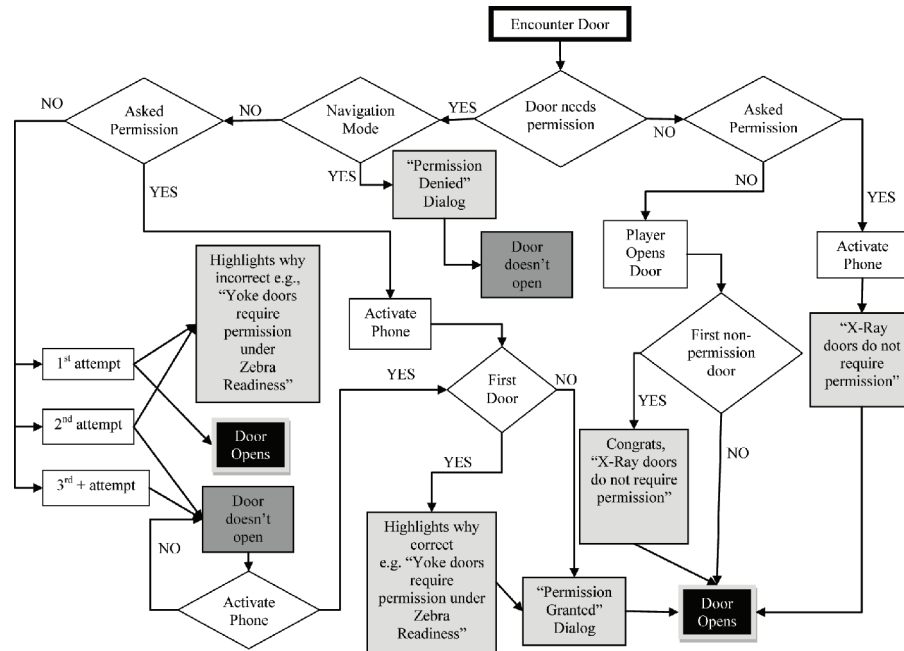
a demerit that interrupted gameplay to provide important feedback. Table 2 provides an example of the assessment strategy for a single learning objective (i.e., Follow safety protocol), showing implicit feedback in response to accurate behavior via a change to the game score, as well as explicit "demerit" feedback in response to errors. Many of the details of the assessment strategy changed during subsequent refinements.

As the detailed assessment strategy was being developed, preliminary instructional logic was also created to identify when to capture data for assessment of player performance, as well as to identify possible situations for performance-based feedback opportunities. The logic for several of the behaviors involved in a flooding control mission was captured by mid-July using flowcharts such as that in Figure 6. The motivation behind these initial flowcharts was to capture an "ideal" trainer by working forward from the ontology and recommended functional assessment requirements to produce a guided discovery instructional strategy that would also support effective assessment. Consideration of gaming strategy, story and mission flow were left as future integration exercises. The logic allowed for multiple attempts to accomplish tasks while providing different guid-

Table 2. Sample specification of assessment and feedback for a learning objective

Skill Area	Learning Objective	Assessment Requirements	Metrics	Positive indicator	Negative indicator	Game Score Feedback Effect - Success	Numerical/ Aggregate Metric	Scoring/ Feedback Effect - Negative
Decision-Making	Follow safety protocol	Did not enter the flooding compartment without permission.	Intent	Asked for permission to enter a room in which student had (incorrectly) reported flooding	Never ask for permission to enter a room	0		
			Accuracy	Asked for permission to enter the actual flooding room	Enter flooding compartment without asking permission	10 points if student enters the room after requesting and receiving permission	1 count per flooding compartment; 1 count per "first" entry into flooding compartment; 1 count per correct request to enter flooding compartment	Demerit: A demerit is issued if the student enters the flooded compartment without receiving permission.
			Multiple instances (flooding compartment)	N/A - only one flooding compartment in this level				
			Multiple occurrences (Over time)	Only keep track of requests prior to the first entry into the flooding compartment			Accuracy percentage: Total correct request / Total flooding compartment	

Figure 6. Preliminary guided-discovery instructional logic for obtaining appropriate permission before opening doors (light gray = direct instruction, dark gray = implied instruction, black = goal achieved)



ance and constraining user actions depending upon the errors made (and amount of error repetition).

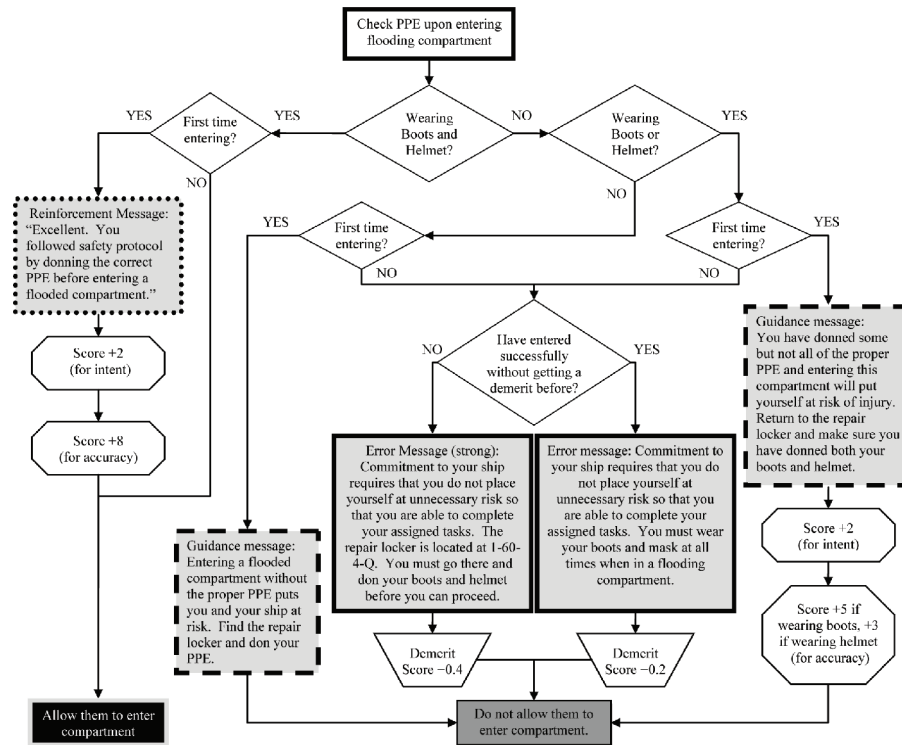
After mid-July, a collective effort was made to resolve the different representation formats preferred by the instructional designers, assessment experts and game designers and to integrate the various aspects of the product design. The most commonly agreed-upon format was the use of flowcharts. Using the preliminary instructional logic flowcharts (e.g., Figure 6) as a starting point, new flowcharts were defined for the key learning objectives of the mission 1 level. Figure 7 illustrates a flowchart specifying the instructional logic for “Following safety protocols”, as determined by donning the appropriate personal protective equipment (PPE). Each flowchart provided a specific set of rules indicating under which circumstances specific guidance messages (dashed border, light-gray), positive reinforcement messages (dotted border, light gray) or negative feedback messages (solid border, light

gray) should be given. These flowcharts integrated the assessment strategy and basic character interactions to identify the instruction, scoring, and dialog to be implemented in the game. New flowcharts covering all key situations in Mission 1 were completed in mid-August. During this revision, a second score mechanism was added to keep track of penalties associated with errors. Specifically, when a negative feedback message was given in response to an error by the student, a negative demerit score value was decreased by some amount. The demerit score (trapezoid) and positive score (hexagon) were separate values. The possibility of mission failure due to a high total demerit score (e.g., -1.0) was also introduced.

During the development of the assessment strategy and the associated instructional design revisions, two key tensions arose:

- Developing an objective versus developing methods for assessing attainment of that objective

Figure 7. Complete instructional logic for learning objective of “following safety protocols: Don appropriate personal protective equipment (PPE)”



- The right documents for sharing knowledge

Software Development

By mid-June, a software requirements document and an initial software design document were completed that identified the key changes needed to the existing simulation in order to support our desired training game design. In addition to supporting the instructional levels we had designed, we adopted an additional requirement to adapt the gaming infrastructure so that pedagogical elements of the training would be specified as much as possible using a data-driven approach rather than implementing a hard-coded game. The goal of a data-driven approach was to facilitate rapid changes to instructional content.

An aggressive agile development schedule was determined with four end-of-month deliverables: the first at the end of June and the last for

our final product at the end of September. The first deliverable would incorporate a basic mission flow (incorporating a briefing screen and a debriefing screen) and include some preliminary user interface elements (such as feedback and information windows). The second deliverable would provide an end-to-end walkthrough that exercised basic missions and basic forms of all interface elements. The third deliverable would include the data-driven infrastructure and all key graphics and animations needed to support the tutorial and main mission. The final deliverable would have a fully functional tutorial and the main mission.

In particular, the data-driven design adopted was as follows. A mission would be comprised of multiple tasks. For each task, specific trigger events would initiate it, and completion of the task would in turn initiate one or more other tasks. The specific tasks in a scenario and all details

concerning each task, such as its triggers and its description, were specified in the scenario data file. Further, a mission could contain multiple “score” objects, each maintaining a distinct value representing user performance. A score object could be triggered by direct player actions, such as dialog choices or entering a room, as well as by indirect actions, such as completing a task. The score object would contain specific feedback messages to provide to the user upon being triggered (e.g., via a “demerit” message or an instructional guidance message), and would maintain internal state reflecting the number of times triggered. The message could vary depending upon the number of times triggered. The specific score objects and all details concerning them, such as their triggers and messages, were specified in the scenario data file.

The key tension of the software development were

- Hard-coded versus data-driven implementation

Introductory Movie

In late June, as we iteratively refined our story, we realized that our product would be particularly enhanced by the incorporation of an introductory movie scene that would present the backstory and lay the foundation for motivating the student. The use of introductory movies and cut-scenes within and between game levels is a powerful method used in commercial games to enhance the player’s sense of immersion in the game. For our product, we determined that the introductory movie needed to:

- Motivate the desire to play
- Motivate the desire to serve in the Navy
- Introduce the backstory
- Promote the Navy core values of Honor, Courage, and Commitment
- Introduce the ultimate game objective

- Orient the student’s approach to playing the game

The introductory movie design was captured in a table that divided the script into small one- or two-sentence segments to facilitate the association of dialog with the appropriate on-screen visual. The team met via phone conference to discuss what should be seen while the narration was spoken. In order to hasten development and save money it was decided that characters would only be seen when absolutely necessary to the story. Likewise, we decided that in order to allow the learner to relate to the game character, the player would not be identified as male or female and that any time the learner had to “speak” it would be via text only. This meant that the learner would not ever see or hear himself or herself as a character in the game. This kept the player “generic” and allowed the learner’s imagination to fill in the gaps. Thus, a player could be immersed in the game without the necessity of choices of character art or voicing.

An artist then created storyboards (sketches) for the intro movie. The sketches were scanned and placed into the draft of the script. This document was shared with the larger team (including the subject matter experts) and feedback was incorporated into successive drafts. To stay true to story and reality, we decided it was necessary to have one non-player character (the officer of the deck who welcomed the learner aboard). Once the storyboard and script were approved by the development team and SMEs, the artists began to create the art and animations for the movie. For maximum effect, a 3D modeling approach with realistic ships and naval scenes was used. After a number of iterations with frequent SME feedback on the accuracy and suitability of our models, the graphic rendering of the movie was completed.

In parallel, a narration and sound script for the scene was finalized with inputs from several team members and from our SMEs. This process also involved the creation of a “scratch track” of

the narration of the introductory movie that was reviewed by our customer. Once the intro video was created, it was passed to our sound production team. Professional voice talent was used to record the narration for the movie, and the audio for the movie was finalized and enhanced with sound effects and music to add to the drama. The introductory movie was then incorporated into the game to be played before the tutorial mission.

There were minimal tensions raised during the development of the introductory movie. However, since the development of the movie was a substantial task, it was important to ensure that it was general enough to accommodate further story refinements in the game itself. During development, the specific wording used in the narration was varied slightly several times to reflect changes in the specific missions (particularly in the mission briefings).

Iterative Review, Refinement, and Testing

The instructional design, game level design, introductory movie, and software design were all refined in an iterative manner after the end of July. Efforts were conducted in parallel and discussions on one aspect of the product often involved team members working on other aspects. Customer design and product reviews were held bi-weekly (on August 4, August 17, September 4, September 17, and October 8). Three rounds of product testing with test subjects were held both before and after the initial product release. A pilot usability test was held on September 18, an end-user usability study on October 22-23, and a pilot validation study on November 17. Following each review and test, desired improvements were identified based on feedback and observations. These were then prioritized based on the importance of the changes and time/resource constraints.

In particular, four instructional elements were iterated upon and refined right up until the beta release in mid-September: instructional objec-

tives, assessment methods, dialog content, and mission debriefing.

On-going refinement of the instructional objectives of Mission 1 led to the following final set of objectives being approved by the customer on September 15 (see Figure 8). For each broad skill category (Situation Awareness, Communication, Decision Making), several terminal objectives were defined. For each terminal objective at least one enabling objective was defined.

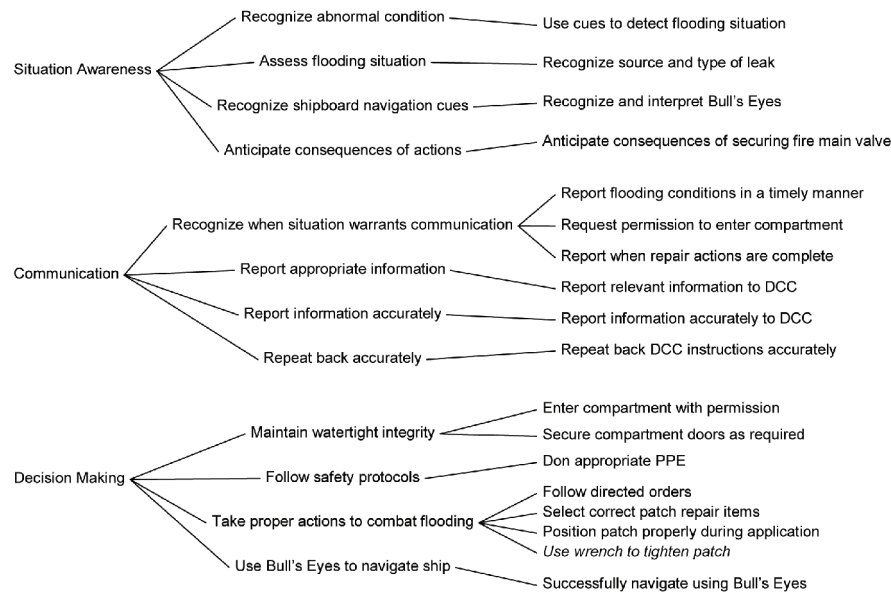
In the final implementation, the student's performance against every terminal objective was assessed automatically via the student's actions in the game and choices in dialogs. Dialog interactions formed a key method for assessing user performance against a variety of communication and situation awareness learning objectives. These assessments were context-sensitive (i.e., the same dialog choice may be correct or incorrect depending upon prior user actions). As shown in Table 3, a single dialog interaction could result in errors against different objectives (e.g., reporting appropriate versus accurate information), and different types of feedback (e.g., dialog responses versus demerits).

The mission was comprised of multiple tasks, and the student's actions were interpreted in the context of the current sub-task(s). At the end of the mission, the student was provided a debrief that summarized their performance against every terminal objective on a three-point traffic light scale (green, yellow, red). An analogous design was adopted for the tutorial mission, though with a much reduced set of terminal and learning objectives.

Tensions that arose during the iterative refinement process included:

- Designing for the novice while keeping the gamer happy
- Balancing revisions to instructional design with meeting software deadlines
- Gaming strategy versus instructional strategy

Figure 8. Final instructional objectives: skill areas - terminal objectives - learning objectives



MULTIDISCIPLINARY TENSIONS AND LESSONS LEARNED

The Basis for Technology Decisions - Pedagogical or Technological

The tension revealed by the intertwined choice of training domain and gaming platform concerns

the weight that should be given to pedagogical or technological factors when making decisions about which training technology to use. In our case, the decision was made primarily for technological reasons, and not for pedagogical ones. For instance, the view of the instructional designers and assessment experts was that the domain should have been chosen first, the cognitive task

Table 3. Assessment and feedback based on students' dialog choices

Dialog choice	Assessment	Feedback
"DCC, this is Seaman Taylor. I'm dressed out and ready to help."	Incorrect	Dialog response from DCC: "Seaman Taylor, DCC. I asked you to go to compartment 1-80-1-Q and report when ready to enter. Get on it!"
"DCC. I am at space 1-80-1-Q. Request permission to enter and inspect."	Error against 'Report Appropriate Information to DCC' learning objective	Dialog response from DCC: "Sailor, this is DCC. Who is this?" and Demerit (e.g., "A proper report should include your name and all relevant information about a situation." and 0.1 demerit score change)
"DCC, this is Seaman Taylor. I am dressed out and ready to enter 1-80-1-Q. Request permission to enter and inspect compartment."	Correct if student is actually reporting from a phone near 1-80-1-Q. If reporting from wrong location, then error against 'Report accurate information to DCC' learning objective	"Seaman Taylor, DCC. Aye. Permission to enter and inspect 1-80-1-Q granted. Report situation as soon as possible." Dialog response from DCC: "I am not showing you near that space. Go find 1-80-1-Q and call me from the nearby phone." and Demerit (e.g., "You made a bad report. The DCC trusts you to be the eyes on the scene. Reassess the situation and give the DCC a better report." and 0.3 demerit score change)

analysis performed next, and then, based on the key learning objectives identified, the technology choice should have been made that would best suit those objectives. Thus, choices such as 3D immersive versus 2D interactive environments, single-player versus multi-player, simulated characters versus no characters, and so on should, in principle, have been driven by pedagogy. The lesson learned is that the practical considerations of customer preferences, schedule, and available resources can significantly impact these choices.

Identifying All the Learning Objectives versus Selecting the Objectives to be Addressed in Level 1 of the Game

The multi-disciplinary approach to instructional design had a clear effect upon the decisions made on how to sequence training in the game. The instructional designers, assessment experts, game designers and story developers all agreed upon a layered approach in which the training was broken up into multiple levels of increasing difficulty. The challenge was determining what was meant by “increasing difficulty.” Everyone had a slightly different understanding of how the learning objectives might be linked to form a beginning level scenario that would be both engaging and prepare the target audience for a live simulation of the entire flooding process. Many interesting, collaborative discussions occurred in refining exactly what would occur in the earliest missions.

The instructional designers envisioned a layered approach focusing on the key steps in the flooding control process in all levels, but varying the complexity of the skills expected. In order to allow the students to experience the entire process in earliest levels, instructional designers advocated that some of the smaller steps in the process be provided to the learner or that the environment be structured in such a way that the player would not have to demonstrate more specific skills until higher levels of the game. Their primary goal was

to build a foundation to ensure that players had a basic understanding of what happens in a flooding situation, and to reinforce all the key process steps in all the levels. The story developers encouraged the idea that not all information about the situation needed to be provided at the beginning, and that an incremental introduction of new story elements to provide context for new learning objectives over successive levels would be effective. The game designers wanted to keep the early levels simple and slowly build up the complexity of the gaming skills needed over multiple levels. Unlike the instructional designers, they did not feel that all aspects of the process needed to be present in every level (i.e., certain levels could focus upon certain elements of the process). The assessment experts were concerned primarily with cognitive overload and wanted to ensure that new skills and information were introduced in an incremental fashion over successive levels.

The decisions regarding which learning objectives to focus on in the first level were made with the intent of satisfying these goals as much as possible, and multiple refinements were needed over time to reach consensus. For example, there were several potential learning objectives pertaining to the rules for opening and closing doors under various readiness conditions. In our developed ontology all possible types of doors and hatches and appropriate entry rules were presented. In a classroom, these rules would likely be learned and tested with a paper and pencil test. An embedded tutorial addressing these rules was possible; however, we did not want this to be our primary instructional target for the beginning level of the game. To do so would burden the learner with information overload and require many permutations for mastering the distinctions governing the handling of different types of doors when in reality, given the readiness condition already set by the collision, most doors would require the same treatment. We resolved the issue by limiting the kinds of doors visible to the player so that the correct procedure would be technically

correct while presenting limited cognitive load. Thereby, the learner could focus on the larger steps required to identify, report, and combat the flood. This solution managed the cognitive load appropriately, maintained cognitive and physical fidelity, kept the learner engaged in the story and prevented negative training.

A lesson learned from this key tension is to maintain communication and seek mechanisms for closer collaboration. Presenting the learning objectives and developing an ontology are critical to developing the appropriate story, rules, and consequences in the game. Instructional designers are accustomed to look at the relationships among objectives in terms of the development of student knowledge and skills and designing for a scaffolded progression based on skill level. Further research is needed to determine whether and when, for game-based training: every skill must be taught from the bottom up in level 1; levels should provide part-task training; or hybrid solutions will be effective. There is more than one way to develop skills, and gaming technology offers unique opportunities to develop skills that are not available through the use of other instructional media. We can select skills on which to focus in a specific scenario and manipulate the physical fidelity of the environment to meet the instructional design. In a game, this can mean restricting the environment or game space or sequence of events or having other characters perform tasks that are beyond the expectations for the level 1 player. There is a fine line between selecting tasks that would be fun but not expected to challenge the learner, and selecting tasks that would confuse or distract the learner at level 1.

Balancing Cognitive Elements with Experiential Elements

A difference in perspective between the instructional designers and the game designers was the basis for understanding and characterizing about the domain. During the knowledge acquisition

process, the instructional designers gravitated towards a focus upon the cognitive elements of the domain (via a CTA) while the game designers gravitated towards a focus upon the context in which learning would occur in the domain (via a scenario element analysis). The goals of a CTA and a scenario element analysis are different. The former is focused on performance and associated knowledge states. The latter is focused on identifying the environmental contexts in which simulated activities occur, the steps of and interactions among those activities, and the possible variations in the details of those activities or contexts. Both analyses were conducted with collaborative discussions among team members. However, there were frequent misunderstandings of how to characterize the domain. Eventually, it became apparent that the two analyses were capturing complementary information. The exercise of merging them (e.g., Figure 3) resulted in several interesting discussions in which some previous misunderstandings were resolved. One benefit was that additional enabling objectives were identified. For example, in the context of the transit phase, an enabling objective for reporting a situation immediately is reporting any hazards encountered en route to the flooding area. On the downside, the merged document was difficult to follow for team members who had not directly been part of the knowledge acquisition process.

The lesson learned is that both the cognitive and context aspects of a domain are critical for game-based training and each leads to different ideas on how to structure the learning experience in a game. More investigation into effective methods for characterizing and refining the two domain aspects is needed.

Story First versus Design First

In our effort, a lot happened very quickly. There was a general feeling that the story development (i.e., the StoryJam™ held on May 6-7) occurred too early in the process since the learning objec-

tives from the CTA were not fully understood and had not yet been prioritized. However, without the forcing function of trying to develop a focused story to support the training, the necessary type of filtering and prioritization of the objectives may not have occurred in a timely manner. Throughout the successive refinements of the instructional design and game design, the basic story elements established at the early meeting provided positive guidance that encouraged convergence of ideas and consensus on decisions. The story decisions were also remarkably stable. For example, the supporting backstory and story elements used in making decisions in the May 29-30 game design meeting were largely present in the final design several months later. The participation of SMEs as well as the customer in the StoryJam was instrumental in establishment of a credible story.

Further research is needed to identify the best way to time and use the story development process to positive effect in game-based training development. However, a clear lesson learned is that a collaboratively developed story facilitates collaborative decision-making during subsequent development.

Gaming Strategy versus Instructional Strategy

The key area of difficulty reflecting the multidisciplinary conflicts in the team was the relative emphasis of instructional elements and gaming elements. There are many different types of computer games and there are many different ways to structure instruction. In developing game-based training, open questions include what type of game is best suited to a particular instructional strategy as well as what type of instructional strategy is best for a particular type of game. When choosing a gaming strategy, one is typically choosing a particular suite of game mechanics (interactions the player may have within the game) and a particular type of event flow. Likewise, when choosing an instructional strategy, one is typically choosing a

particular suite of instructional interactions with the student and a particular organization to those interactions.

A general methodology for determining how to provide game-based instruction for a particular domain is to map the enabling objectives to specific game mechanics and specific encounters within each level to ensure that the game player is learning what the designer has set out to instruct. During the knowledge acquisition process of our effort, we discussed a variety of possible game mechanics for various enabling objectives. In fact, the SMEs would occasionally proactively suggest a means for how they would “teach this in a game.” In our case, these initial characterizations of the instruction led to an early choice of two “complementary” strategies - guided discovery instruction using adventure style gaming. Guided discovery instruction uses implicit and explicit interventions to encourage and focus a student’s exploration of the training domain to achieve the learning goals. Adventure style gaming uses carefully placed hints and clues to encourage the player to continue to explore the game world and achieve the adventure’s goals.

This choice led to a lot of synergy at the beginning of the design process. Instructional designers would suggest a need for an intervention, and the game developers could easily map this into an event furthering the adventure. However, as the instructional design process progressed, issues of how to embed new instructional elements often turned into discussions of how the “gameplay” might be adversely affected. Issues that caused the greatest tension were the instructional designers’ and assessment experts’ desires for increased guidance and feedback explaining all the student’s mistakes as they were made, explicit didactic information on every element of relevance in the scenario (e.g., a help lookup facility), and increased scaffolding, such as the use of a compass-like aid to assist in navigating around the ship. Their goal was to reduce the student’s cognitive load and to ensure that the student formed good mental models

as early as possible during training. Countering this, the game designers wanted to minimize the amount of non-embedded information (i.e., not delivered as a natural part of interacting with the environment and other characters) to reduce negative impacts on the player's immersion and to maintain the sense of adventure. After many discussions and necessary compromises on everyone's part, we succeeded in resolving most issues to produce a final instructional design and game design that supported one another.

Hence, the two related lessons learned are that linking gaming strategy to instructional strategy can lead to good synergy of design and a compelling experience, but that an early choice of gaming strategy can lead to difficulties in trying to incorporate incompatible instructional elements later on.

Directive Instruction versus Guided Discovery

Expectations for the design of directive instruction and discovery learning are not the same. Our task was to pull the best elements of each into an engaging game that fosters learning through guided discovery. Just how much guidance is required in guided discovery? Which are the elements that must be more closely guided? When is there no harm in letting learners play until they get it right versus when must one guide them so they are not bogged down by details that are insignificant and detract from learning (i.e., avoiding situations in which the learner becomes overwhelmed with less important details and misses the key learning opportunity)? A prime example was in reading the compartment identifiers, or "Bull's Eyes", which indicate the location and type of compartments. We purposefully focused the player's attention on two of the elements in the four element series of number and letters that defines a compartment identifier. The goal was for the player to learn to use the two elements well enough to navigate fore and aft and to recognize which side of the ship

they were on. Once these tasks were mastered the additional elements could be addressed. In the game, however, how long should the player wander before being guided to information that will help him or her reach the intended destination?

The lesson learned is to use the cognitive task analysis to focus on identifying the actions a student must make to carry out a task as well as the typical wrong paths a student can take. In experiential learning, we include these actions in the environment and make some of them options – deliberately selecting these to promote successful task development while not overwhelming the student.

Feedback for Learning versus Feedback for Motivating Gameplay

Games offer opportunities for players to see the consequences of their actions in ways other instructional methods do not. Feedback in the form of natural consequences of actions can be powerful; the trick is to ensure that the feedback is driven by the learning objectives and emphasizes the cause and effect relationship between learners' actions and the consequences so they understand what has happened and why. Consequences of actions in games often provide the "wow" effect garnering the player's attention but not always making clear exactly what the player did to give rise to them. For example, one of the early feedback responses considered was to have a Chief non-player character yell at the player's character when certain key mistakes were made. This kind of feedback was not necessarily appropriate from a chain of command perspective and did not support the learning objective. However, from a gaming/story perspective, it added some emotional stress and made the experience more exciting. Providing the player with appropriate consequences resulting from his or her actions had to be carefully considered as part of the entire gaming/instructional strategy. The experiential aspect of the game environment opens possibilities that should continue

to be explored while maintaining the instructional focus. Decisions about which type of corrective feedback to provide immediately within the game and which to provide in the post-game debrief remain important questions for research.

The lesson learned is that finding innovative ways to provide feedback that promotes reflection requires concerted effort, ongoing discussion, and continued research. The game design must examine the intended outcomes and the paths people take that compromise those outcomes. We can then devise strategies to promote awareness and reflection, such as by setting up distractions to entice players into making common errors and providing feedback to help them refine their thinking.

Developing an Objective versus Developing Methods for Assessing Attainment of That Objective

A game story line must be developed so as to create situations that challenge learners with respect to the learning objectives and that provide opportunities for learners to react and receive feedback on their actions. Therefore, the objectives as well as the assessment strategy need to be developed first in the development of the game. In formal schooling, assessments often occur after a learning event (e.g., end of module test). As a team with such a short development cycle, it was easy to slip into this way of thinking. Also, team members had differing expectations about the role of assessment and even about the meaning associated with it.

Assessment is another area where gaming technology offers new possibilities for learning. Using both time to complete and path taken are possible options in addition to “correct” actions. One promising discussion focused on assessing intent and accuracy as one way to understand reasons for a player’s actions and to tailor future trigger events so as to hone skills appropriate to that player’s needs. This kind of assessment

also has implications for the type of feedback provided. Van Merriënboer and Kirschner (2007) for example make the following recommendations for assessing intent and accuracy:

- If the learner makes an error that conveys an incorrect goal, the feedback should explain why the action leads to an incorrect goal and should provide a hint or suggestion as how to reach the correct goal. .
- If the learner makes an error that conveys a correct goal, the feedback should only provide a hint for the correct step or action to be taken and not simply give away the correct step.

The lesson learned is that objectives and assessments must be linked at the outset of the development process.

The Right Documents for Sharing Knowledge

A key challenge throughout the effort was conveying our thoughts and ideas to each other in an effective manner. Most stakeholders in the effort tended to think and operate at a different level of abstraction or with a different focus. Further, different stakeholders entered with different preconceptions about the motivations of other stakeholders. Exacerbating this quintessential inter-disciplinary communication issue was the fact that our team was widely distributed geographically. Despite roughly monthly face-to-face meetings and frequent discussions by telephone, numerous misunderstandings would arise and persist.

The knowledge sharing issue was particularly revealing in the documents that we generated to share our instructional design ideas. Every single performer had a different preferred format for capturing their ideas, even if the general type of document was similar. For instance, each of

us had a different view about what a storyboard entailed. This confusion led to various persistent misconceptions. For instance, the game designers tended to conclude that the instructional designers were seeking to provide learning that was linear in nature due to the list or table formats they used to capture instructional events.

At several points during the effort, attempts were made to integrate the different perspectives and create a single format that met the needs of all performers. During knowledge acquisition, a table format merging the key CTA information and the scenario element analysis was created (see Figure 3). During development of instructional and assessment logic, a rich flowchart format was used to draw together inputs from several sources (see Figure 7). During the specification of the dialog, three different formats were explored (a dialog tree, a storyboard with optional paths, and a linear list with linked dialog fragments), but ultimately the actual dialog implemented in the game prevailed as our means of discussing and reviewing dialog content.

There is a strong need for effective collaboration mechanisms in a diverse game-based training development team. While we identified some collaborative document formats, further research and refinement is needed to find those communication means that are most effective for game-based training design.

Hard-Coded Versus Data-Driven Implementation

In the field of game-based training, there is always a tension between implementing exactly what is needed for the specific instruction and implementing general game mechanics which can be used to support a variety of instruction. In many cases, the former approach is used, leading to a system that requires significant effort to adapt. Due to our broader project goals, we adopted the latter approach. In addition to a data-driven

task mechanism, several data-driven feedback mechanisms were implemented.

The software development iterations during July and August were focused on implementing a data-driven infrastructure and basic support for the game mechanics we wanted in our initial prototype. By the end of August, a preliminary implementation of the tutorial and Mission 1 levels had been implemented. However, further revisions to the instructional content continued right up the end of September. These revisions were easy to incorporate into the system, and we made numerous revisions to the instructional content without slipping our software deadlines.

A key lesson learned was that the focus on a data-driven approach to specifying the instructional logic in the game greatly reduced the stress of making changes to the game and avoided the need for any significant re-factoring of the code.

Designing for the Novice While Keeping the Gamer Happy

Aside from age, Navy recruits are the very embodiment of diversity – 40,000 recruits each year who come from every conceivable background. It was essential that our training system be accessible to everyone from super users to computer neophytes and be effective with everyone from expert gamers to non gamers. However, since our target population truly are novices in the domain of Navy skills, it was critical that the instruction be delivered at an appropriate level and not be overly challenging. In making our instructional design and game design decisions, there was an ongoing tension between designing for the novice and ensuring that the game was usable and appealing to a very broad population. This tension revealed several lessons learned.

The interface of the game needed to be simple to accommodate the broad range of users. Further, a simple interface is a common trait of many good games. However, in our effort, being simple was

often at odds with being comprehensive. The more instruction, data, feedback, interventions, and details we added, the more complex the interface became and consequently, the less usable. In the end, we decided to postpone some instructional interventions in order to maintain a simple, clean interface.

Dynamic interaction is the most obvious quality of games. After all, if one can't interact, a game reduces to a spectator experience. However, what types of interactions are appropriate for novice game players, while retaining appeal for the experienced gamer? In our game, the player assumed the role of a Seaman recently assigned to his or her first ship. By making the role in the game reflect the near future for all recruits, issues of experience in gaming were partially avoided (e.g., all the recruits are new to being aboard a Navy ship, so navigating around a ship effectively requires diligent attention to details in the environment). Further, we made actions in the game reflect real-world actions. Since these actions (e.g., navigating within a ship, repairing a leak using correct procedures, communicating properly with a superior officer) are not typical of a commercial game, both the inexperienced and experienced gamer still needed substantial learning in order to do it right.

Each mistake made by a player creates a brief teachable moment where corrective guidance can make a huge difference. However, the right level of guidance to give to a novice can conflict with the degree of freedom expert gamers expect. Our approach was to provide both non-interruptive and interruptive feedback of varying detail depending on the nature of the mistake made while keeping the player immersed in the story as much as possible. Minor errors would result in some guidance provided in a small pop-up window that was not intrusive. Conversely, when the student made a critical error, a demerit would interrupt gameplay visually and aurally with a specific message about the error. For both hints and demerits, the initial

message would be somewhat general. If the error was repeated, subsequent messages would be more detailed.

These decisions were borne out by results of product testing across all a variety of users. For instance, a student's first demerit stops mere button-clicking behavior and leads quickly to increased attention by both gamers and non-gamers.

Balancing Revisions to Instructional Design with Meeting Software Deadlines

In addition to our data-driven approach, another key contributor to our success was the use of an agile software development methodology. A particularly relevant aspect of agile development is frequent deliveries. One of the key tenants of agile development is getting working iterations of the software into the hands of stakeholders as early and as often as possible. With six geographically distributed groups, frequent releases helped mitigate communication issues and maintain a cohesive vision for the product.

As in many software products, the requirements provided by the customer may change over time. In our case, there was an increasing emphasis placed upon the depth of training to deliver. Initial requirements were for a skill practice environment with limited guidance. Later requirements were for a training environment with limited assessment that could produce some validated learning outcomes of certain skills. The final requirements, determined several months into the project, were for a training system with focused guidance, general assessment on all key skills, comprehensive feedback in response to errors, no negative training, and no irrelevant elements that would produce validated learning outcomes across most skills taught. Our agile approach to software development, iterative approach to instructional design and frequent interactions with

the customer enabled us to accommodate these changes in requirements.

Although key to our success, the agile method was not without issues. In fact, it caused some interesting tensions and challenges among the team. In order to produce frequent releases, software development moves extremely quickly. Yesterday's ideas become tomorrow's implementation. This put an extra burden on quick turn arounds and the rapid iteration of ideas and forced the team to focus on what's important. Ideas that fell into the "could-be" or "might be nice" categories quickly got pushed aside by "must have" and "critical" requirements. Whenever an idea cropped up, it was immediately weighted for its instructional or gameplay value and then balanced against the rest of the to-do items. The most important items always got done and the rest got set aside for another day. The result was a game that was delivered on time and within budget, met all customer needs, and passed the usability tests with flying colors.

FUTURE RESEARCH DIRECTIONS

In the next two years of our project, our plan is to investigate further issues related to the development of game-based training and to build upon the lessons learned so far to identify design and development methods that support consistent and effective outcomes. We plan to create additional refinements of the flooding control training system, as well as to create additional training systems in other domains for the same customer. These development efforts will inform and be supported by efforts to create better authoring and assessment tools for game-based training (e.g., of which our data-driven infrastructure was an early step). To ensure that our advances are well-founded, we will conduct a variety of empirical investigations into the effectiveness of different gaming features for training, and the interaction between different gaming and instructional approaches.

The field of game-based training is at an interesting crossroads as it moves from a poorly understood cottage industry to a well-founded discipline of its own. The multifaceted nature of game-based training is both its strength and its weakness - no other medium can provide as rich and varied learning experiences, but few other instructional mediums are as difficult to get right. There is a need for increased communication across practitioners to share processes, mechanisms, and lessons learned. We believe our continuing efforts in this project will provide seminal contributions towards formalizing game-based development methodology.

CONCLUSION

Conducting research on instructional games begs the question, "How can games be made instructional *and* engaging?" A critical battleground for this debate is the learning objectives and how they are used during design and development of the game. Respecting the role of learning objectives was an easy point of agreement for the team in the abstract. However, it was difficult to reach a common understanding of what that meant in terms of game play, story, actions, dialog choices, feedback, guidance, and the game environment. Instructional design based on learning objectives can limit distractions that overload the player with extraneous information that interferes with learning. However, the objectives alone do not guarantee focus on relevant information. Structuring the story must work in concert with treating the consequences of errors to help the player develop a mental model of what actions lead to the desired outcomes. The interactions between the player and the game must maintain the player's sense of immersion while also ensuring that the experience remains focused on the skills being taught. Finding the balance between adhering to the learning objectives while maintaining the characteristics

associated with a game was a persistent challenge that revealed itself in a variety of ways.

A second key battleground for this debate concerns the processes followed in producing an appropriately instructional and fun game. In general, the agile approach adopted in this effort resulted in ongoing priority conflicts between the instructional, gaming and story mindsets. The instructional designers by nature preferred a more traditional waterfall approach in which all key decisions regarding learning goals, content selection, and specification of instructional methods and strategies would be made prior to involving considerations about the story, the technology, and the gaming style. Their concern was that that key components, affordances, and experiences in the training system necessary from a pedagogical and assessment standpoint would be undermined or inadequately represented if instruction came second. The gaming developers by nature preferred clear direction on the basic interaction modes desired for instruction and the basic structure of a game level so that the associated software interfaces and graphics could be created in a timely manner, and were content to leave easy-to-change data details (e.g., the specific dialog and instructional messages, or sequencing of activities within a level) as part of an iterative refinement process led by the instructional designers. Finally, the story developers by nature preferred a strong early investment in coming to agreement on the basic story in order to ensure that successive iterative refinements of the instructional design or technology could be shaped to maintain a powerful story. From their vantage point, powerful stories create powerful experiences that invite participation while information and data, on the contrary, invite critique. The danger of ignoring the story aspect of a learning game at any stage of the process is that achieving a powerful story becomes difficult.

Of the many lessons learned in this effort, most involve the challenge of effective communication among professionals from diverse backgrounds.

It is important to clearly articulate each team member's priorities as early as possible and work together to devise methods for sharing and integrating information that will accommodate any competing priorities. From this, specific critical paths and components must be identified that, if organized and prioritized correctly, can inform the overall design and development approach. Since the process of combining the craft of game design and the science of learning has yet to be established, the lessons learned from this project may serve to inform the process and lead to an efficient and effective model for the development of games for learning.

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Chapter 2.16

Bridging Game Development and Instructional Design

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ABSTRACT

Instructional video game development is occurring in both the commercial game development and the instructional design/development communities, but regularly in isolation from one another. While many proclaim that game-based learning offers an instructional revolution, the empirical results on instructional effectiveness have been mixed. These mixed findings may be due to the contrasting approaches utilized within these two communities. These communities dif-

fer with respect to prioritizing goals and design/development processes. However, the creation of an effective instructional video game—one that both motivates and teaches—is dependent on the successful partnering of these communities. Accordingly, this chapter elucidates the commonalities and differences in the development goals and approaches of these communities and discusses how best practices of each community should be blended for optimal instructional video game design. This chapter also includes relevant experiences from an instructional PC-video game development project, illustrating challenges faced

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and new opportunities afforded via a collaborative development effort.

INTRODUCTION

With traditional instructional methods, such as formal classroom instruction, one fundamental challenge can be motivating students to fully engage in the instructional content. PC-based instructional video games have become an increasingly popular instructional medium, as many proclaim that video games engage and motivate learners in ways that traditional instruction hasn't in the past (Gee, 2003; Herz & Macedonia, 2002; Prensky, 2001). Further, some proponents of instructional video games suggest that today's learners (and game-players) are wired differently than learners of the past, and that game-based learning leverages this difference, capturing their motivation to learn (e.g., Prensky, 2001).

While many assert that game-based learning offers a new revolution in instruction (Gee, 2003; Herz & Macedonia, 2002; Prensky, 2001), the empirical results concerning its effectiveness with respect to student knowledge acquisition and retention have been mixed to date (Hays, 2005). Thus, utilizing this engaging medium may help alleviate the concern of low student motivation; however, motivation alone is not a sufficient condition for learning. This suggests that the important question for instructional game developers is not whether a learner is fully engaged in game play; rather, is the "engaged" learner actually learning the instructional objectives embedded in the video game or merely playing the game? In short, both student motivation and pedagogical structure are necessary determinants of the effectiveness of instructional video games.

The development of instructional video games represents new territory. Experts in the instructional design/training development community have typically developed tools used for instruction, while commercial game development experts

have mastered the development of video games for entertainment purposes. Video games designed specifically for instructional purposes represent a gray area, with training game development occurring in both communities but many times in isolation from one another.

It is possible that the demonstrated mixed effectiveness of instructional video games (e.g., Beal, 2005; Hays, 2005) can be attributed to the contrasting approaches utilized within these two communities. Many believe that the commercial game development and instructional design/training development communities differ greatly with respect to their fundamental goals (i.e., entertainment versus learning) and processes involved in design/development (i.e., game development versus instructional design processes).

The creation of an effective instructional video game—a game that motivates and also successfully teaches the intended instructional objectives—is dependent on the successful partnering of these two communities. While these communities may hold different goals or definitions of a successful development initiative, these goals are not incompatible. Further, while on the surface these communities may appear to utilize unique design/development approaches, these two communities actually embrace complementary approaches. Accordingly, the purpose of this chapter is to elucidate the commonalities and differences in the development goals and approaches of these two communities, and discuss how the best practices of each community should be blended for optimal instructional video game design.

The remainder of the chapter is organized as follows. First, the overarching development goals of both game developers and instructional designers are described. This includes how these goals differ, as well as overlap. Next, is a description of the different developmental processes that game developers and instructional designers are likely to follow in product development. Again, differences and similarities in the product development processes of both communities are highlighted.

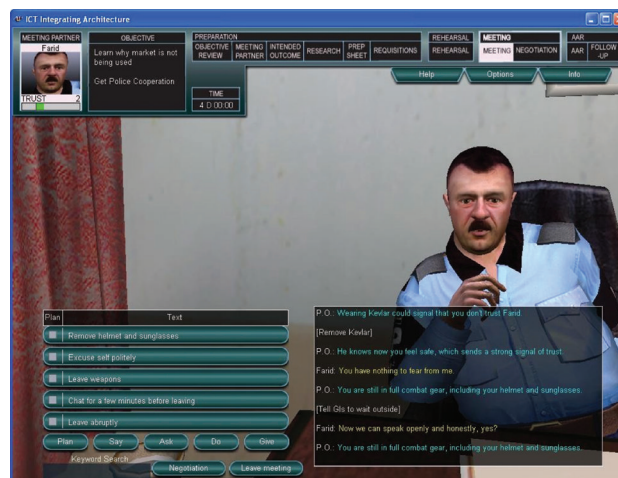
Further, to illustrate the challenges faced and new opportunities afforded when these two communities partner in the development of an instructional game, examples from experiences during the development of a training game called ELECT BiLAT are provided. This game-based training tool was designed to provide U.S. Army officers instruction on preparing for and conducting bi-lateral, cross-cultural negotiation meetings. Specifically, in ELECT BiLAT, learners are confronted with a series of scenarios that involve meetings with leaders in an Iraqi village. In order to successfully accomplish their mission, learners must correctly plan and execute these meetings, thereby demonstrating proper cultural, negotiation, and decision-making skills.

ELECT BiLAT is based on a commercial game engine and includes interactive computer-generated characters and automated instructional feedback/coaching. Although ELECT BiLAT uses a 3D game engine, it is not a first-person-shooter game; in fact, there is no shooting in the system, and most user interaction is accomplished through a menu system. Figure 1 displays a sample screen shot from ELECT BiLAT. In this portion of the game, the learner is engaged in a negotiation

meeting with the local police chief. The choices of available actions (for the learner) are selected from the menu at the lower left corner of the screen, and the computer-generated character verbally responds to the learner's choice. In the lower right window, there is an on-going printed transcript of the interaction, along with hints and coaching from an intelligent tutor built into the game.

The ELECT BiLAT project described here has been sponsored and managed by the U.S. Army Research, Development, and Engineering Command's Simulation and Training Technology Center (STTC). The development of ELECT BiLAT was a collaboration between the University of Southern California's Institute for Creative Technologies and three U.S. Army research agencies (STTC, the Army Research Institute for the Behavioral and Social Sciences, and the Army Research Laboratory—Human Research Engineering Directorate). In order to maximize the potential success of both the development and implementation of this instructional game, this collaborative effort brought together multiple researchers and practitioners in the fields of game design, human factors, and instructional design, along with U.S. Army trainers and students. Ad-

Figure 1. Screenshot of ELECT BiLAT, depicting a negotiation meeting with the police chief (©2007 University of Southern California. Used with permission)



ditional details about ELECT BiLAT can be found in Hill et al. (2006).

DEVELOPMENT GOALS

Commercial game developers and instructional designers do not have incompatible goals for product development (e.g., instructional video game development); however, their priorities may be a bit different. At a general level, both game developers and instructional designers want to develop a successful product; however, the standards with which these groups measure success differs. For game developers, if the game results in a high sales volume and users want to play it, they are successful. Thus, the primary goal of a commercial game developer is to maximize player enjoyment and motivation to continue playing the game. For instructional designers, they are only successful if the students learn the instructional content. It doesn't matter how much the learners enjoy the game and want to continue playing if they are not learning as a result of game play. Accordingly, the primary goal of an instructional designer is to assure that the student has achieved mastery over the learning objectives.

Both the primary goal of the game developer and of the instructional designer are critical to the success of an *instructional* video game, in that a successful instructional game must maximize player motivation/engagement, as well as knowledge acquisition and retention (see Figure 2). Further, to ensure that both goals are optimally achieved, the utilization of a multi-disciplinary team, consisting of both game developers and instructional designers (as well as team members with other qualities like training domain subject matter expertise, graphic artists, and product management) is critical. Game developers are skilled at designing games that are engaging and have motivating and intriguing story lines (Dickey, 2005); whereas, instructional designers are skilled at structuring information within a learning environment so that learning will take place (Branson, 1978; Dick & Carey, 1990). Both skill sets are required for development of an instructional video game.

A multi-disciplinary team may initially struggle in the process of instructional game development because of their varied world view of product development. The initial struggle can be minimized through clarifying each others' objectives, common terminology, and processes for meeting their overarching goals (i.e., motivation

Figure 2. A depiction of the overlapping goals of commercial game developers and instructional designers when they work together to build an effective training game



or learning). During the development of ELECT BiLAT, there was a realization that the two communities possessed different operational definitions for the same term. For example, on the instructional design side, the term “content” relates to the information/domain to be trained (e.g., negotiations and cultural norms). On the game development side, “content” relates to objects that appear on the screen (e.g., buttons, characters, and background items). Another example of a term that needed clarification was training support material. The instructional design view was that background information on the training domain was the primary component of supporting material, while the game development view was that supporting material consisted of mainly instructions on how to use the game. To assist in minimizing such misunderstandings of “common” terminology used, a list of shared vocabulary was developed—a comprehensive list of terms and definitions that the different partners used. Discussing and clarifying the differences provided a means to communicate more clearly across specialties and to better understand each community’s goals and objectives for the project. This also helped to mitigate some of the challenges of bringing together individuals from fields that have distinct cultures (Finholt & Birnholtz, 2006).

While the fundamental goal of game developers and instructional designers may not be identical, they do share the desire to avoid the same obstacles to success (see Table 1). No game developer or instructional designer wants an uninteresting and confusing product that is easily forgotten. Thus, one way to help circumvent this initial difficulty in collaborating is to shift the focus of the team to minimizing obstacles to training game success. For example, if during the development process the instructional designers realize that the game, as currently conceptualized, fails to teach all aspects of the intended set of competencies, then the game developer (and team) should take that as an opportunity to modify properties of the game to more effectively link it with the learn-

ing objectives. Conversely, if a game developer observes that the training game appears to be a little boring, then the team can work together on alternative ways to engage the learner and maintain learner attention.

Just because the primary goals and objectives of game developers and instructional designers are not identical, does not mean that they are incompatible. By working together during the development process, they can achieve both goals—a training game that is motivating to play and maximizes acquisition and retention of the instructional content. Each group must be aware of the other’s perspective (likely through extensive communication) and respect the other’s position while working toward the common goal of developing an effective training game.

DEVELOPMENT PROCESSES

In this section, the general approaches that the two groups take toward product development are described (see Table 2). The terminology used for the various steps of design/development across the gaming and instructional design communities are explained, followed by a discussion of how the operational definitions of some of the terms vary between these groups. The goal is to illustrate that while these two groups have distinctly

Table 1. Examples of goals and obstacles for commercial game and instructional designers

	Primary Goal	Objectives	Obstacles
		Engaging	Lack of Interest
Games	Motivation	Playability	Confusion
		Challenge	Boring
		Skill Acquisition	Skill Degradation
Instruction	Learning	Mastery	Confusion
		Attention	Lack of Interest

Table 2. A comparison of the five steps in the development processes of instructional designers and commercial video game developers

→→→ Development Process →→→					
	<i>Step 1</i>	<i>Step 2</i>	<i>Step 3</i>	<i>Step 4</i>	<i>Step 5</i>
Instructional Design	- Analysis	- Design	- Development	- Implementation	- Evaluation
Computer Game Design	- Choose goal/topic - Research	- Design - Storyboard	- Program - Playtest	- Deliver	- Post mortem

different design/development steps, they share many similarities.

The instructional design approach tends to be structured rather linearly with respect to product (instructional system) development. While the specific processes used by instructional designers may vary to some extent (e.g., Branson, 1978; Dick & Carey, 1990; van Merriënboer, Clark, & de Croock, 2002; Winston, 1968), with some processes involving an iterative component, for the most part, the linear approach seems to be the norm when applied. For instance, a commonly used approach for instructional systems design is captured by the acronym ADDIE, which stands for the steps of: analysis, design, development, implementation, and evaluation. These steps are well known by instructional designers and frequently utilized to guide their development of instructional software.

In the commercial game industry, there is also a fairly standard process for developing a product. Many game developers have previous experience with software development; this is why the computer game development processes often share many similarities with well-known software development processes (Boehm, 1988; Royce, 1970). Generally, the first step is to choose a goal/topic/theme for the game, followed by the steps of research, design (preprogram & storyboard), program/playtest, delivery, and post mortem (Crawford, 1997). For commercial game development, many of these processes tend to be very fluid, with multiple steps being worked on at any one point in time and with continual revisiting of any given step. This iterative process may

include potential users playing paper-based and software-based prototypes, with feedback being used to make modifications to the design. Also, the first “working” version is not thought to be the final version, but a work in progress. There tends to be a good deal of testing, continued modification, and retesting until the developers are ready to “go gold” (i.e., have a final version ready to deliver to users).

The steps and processes used by game developers share many features with those used in the instructional design approach, in that they both have analysis, design, development, implementation, and evaluation phases. The remainder of this section describes in detail the similarities and differences between the processes used by these two communities, and provides examples of how game developers and instructional designers can effectively combine their efforts throughout the development of an instructional video game.

Step One. For an instructional designer, the “analysis” phase involves identifying what needs to be learned (Branson, 1978). The primary aspect of this is to specify explicit learning objectives. This also includes determining the current knowledge base of the intended learners, as well as the gaps in their knowledge, skills, and abilities that need to be addressed by the training to be developed. For a game developer, the first step involves making decisions about: (a) the type/genre of game they plan to build (e.g., first-person-perspective, multi-player), (b) the development and delivery platform to utilize (e.g., licensing an existing game engine versus creating a new one), and (c) who will be their target audience. In the design

of an instructional video game neither of these “analysis” decisions needs to supersede the other; and it is suggested that all of these decisions are valuable and should be explicitly considered.

One clear parallel between the worlds of game developers and instructional designers is the analysis/research of the intended audience. Game developers may ask questions about their target audience, the complexity of the set of rules governing game play, and the game’s story line. Whereas, instructional designers may ask questions about the intended trainees, such as their current level of understanding of the topic of instruction (as well as the intended mastery level post-training), the ability of the students to use the training technology, and how this fits into their broader curriculum. Both sets of questions address who the targeted end user will be. Understanding the characteristics of this user in turn will facilitate the development of the most effective training game—one that meets the needs of the learner.

The choice of game genre is another important decision for both commercial game developers and instructional designers intent on creating a training game. From the commercial game perspective, the choice of game genre is often driven by factors such as the expertise and experience of the design team, with teams playing to their strengths. Marketing and sales concerns also play a role in this decision. As an example, not only is a company with a history of producing sports games likely to be better at producing sports games than other types of games, this company is also more likely to have a greater understanding of the sports gaming market. If such a company were to decide to create a strategic war game, they would face a number of challenges—both in the development and sale of a new title. With the exception of a few highly popular franchises (e.g., *Star Wars*), game purchasing behaviors are more likely to remain within genre than between genre (Horn, 2006).

For the instructional designer, there are two key aspects to the decision of game genre: (a)

game-training content match, and (b) learners’ prior video game experience. With respect to the former, the training content of a game can be intrinsic or extrinsic to the game genre. An intrinsically instructive game is one in which the training content is a fundamental aspect of the game mechanic—for example, using a flight simulator to train pilots. Research suggests that by selecting a game with similar attributes to the training domain, less effort will be required for the learner to transfer what is learned in the game to the real-world context where they must apply those lessons (Auffrey, Mirabella, & Siebold, 2001).

An extrinsic training game is one for which the training content is not directly related to the underlying game mechanic, but instead uses the game as a way to deliver unrelated content. Prenksy’s *Straight Shooter!*, a first-person-shooter game designed to teach bankers about derivatives policies and practices, is a good example (see Prensky, 2001, pp. 248-253). If the training content is particularly well suited for a particular game genre (e.g., a flight simulator for some basic flying concepts and skills), it is often advantageous to use that game-training content match. However, even when there is a clear game-training content match, the decision to develop that particular type of game is not necessarily warranted. As an example, consider attempting to train infantry squad leaders. While it may seem natural to use a first-person-shooter, if the goal is to train decision-making and strategy it may be better to rely on a more strategic (perhaps even turn-based) game-style in order to encourage more deliberative thought. In short, one needs to seriously consider the knowledge and skills to be trained before selecting the game genre of the instructional game.

In selecting the genre of a training game, it is also useful to consider the prior video game experience of potential learners; as aforementioned, the analysis of who will be using the training game is critical. If the users are not familiar with a particular game genre, then there may be time wasted trying to teach the learner how to use the game

interface, sacrificing time devoted toward learning the training domain. Further, research suggests that learners who have previous experience with video game genres similar to the training game are more likely to demonstrate positive training outcomes, such as enhanced training performance, training satisfaction, and time spent engaging in the training game (Orvis, Horn, & Belanich, 2006; Orvis, Orvis, Belanich, & Mullin, 2007).

For ELECT BiLAT, on the instructional design side, the analysis step/phase started with interviews of Army instructors and other subject matter experts (SMEs) to understand the targeted training domain and typical gaps in trainees' knowledge, skills, and abilities (Hill et al., 2006). A set of learning objectives was developed to clearly identify what should be learned by the students. There was also a discussion about the game technology that would be most appropriate for the target group of learners. Since the target learners were Army officers with considerable years of military experience (typically in their 40s), it was noted that these individuals were not typical gamers (Belanich, Orvis, Moore, Horn, & Solberg, 2007). Thus, a training game involving complex movements through a 3D world would likely be foreign to many of them and require a good deal of up-front training on the game technology, with little added value to training the instructional domain. Accordingly, the decision was made to simplify the game mechanics and interactions with computer-generated characters as negotiation meeting partners. There was a focus on more familiar types of buttons and menus in the user interface to best meet the needs of this group of learners. On the game development side, the choice was made to use the rendering capabilities of a 3D game engine to provide an engaging environment for the training that would immerse the students in the training scenarios. All of this minimized the time needed to learn how to use the training game, allowing more time to be spent learning while engaging in the game.

Step Two. For both instructional designers and commercial game developers, the design phase includes developing a plan that will accomplish the goal of making a successful product. Instructional designers frequently accomplish their overarching goal of maximizing student learning by breaking down what needs to be taught into small chunks and then organizing these instructional chunks in a structured, sequenced way (i.e., an organization scheme that leads a learner toward mastering the learning objectives) (Bransford, Brown, & Cocking, 1999; Branson, 1978; Moreno & Mayer, 2002). Typically, commercial game developers would work toward accomplishing their overarching goal of maximizing player motivation/engagement by creating a general story or path that they want the player to experience as part of the game, filling in details as they proceed. This process would end with the development of paper-based storyboards which include the sequence of events that are likely to occur during the game experience and what the different game screens would look like to the user.

In short, instructional designers tend to take a bottom-up approach, starting with small chunks and organizing them into a whole. Conversely, game developers tend to adopt a top-down approach, working from a general story idea/theme and progressively adding detail. These processes do not need to be incompatible; in fact, they can be integrated. For example, instructional designers can first develop their learning chunks/nuggets. Then, the game developers can utilize this information to develop a general story line that will include all of the learning chunks. Both groups can then work together to fill in the gaps so that there is a meaningful organization of chunks within the story line.

In fact, it can be argued that the story line and the teaching points *must* be fully integrated; building the instructional content into a story line is key for an instructional game (Dickey, 2006). Research has shown that learners are more likely to learn

information in an instructional video game when it is integrated into the story line or progression of the game versus information that is superfluous to the overall flow of the game (Belanich, Sibley, & Orvis, 2004). There are several techniques for aligning instructional content with the game story line (see Dickey, 2006). The practical take home point is that story development and training domain development should not occur in isolation. The instructional content must be fully integrated into the overall story line of the game to maximize effectiveness.

One caution when developing a story line is that even if it shares an overall theme with the training domain, it may not match up well with the specific teaching points/learning objectives that are required. For example, playing a game like *Rollercoaster Tycoon*TM may make a player aware of some of the aspects of building and maintaining a theme park that the player wasn't aware of before. However, it won't teach a person the engineering skills of building an actual rollercoaster or the accounting/business practices of running an actual theme park.

To avoid this issue during the development of ELECT BiLAT, active collaboration between the instructional designers and game developers was critical, as well as seeking input from training domain content experts. First, instructional designers identified the tasks and learning objectives that were to be trained, and made sure that they were integral parts of the immersive story line (Hill et al., 2006). This involved performing a detailed task analysis, identifying the skills and behaviors necessary for planning and engaging in bi-lateral meetings. This task analysis was based on interviews with Army instructors and other SMEs, a review of Army doctrine, and a review of the published literature on culture and negotiations. Results from the task analysis were later fed back to the SMEs and instructors to ensure that it accurately represented the training domain. Further, in order for the game developers to build an engaging but realistic story line for the training

scenarios, direct questions were asked to the SMEs, such as "When you are engaging in *Task A*, what are the most important aspects to be aware of?" In addition, some examples of critical incidents pertaining to this task were requested (i.e., real-world situations of when they had effectively/ineffectively engaged in the task) (Anderson & Wilson, 1997). These "important aspects to consider" and SME-provided critical incidents were then woven into the story line, paired with the identified skills and concepts to be trained.

Another important variable to consider in the design phase is the level of challenge that will be most appropriate for the training game. This is important on an instructional level, in that you want to push learners to gain new knowledge and skills; however, you also do not want to overwhelm the learners by asking them to perform tasks that are well beyond their current mastery level (Bowman, 1982; Garris, Ahlers, & Driskell, 2002; Rieber, 1996). The appropriate level of challenge is also important on a motivational level, in that to maintain high levels of motivation, the task being performed should be neither too easy as to become boring, or too hard to be frustrating (Belanich, Sibley, & Orvis, 2004; Crawford, 1997; Csikszentmihalyi, 1990; Malone & Lepper, 1987).

With ELECT BiLAT, we knew it was possible that some of the target learners might possess limited prior experience with the training domain; therefore, starting the game at a high challenge level would have been problematic. However, it was also critical to include scenarios that would challenge those with greater levels of prior experience, as well as learners that had improved their knowledge and skills over the course of using the game. Accordingly, a series of progressively more difficult negotiation scenarios were developed and used in the game (Hill et al., 2006).

The design phase is critical for instructional video game development success, and will require game developers and instructional designers to communicate their *wants* and *needs*. Because the product is in the conceptual stage at this point, it

is not that easy to clearly explain what is required and why it is important across the two communities. Simple prototypes or examples from products that share similar features can help in this interchange of ideas. With ELECT BiLAT, the game developers created a paper-based prototype to show instructional designers (and later potential users and Army instructors) how the training game would work. From these “show and tell” sessions with users and instructors, the game developers and instructional designers gathered extensive feedback (in terms of engagement of the story, ease of use, and if the game adequately captured the instruction domain). This feedback was used to improve the design and update the prototype. Over time, the prototype was iteratively refined and tested until the major game-play elements and instructional components were deemed sufficient and fully integrated.

Step Three. During the development/programming step, the plan (created during the previous step) is used to produce the actual video game. This is where the programmers start typing out computer code, working to implement the plan. In order to minimize any misunderstandings as the paper plan is being translated to software code, it is important that the plan is clear, both in terms of instructional content and motivational game features (e.g., realism of graphics, usability of interface, challenge level presented).

As with any plan, once it is put in motion there are often modifications that need to be made. While both instructional designers and game developers tend to use iterative development models (to some capacity), there are some differences in the kind of feedback that loops back into the development process. For instructional designers, feedback is typically provided by someone in the role of an instructor. This feedback entails the aspects of the instructional tool that they think would be effective for teaching their students, as well as what components need modification. Ideally, instructional designers are able to obtain some level of in-class evaluation using a pilot group

of learners (e.g., whether through cooperative agreements with instructors intending to use the instructional tool or through individuals recruited to participate in a focus group).

Game developers typically involve people from the actual target audience to play-test alpha and beta versions of the game. The game developers observe the play-testers using the game and ask for their opinions about different aspects of the game (e.g., Is it fun? Is it challenging enough? Did they find the storyline interesting? What worked and what didn't?). Play-testing is very important because the best way to determine if intended users will enjoy the game is to have them play it and then capture their feedback (Salen & Zimmerman, 2004). In addition to using such a pilot group of play-testers, commercial game developers are often able to glean feedback from the player community through alpha and beta versions which have been released to the public. This feedback, while valuable, typically focuses on issues that are of concern to experienced, highly motivated players—making it a bit more difficult to predict the types of problems that novice game players may face.

Commercial game developers attempt to get as much feedback as they can at this point in the product development process because they typically do not have the opportunity to make significant revisions once they go to the delivery phase. (It should be noted that while game patches have become relatively common among computer games, they have been historically difficult or impossible with console games. This is starting to change as the newest generation of consoles typically have Internet access.) Conversely, instructional designers are expecting to also get feedback at a later stage (i.e., Step 5—Evaluation) and this information is frequently used to make further revisions. In short, game developers have a tendency for a shorter feedback loop for each iteration of the game. Further, they will develop segments of the game and get feedback on their development all within this step. In contrast, instructional design-

ers have a tendency for a longer feedback loop in that they will develop the training tool (Step 3), formally evaluate how well the training worked (Step 5), and use the results of this evaluation to update/revamp the training tool.

With ELECTBiLAT, an iterative development process with both short (within step) and long (across Steps 3-5) feedback loops was used (Hill et al., 2006). Examples of short feedback loops include when the game developers/programmers would demonstrate their work for the team and make quick modifications based on feedback received. Also, when the software was at a stage to be play-tested, a pilot group—representing the population of instructors and students in which the training was intended—were asked to try out the instructional game and give extensive feedback both in terms of instructional content and playability/engagement. An example of a long feedback loop includes the iterative delivery of versions of the game to individuals in the U.S. Army course where the game was to be implemented. During this roll out, multiple versions (based on the suggested feedback) were delivered and formally evaluated for instructional impact (i.e., did they learn?), usability, and motivational factors. The cooperation and patience of Army instructors during this process was critical. The detailed, expert assessment that instructors, students, and other SMEs were able to provide enabled both incremental and significant improvements relatively quickly. Had this tool been created by a team without direct access to the target group of learners/instructors, this type of user feedback (across Steps 3-5) would likely not be available.

Step Four. In Step 4, the end user gets to actually use the game. For instructional designers, the term implementation is used because the instructional tool is often part of a course or some larger curriculum. When used as part of a course/curriculum, there is the possibility that guidance on the instructional tool will be provided to the learner by an instructor or someone else who provides this support function. Learners are not

necessarily expected to utilize the tool independently. In contrast, with entertainment games, the term delivery is used because it is expected that the system will stand on its own. Game directions are important and needed to guide users. However, if users have questions that go beyond the provided directions, gamers are usually more than willing to search around for answers. For example, users may go to gaming Web sites or read other material that may provide the answers they seek.

It is important to note that in both the instructional and entertainment domains, there is a need to provide sufficient guidance regarding *how* to use the game. Further, the guidance provided may need to be expanded with an instructional game. For example, there typically is a need to provide support to not only the learner, but also the instructor, who may not have expertise with computers or video games. This “train-the-trainer” effort plays an integral role in the success or failure of an instructional video game, as an otherwise excellent training game can fail if it is not effectively implemented in a course (Belanich, Mullin, & Dressel, 2004).

Several pitfalls can lead to poor implementation/delivery of training games. Belanich, Mullin, and Dressel (2004) described various obstacles to successful training game implementation. One of the main reasons for ineffective implementation is that the game is not clearly integrated into the curriculum of the course. For instance, learners are never explicitly told the purpose of this instructional tool or what they should seek to achieve by engaging in the game. Without a reason as to why the learners are devoting effort to play the game, students may wonder, “What’s the point?” It should be clear to students what they are expected to gain from playing the training game (i.e., the learning objectives to master and/or competencies to be developed). Also, if the instructor does not know how to use the training game (e.g., maneuver through the user interface), this can lead to wasted time as the students have to learn how to use the game on their own. Furthermore, the students may

gain the impression that the instructor doesn't really know the instructional material. Clearly, proper implementation is critical for a training game to be fully effective.

With ELECT BiLAT, the intended implementation was for the game to be used as an in-class exercise (to take only a few hours) as part of a two-week course. First, the instructor would highlight some of the topics to be addressed within ELECT BiLAT. The instructor would also go through some of the procedures that the students would have to complete as they were progressing through the game. Then as the students used ELECT BiLAT, the instructor would be available for assistance. Fortunately, the lead instructor had been involved in early discussions and demonstrations of the game and was motivated to provide feedback, which were critical to making the implementation of the game successful. There has been discussion regarding the best way to ensure that this knowledge is available to students in other contexts (e.g., contexts with less active/knowledgeable facilitators or no facilitator), and future versions of ELECT BiLAT will include additional support information. Among the solutions being discussed is the inclusion of a video introduction to the game and its interface. This is a key area which must be considered if gaming savvy instructors will not be available at the implementation site.

Step Five. For instructional designers, the evaluation phase is not necessarily the end. Based on the results of the evaluation, they are likely to revamp the design and may go through another cycle of development. Because there is often an instructor overseeing the use of the training tool, the instructional designers might get feedback from the instructor's perspective. If there is a formal evaluation conducted, which is not always the case (Hays, 2005), student feedback may also be available.

With game development, there are different avenues to gather feedback on the success/failure of an effort. The evaluation of a commercial game may rely on sales data and player critiques on game

Web sites. If the game is successful, there might be a second version—only “bigger and better,” with new features. If the game is not successful, they may chalk it up as experience and develop a completely different game. The market response to entertainment games is relatively quick—if gamers are not satisfied, a game will not sell well. Additionally, the gaming community has evolved to a point where there is a good deal of feedback provided via online forums, magazines, and so forth. With instructional games, sales often rely on slower procurement processes, with decisions often being made not only by instructors, but by other administrators.

The challenge of evaluating the effectiveness of an instructional game, both in terms of accuracy and time, may not enable the development team to assess market satisfaction quickly. This can significantly delay the feedback loop. A combination of the aforementioned methods to evaluate the effectiveness of an instructional game might be most appropriate. This evaluation should address both instructional (did learning occur) and motivational (was it engaging to the learner) aspects of the instructional game.

The evaluation of ELECT BiLAT has been ongoing, and has relied on measures of learning, performance data logs, student feedback/satisfaction, and instructor feedback. Again, because of a close relationship with the course instructors, detailed feedback was provided which influenced subsequent updates. The initial results indicate that the students are learning due to this implementation. There is always room for improvement, and based on the initial evaluation, additional modifications are currently being made.

CONCLUSION

Instructional designers and game developers may be quite different, and their experiences and priorities might, at times, appear to be at odds with one another. However, when developing instructional

games, they do share a similar overarching goal—to build a successful product, and in this case, a successful instructional game. Remaining focused on this common goal as the priority should assist these two communities in bridging their diverse perspectives and expertise in order to develop the optimal instructional video game.

Throughout this chapter, it has been argued that the critical determinant of the success of video games as instructional tools lies in the willingness of commercial game developers and instructional designers to work with one another, as well as their ability to successfully integrate their central goals and design/development processes. The primary implication of this work suggests that a collaborative team with members of different specialties working together is essential for achieving the goal of building a game that is both instructional and motivating to use. Unfortunately, according to Squire (2005), who conducted a series of case studies of video game-based learning product development, organizations may use interdisciplinary game development teams, but they do not include instructional designers as part of the team. A typical team includes program managers, graphic artists, and programmers—no instructional designers. Without specialists who understand how to provide instruction, it isn't surprising that many instructional games do not effectively teach the intended instructional objectives (Hays, 2005).

To provide insight into how a successful merging of these two communities can be accomplished, relevant research in both game development and instructional design has been presented, and practical lessons learned from experiences during the development of an instructional video game were provided. A mutual understanding is key to successful partnerships, and this requires consistent communication and a respect for the skills and attributes that partners with different backgrounds bring to the team. Game developers may benefit from understanding and incorporating

several processes used by instructional designers (Bransford et al., 1999; Dick & Carey, 1990; Moreno & Mayer, 2002). Likewise, instructional designers may benefit from understanding and incorporating several processes used by game developers (Bethke, 2003; Crawford, 1997; Salen & Zimmerman, 2004; Squire, 2005). In short, communicating and understanding the commonalities and differences of the expectations and processes of their partnering community should facilitate their successful collaboration. Further, the unique elements of each community's approach should be blended for optimal instructional video game design—an instructional video game which is both intrinsically motivating and pedagogically sound.

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KEY TERMS AND DEFINITIONS

ADDIE: The ADDIE model is commonly used in instructional systems design. The acronym stands for analysis, design, development, implementation, and evaluation. The output of each stage serves as the input for the subsequent stages.

Instructional System Design: The practice of creating and organizing media in a way that enables individuals to learn effectively. Instructional system design incorporates a variety of disciplines

including education, psychology, information technology, graphic design, and others.

Iterative Development: A model of system development in which the ability to rework and revise aspects of the software is scheduled. In this approach, the developer benefits from prototype evaluation during the development process.

Learning Objective: A specific, measurable task (or class of tasks/actions) a learner should be able to perform as the result of training. It should include the conditions under which the task should be performed as well as the criteria by which performance will be judged.

Subject Matter Expert (SME): An individual with a high level of knowledge in a particular domain—subject matter to be taught. Although an

SME typically may not have an expertise in training or instructional design, he or she can play an integral role in the design of instructional games.

Spiral Development: An iterative model of system development in which software is built in progressive phases. In each phase, a prototype of the software is reviewed by the customer and evaluated prior to further development. Following the review, another prototype is built and evaluated. This process continues until the final product is delivered.

Storyboard: A graphic means of presenting the story line of a video game, movie, or cartoon. In serious games, this depicts the plot of the video game in which learning objectives are embedded.

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Chapter 2.17

Lessons Learned about Designing Augmented Realities

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ABSTRACT

While utilizing GPS-enabled handheld computing units, we have developed and studied augmented reality (AR) curricula to help middle school students learn literacy and math. In AR, students move around an outdoor physical environment, interacting with virtual characters and artifacts on their handheld computer. These invisible objects and characters provide clues to help solve a mystery, guiding the students through a process of inquiry and evidence building. The first AR curriculum we developed, *Alien Contact!* is based on a scenario where aliens have crash landed near the students' middle school. Students, working in teams, learn math and literacy skills in the course

of determining why the aliens have come to earth. This study describes the design heuristics used during the initial development and deployment of *Alien Contact!*, the results of two formative evaluations of this curriculum, and the impact these findings have had on revising our design heuristics for a subsequent AR curriculum about beached whales, called *Gray Anatomy*.

INTRODUCTION

Researchers are starting to study how AR modalities for learning aid students' engagement and understanding (Dunleavy, Dede, & Mitchell, in press; Klopfer & Squire, 2008; Klopfer, Yoon, & Perry, 2005; Klopfer, Yoon, & Rivas, 2004). This article explores the background of AR, describes

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the Handheld Augmented Reality Project (HARP) at Harvard University, explains the results from formative evaluations of the first AR curriculum created through HARP, and delineates how the lessons learned from this evaluation impacted the development of a subsequent AR curriculum.

THEORETICAL FRAMEWORK

The theory that learning occurs most effectively in authentic setting is not new. Hendricks (2001) stated that complex social interactions are at the heart of learning. Brown, Collins, and Duguid (1989) more precisely defined this thinking through their belief that individuals' interactions with their social teams lead to their adoption of learned behaviors. This phenomenon, which Hendricks called situated cognition, is different from practices in traditional educational settings. There is ample research to substantiate that social interactions are important for accomplishing challenging learning tasks. Bandura (1977), Vygotsky (1978), and Scaife and Bruner (1975) found that observation of and assistance from others at times precedes and always interacts with human cognitive development. Bandura (p. 12) highlights the importance of "symbolic, vicarious, and self-regulatory" processes in social learning. As compared to a psychological view where learning is a matter of an individual "performing responses and experiencing their effects." Bandura elaborates on his theory that learning is a social process, explaining that we learn everything vicariously before we learn it directly because it is the only way we can "acquire large, integrated patterns of behavior without having to form them tediously by trial and error. The harder the task to be learned, the more we must learn it through observation first.

Hendricks (2001) found evidence to support the idea that practices based on situated cognitive theory can have significant impacts on immediate learning. Klopfer et al. (2004) focused on the use of

technology to facilitate situated learning environments—particularly through the use of handheld and wearable computing devices. Through the use of *participatory simulations* they found that students were more motivated, engaged, and excited by the process of participatory learning than they are by more traditional means of learning.

Motivation concerns the selective direction, energizing, and regulating of behavior patterns (Ford, 1992). It is central to persistence in learning and to producing positive outcomes (Ryan & Deci, 2000). Vygotsky (1978) found that, even before behavior sets in, through motivation we decide where we direct attention. There are different types of motivation, and they have different impacts on learning and sustaining learning (Ryan & Deci). Extrinsic motivation ranges from, at one end, a sense that our behavior is controlled by others who do things to regulate our behavior, to the other end, where we have a sense that we are in control of our own actions and get support from outside actors but little direct regulation of our behavior (Ryan & Deci). Most of the incentives to succeed academically in postsecondary education are designed to stimulate various forms of extrinsic motivation. For example, in a competitive classroom, some students' suboptimal performance, made explicit through student rankings and bell curves, serve as extrinsic motivators for other students to achieve.

There is strong evidence that cooperative learning is better for stimulating intrinsic motivation than competitive learning (Gehlbach, 2007). Classrooms that focus on cooperative learning make students responsible for one another's outcomes (Gehlbach). Social learning approaches may be more likely to foster intrinsic motivation, the form of motivation most likely to positively influence persistence, because it is the most self-directed form of behavior regulation and taps into our innate desire and capacity to seek out challenge and explore (Ryan & Deci, 2000). Later research by Klopfer et al. (2005) substantiated these earlier findings as to the impacts of simulations. More

recently, Rosenbaum, Klopfer, and Perry (2007) placed their participatory simulations within the context of augmented reality.

AUGMENTED REALITY

Squire and Jan (2007) define augmented reality as “games played in the real world with the support of digital devices (PDAs, cellphones) that create a fictional layer on top of the real world context” (p. 6). Squire and Jan focus on place-dependent AR games, which require participants to come to specific locations to work through the game. Alternatively, place-independent AR games are designed to overlay game elements on a map of any physical location.

In AR environments, students interact with virtual and physical objects, people, and environments. Unique capabilities of AR include the amplification of real world environments, the ability of team members to talk face-to-face while interacting simultaneously in the virtual environment, and the capacity to promote kinesthetic learning through physical movement through sensory spatial contexts. In the form of AR that we studied, students utilize GPS-enabled wireless devices that allow them to engage with virtual information superimposed on the physical world. For example, a student may be guided by a map of Washington DC on their handheld to walk to the Lincoln Memorial. When they arrive, an image may appear of the memorial itself containing architectural specifications, or a movie may become accessible that talks about famous events in history that have occurred at this location, or they will be asked to perform a particular task. By infusing digital resources throughout the real world, augmenting students’ experiences, improving their recognition of patterns, critical features, background information, and reinforcing what they are learning through multiple sensory experiences (i.e., hearing about the memorial from an expert, seeing it with their own eyes, and even

possibly touching a feature of the memorial itself while seeing that feature explained up close on their handheld device). Unique capabilities of AR include the amplification of real world environments, the ability of team members to talk face-to-face while interacting simultaneously in the virtual environment, and the capacity to promote kinesthetic learning through physical movement through sensory spatial contexts.

In addition, the current software developed to facilitate the delivery of AR curricula allows authentic team interactions and collaboration. This is due to the fact that the technology provides individuals within a team of students the ability to take on different roles within the augmented reality environment, thus allowing each individual to interact with the virtual elements in different ways than their teammates. While students may arrive at the same physical location as their group, a different artifact, interview, or task will appear on their handheld device than on their teammates who holds a different role. This is more authentic as a collaborative tool due to the fact that individual students within a team must collaborate and share information in order to progress through the game. The frequently seen suboptimal practice that team work is *turned over* to an individual student within the team to complete is not possible with this pedagogical approach; each individual must participate for the team to be successful.

THE HANDHELD AUGMENTED REALITY PROJECT

HARP is part of a three-year federal grant through the U.S. Department of Education Star Schools Initiative. HARP is a collaborative effort between Harvard University, the University of Wisconsin, and the Massachusetts Institute of Technology to study the efficacy of AR technology and curricula for the instruction of math and language arts at the middle-school level.

Lessons Learned about Designing Augmented Realities

This project has as its primary objective to design and study engaging and effective augmented reality learning environments using wireless handheld computers equipped with GPS receivers. In order to do this, HARP personnel have developed an AR curriculum called *Alien Contact!* and a subsequent curriculum called *Gray Anatomy* that incorporates many of the lessons learned from formative evaluations of the earlier curriculum.

ALIEN CONTACT! CURRICULUM

We designed *Alien Contact!* to teach math and literacy skills to middle and high school students (Dunleavy et al., in press). This narrative-driven, inquiry-based AR simulation is played on a Dell

Axim X51 handheld computer and uses GPS technology to correlate the students' real world location to their virtual location in the simulation's digital world (Figure 1).

As the students move around a physical location, such as their school playground or sports fields (Figure 2), a map on their handheld displays digital objects and virtual people who exist in an AR world superimposed on real space (Figure 3). When students come within approximately 30 feet of these digital artifacts, the AR and GPS software triggers video, audio, and text files, which provide narrative, navigation, and collaboration cues as well as academic challenges.

In *Alien Contact!* the students are presented with the following scenario: Aliens have landed on Earth and seem to be preparing for a number

Figure 1. Dell Axim & GPS receiver



Figure 2. Students exploring school grounds



Figure 3. Handheld display of digital objects on school grounds



of actions, including peaceful contact, invasion, plundering, or simply returning to their home planet, among other possibilities. Working in teams (four pupils per team), the students must explore the augmented reality world, interviewing virtual characters, collecting digital items, and solving mathematics and literacy puzzles to determine why the aliens have landed. Each team has four roles: chemist, cryptologist, computer hacker, and FBI agent. Depending upon his or her role, each student will see different pieces of evidence. In order to successfully navigate the augmented reality environment and solve various puzzles, the students must share information and collaborate with the other members of their team. As students collect this data, they will discover different possibilities for why the aliens may have landed. It is up to the students to form hypotheses based upon the data collected. At the end of the unit, the students orally present their findings as a team to the class and support their hypothesis with data collected in the field (Figure 4).

In order to keep the game space uncluttered, only the current and next interactions are shown on the map at any one time. This reduces confusion pertaining to the order of the game, and clarifies where the students should progress to next. This is done through a *triggering* mechanism built into the game development editor. Each

character or object with which the students interact activates the next character or object to appear in the progression and deactivates the previous character or object.

In its full form, *Alien Contact!* is a six-day, multidisciplinary curriculum that includes two days dedicated to playing the game, and four days interspersed to introduce concepts, allow for analysis and synthesis of data gathered during the game days, and enable students to develop and present their hypothesis for why the aliens have come to Earth. This curriculum is based on Massachusetts state standards and fosters multiple higher-order thinking skills. In designing this unit, HARP personnel targeted concepts in math and literacy typically difficult for middle school students to master. Using the spring 2005 8th grade MCAS test as a reference to determine high-need areas, project personnel focused primarily on aspects of ratio, proportion, and indirect measurement (Math Standard 6.M.3, 8.M.4, 8.N.3) in combination with how English vocabulary has been influenced by Latin and Greek languages (ELA Standard 4.18, 4.21, 4.24). However, other Math and ELA standards are embedded within the unit, such as reading graphs (Math 6.P.6, 8.D.2) and conducting team discussions and presentations (ELA 2.4, 3.8, 3.9, 3.11, 3.13).

This game also aligns with other standards. The Partnership for 21st Century Skills, a state-level, public-private partnership geared at making U.S. public education relevant in the 21st century, has recognized education's role in building social capital through education and how challenging this will be. The Partnership for 21st Century Skills believes key skills students need include: global awareness and civic literacy; communication and contextual learning; and leadership, ethics, and social responsibility (Hardy, 2007). The Organization for Economic Cooperation and Development (OECD) has included new measures in its Programme for International Student Assessment (PISA), a 42 country comparative study conducted every three years on the skills that 15-year-olds

Figure 4. Students presenting their hypothesis



are developing in school. In 2003, PISA added a problem-solving section to its international assessment designed to assess cross-disciplinary, problem-solving skills. In future iterations of the problem-solving skills section, PISA plans to include an assessment of collaborative problem solving skills (OECD, 2008).

In addition, the game content and structure are designed to allow for multiple entry points on which teachers may build in future iterations (Dunleavy et al., in press). The design allows teachers the flexibility to emphasize: (1) different academic standards; (2) different content areas (math, ELA, science, social studies/history); and (3) different current events (energy crisis, oil shortage, global nuclear threat, cultural differences).

This design rationale is three-fold: (1) build in multiple entry points for teachers; (2) build in mathematical and linguistic patterns that, when recognized, reveal the ubiquity and mystery of mathematics and language; and (3) build in multiple layers of complexity that will engage and challenge students regardless of ability and will provide teachers opportunities for differentiation. As students engage in the mathematics and literacy of the content, the curriculum attempts to capitalize on some of the inherent properties of these fields that are fascinating (e.g., mapping latitude and longitude, ancient languages, and cultures) regardless of the standards that are targeted.

AR in general and *Alien Contact!* specifically incorporates several elements from popular video games that increase learning and engagement: (1) narrative and setting; (2) differentiated role playing; (3) master goal divided into subtasks; (4) interactivity; (5) choice; and (6) collaboration. In *Alien Contact!* the narrative and setting is the unfolding saga of the aliens' interactions with Earth. To infuse this situation with challenge and invite curiosity, each student's differentiated role is presented with an alternate, incomplete view of the game space. For example, when presented with a piece of alien spacecraft debris, each team member is given a different dimension of the

wreckage to measure or a unique clue as to how to measure it. If the students do not collaborate, they will not be able to solve the problem and advance to the next stage of the game (Figure 5).

The master goal of the curriculum unit is to discover why the aliens have landed. However, in order to collect sufficient evidence to form a hypothesis, the students must successfully complete multiple subtasks requiring math and literacy skills. Throughout the scenario, the students interact with virtual characters, digital items, and each other to navigate the game space. Choice and collaboration are embedded within the entire unit. Finally, the entire scenario is open ended, with multiple possible explanations for why the aliens have landed.

FORMATIVE EVALUATION

During the fall of 2006 and the spring of 2007 early iterations of the *Alien Contact!* curriculum were implemented for the purposes of conducting formative evaluation of the format. As there was no existing design for developing in-practice AR curriculum, much of this formative evaluation was intended to develop the heuristics for developing appropriate and effective AR curricula. The methodology and results of this pilot formative evaluation are described in depth by Dunleavy et al. (in press); however, for clarity purposes,

Figure 5. Students collaborating to measure a physical object used in the AR gamespace



the methodology and findings of this study are described here.

Utilizing a multiple case studies design, a series of data collection techniques were implemented at three sites (selected through convenience sampling) in order to gather in-depth information on how students and teachers perceived the AR curriculum. These data sources (including observations, formal interviews, informal interviews, and Web site postings) provide rich, contextual data that allowed for triangulation of results.

These data were qualitatively analyzed within each site using a structured-coding scheme that followed an initial open-coding process. The initial open coding resulted in 30 descriptive codes, which were then analyzed iteratively using pattern matching analysis. The analysis from each case study was then used for cross-case analysis to determine if there were similarities across implementations in usage and perceptions.

RESULTS

Through the analysis of case study data from the initial formative evaluation, Dunleavy et al. (in press) documented high student engagement during the implementations of the *Alien Contact!* AR curriculum. According to Dunleavy et al. “high motivation and engagement seems logical and almost a given during an activity that has students go outside with handheld computers and search for clues about aliens, it was nonetheless a critical threshold that needed to be reached during this first year of the AR design development.”

Students and teachers reported several factors that played a role in motivating them throughout the curriculum implementation. Among the most common factors mentioned by both teachers and students were the use of the GPS-enabled handhelds themselves, the ability to collect data outside, and the interdependence of the roles within the team dynamic. In addition, teachers focused

on how the AR curriculum engaged previously disengaged students (Figure 6).

However, in addition to the increased motivation, Dunleavy et al. (in press) also found significant logistical limitations in implementing AR curricula. In particular, hardware and software issues, particularly due to GPS errors, interfered with the seamless integration of this technology. Another issue dealt with the substantial management and technical support required to maintain the instructional process and the technology—a problem deemed to be *prohibitive* in any effort at scalability. Also of concern were findings of substantial cognitive overload on the part of students involved with the AR curriculum. Students and teachers indicated that learning the technology while also trying to work relatively complex content problems caused confusion and led to some students giving up before completing tasks.

Another result from the research was the discovery of unanticipated competition between teams. Due to the linear nature of the learning path (that is, all students moved from one character to another in an identical and predictable progression), student teams were able to visually see where other teams were within the progression. Therefore, each team had the sense that they were either *ahead* or *behind* other teams in the game space. This led to student teams hurrying through the activities in order either keep pace or pass other students, whom they viewed as their

Figure 6. Students engaged in the AR game



competition. As would be expected, this resulted in students missing valuable information within the game space.

An additional unanticipated finding was a desire on the part of the students to know the *right* answer. As would be expected with students at the middle-school level, especially with those accustomed to commercially available games designed to provide closure, participants expressed a strong desire to know why the aliens were actually here at the end of the game (this was usually articulated through the focus group interactions). In most cases, the ambiguity of the game's multi-hypothesis nature was difficult for these students to accept.

It is important to note that current implementations of the *Alien Contact!* curriculum are validating the findings from the formative evaluation—particularly where the issues of technical and logistical support are concerned. Students appear to be motivated by the AR curriculum; however, competition between student groups is present in nearly every implementation, and the issue of having the right answer continues to persist.

FURTHER EVALUATION

Building upon the formative evaluation conducted by Dunleavy et al. (in press), further research is being conducted to study the impact that *Alien Contact!* has on academic achievement and affect. Through a pre-test/post-test, control-group design, it will be possible to draw preliminary conclusions about how effective this version of an AR curriculum can be in an educational setting.

Data for this analysis is being collected during the spring of 2008. The control curriculum is identical to the *Alien Contact!* AR curriculum in terms of content, however, it is played inside using a board game rather than outside using the handheld computers (Figure 7).

MODIFICATIONS BASED ON FORMATIVE EVALUATION

HARP personnel responded to the results from the formative evaluations to better design a subsequent AR curriculum called *Gray Anatomy*. This section will describe the initial version of this new curriculum and the changes that were made to our AR design template based on the findings of the formative evaluations discussed previously.

Gray Anatomy

Gray Anatomy, just as is the case with *Alien Contact!*, is a scenario-based AR curriculum. As the game begins, students are presented with a scenario in which a gray whale has beached itself. Working in teams, the students must interview virtual characters, inspect virtual objects, and work through mathematics and language arts problems to determine what occurred and why the whale beached.

Similarly to *Alien Contact!*, this curriculum also focuses on middle-school, Massachusetts state math and language arts standards. In this case, the math standards revolve around data analysis, statistics, and probability (MCAS standards 6.D.1 and 8.D.3) and the ELA standards include thematic

Figure 7. Students playing the boardgame control curriculum



identification and support (MCAS standards 11.3 and 11.4), understanding a text (MCAS standard 8.19), and support hypotheses with evidence from text (MCAS standard 8.24). Additional standards that are touched upon are numbers and number sense (MCAS math standards 8.N.10 and 8.N.11), vocabulary and concept development (MCAS ELA standard 4.17), formal and informal English (MCAS ELA standard 6.6), questioning, listening, and contributing (MCAS ELA standard 2.4), and oral presentation (MCAS ELA standards 3.9, 3.11, and 3.12).

As with *Alien Contact!*, this curriculum incorporates the previously mentioned video game characteristics that increase learning and engagement. However, several substantial changes have been made to the game play in response to the results from evaluating *Alien Contact!*'s design.

Cognitive Overload

The most difficult of the concerns identified by evaluations of *Alien Contact!* was the issue of cognitive overload. Due to the fact that the overload was caused by difficulties synthesizing several tasks, each of which was relatively complex in and of itself and was dependent on the individual student, it was difficult to develop solutions to address the problem. For this reason, several steps were taken to mitigate complexity of the tasks required in the *Gray Anatomy* curriculum.

The first step taken was to limit the number of characters or objects that any student would interact with during a given time period. Initially, the *Alien Contact!* curriculum incorporated far too many characters and objects. Through the formative evaluation conducted by Dunleavy et al. (in press) as well as lessons learned through subsequent implementations of the AR curriculum, we determined that between five and six items or characters per AR session is optimal for progressing through the game in a timely, efficient, and effective manner. For this reason, each of the two

game days involved with *Gray Anatomy* include a maximum of six interactions.

In addition in attempting to limit the scope of the interactions that any individual student might have, we also made efforts to limit the opportunities to misunderstand directions for given tasks. The *Alien Contact!* curriculum depends to a great extent on providing written textual directions to students. In many of these cases, the content required at least one scroll to complete the reading of the directions. Following several of the principles of game design for effective learning laid out by Gee (2003), it was decided to focus on using multimedia for the delivery of directions and content through the game. According to the work of Gee, by leveraging the technological capabilities of the handheld computers themselves, the AR games pace can effectively provide multimodal meaning (i.e., use materials other than text to provide meaning). In addition, by providing materials in other formats than simply through text, the curriculum can address semiotic principles (i.e., identifying and appreciating the interrelations between multimedia elements in a complex system) (De Oliveira & Baranauskas, 2000).

More tangentially, in response to a perceived need for greater clarity throughout the game, a new design paradigm was implemented for *Gray Anatomy*. As HARP staff did not have any previous experience designing AR curricula, this first effort was done without a roadmap. In essence, project staff designed the process for developing an AR curriculum through the process of developing the AR curriculum itself. Based on lessons learned from this *bootstrapping* design strategy, a more structured development process utilizing a storyboarding approach was implemented for the development of *Gray Anatomy*. This process involved multiple meetings among HARP staff during which the broad strokes of the story involved with the curriculum were outlined. In these meetings, we decided that there would be various possible theories to why the whale would

have beached, one of which would be a *correct* response. Documents were developed to guide the formulation of these different theories, and each member of the HARP team designed one set of evidence that can confirm or deny individual theories using these guides to assure consistency across the different answers.

Competition

The other major unanticipated issue seen throughout our evaluations of *Alien Contact!* was the competitive interactions among the student teams when playing the game. As was discussed earlier, this was generally due to the fact that all students followed the same path of characters and objects, and thus each team could see which other teams were ahead or behind them in that progression. On its face, competition is not necessarily a negative thing to build into a game; however, in this instance, it did have negative repercussions. Because of the competition, students who wished to *win* would rush through the individual interactions that make up the game and would miss important information that they needed to progress through subsequent characters or to identify possible support data for individual hypotheses.

In order to undercut this competition across teams, the HARP staff developed a nonlinear path through the game. Instead of each character/object triggering the next character to appear along a proscribed path, an entry-point character will trigger all of the other characters in the game. This entry-point character will direct the students on the scope and sequence of the game playing experience and will inform them that each team must visit all of the other characters within the game space during the course of the AR event. The path through which the students progress can be determined by them, thus making it less likely that student teams will see other teams as ahead or behind them.

Modifications Based on Other Considerations

In addition to the modifications that were made based on our evaluation findings, there were also several modifications that came about due to informal analysis of the *Alien Contact!* curriculum and implementations that took place after the formative evaluation was conducted.

Flexible Roles

The first change occurred due to difficulties that were caused by the hard coding of four roles within the *Alien Contact!* curriculum. As was mentioned previously, students were placed into teams of four, with each of the students within a team taking on one of four roles (chemist, cryptologist, computer hacker, and FBI agent). However, the relative inflexibility of this system caused difficulty when there were a number of students that was not divisible by four. What would be done with any *excess* students? In implementations of *Alien Contact!* these additional students would be allocated to teams and would duplicate one of the four roles (thus a team might have two chemists). Obviously, this is not optimal due to the fact that the content was developed to assure that each of the students within a team would receive unique information that would need to be shared with other members of the team in order for the team to be successful. Having two students playing one role, although expedient, created a situation where the additional student was not necessary to the team's success.

In order to combat this situation, *Gray Anatomy* was designed with a flexible role structure. The AR editing software and the needs of the curriculum design still dictated the hard coding of roles within the game space. However, HARP personnel decided that two different versions of the game would be created. The first version would have three students in each team. Each of these three

students would take on one of the following roles: marine biologist, oceanographer, and reporter. The second version of the game would entail two students pairing together to play the game. These two students would play the game as the marine biologist and oceanographer.

In keeping with the design paradigm used within *Alien Contact!*, the reporter would receive unique information within the three-person version of the game. The fact that this information would be necessary to progress through the game effectively created the problem of how to allocate the reporter's information to the participants within the two-person version of the game. The solution for this was to have the reporter incorporated as a character the paired students would interact with within the game space itself. Thus, each of the two students would still be receiving all of the information that any student working within the three-person version would see, while allowing the flexibility to accommodate any number of students without the need of duplication of roles.

Correct Answer

Another issue that was present within most of the implementations of the *Alien Contact!* AR game was a desire on the part of the students to know the correct answer to the question of why the aliens had come to earth. Manifesting itself within the focus team interviews that followed the full implementation of the curriculum, students asking for the *right* answer lead to discussions of the need to use data to support hypotheses in ambiguous situations. Although this is a valuable lessons for students to learn, and one that *Alien Contact!* attempts to convey, one of the strengths of many commercially available games is that they build to a climax and then offer closure (whether this is on a small scale based on individual tasks within a game or on a larger scale as the structure of the entire game). For this purpose, HARP personnel decided that *Gray Anatomy* would include such a correct answer.

This, however, presented its own unique challenge, as there is no explanation widely accepted in the scientific community as to why whales beach themselves. In a game based on having students answer this question, it is not appropriate to offer a solution as correct if the wider scientific community cannot support such an assertion. Such an act would provide students a false sense of the real world and would be impossible to support ethically.

The solution that the HARP staff decided on was to have a series of "crackpot theories" that were viable sounding, but which each had a "fatal flaw" that made them impossible to have actually caused the beaching. Thus, whichever theory was not fatally flawed could be seen as the correct answer to the simulation. HARP staff developed three theories, two of which are fatally flawed. These theories, along with the corresponding characters used to support or debunk them, make up the suite of interactions that each team of students has over the course of two days of outdoor AR interactions.

Redesigned Control

In order to do rigorous research into the efficacy of both AR curricula as an instructional strategy, we use a pre-test/post-test control group research design. As such, a board game version of the AR game is developed to act as the control curriculum to determine what value, if any, the technology adds. All content was the same as would be found in the AR curriculum, and the team dynamics remained the same. This board game consists of an 8x8 checkerboard, around which student teams move game pieces. Each of the 64 squares on the checkerboard corresponds to an envelope on a tri-fold poster demonstration board. According to where they were in the game, the team is directed to open a particular envelope, which holds cards that deliver the role-based content for that interaction. In addition, the teams are directed to

move their game pieces to the corresponding next square on the checkerboard.

Using the version of the board game initially developed for *Alien Contact!*, HARP staff determined that the design of the board game made it unnecessary to interact with the actual checkerboard for all but the most ancillary activities. In order to make the interface more interactive and engaging, the board game portion of this control curriculum was redesigned. The new version of the board game includes a foam board image of a neighborhood with puzzle-piece shaped, yellow spaces interspersed throughout the image. As students move through the game, they receive puzzle pieces that show them with whom or what they were interacting with next and in which envelope that character's or object's information would be found. This redesign dramatically improved the *feel* of the board game and has created a situation where the students need to interact with the board, making the control curriculum more similar in its format to the AR curriculum.

Shorter Curriculum

Another modification made to the curriculum template for *Gray Anatomy* was to switch from a six-day to a five-day schedule. The *Alien Contact!* curriculum follows a staggered indoor/outdoor pacing. As was discussed earlier, four of the six days within the *Alien Contact!* curriculum are dedicated to work in a traditional classroom setting. Each day immediately following the two game days are dedicated to analyzing and synthesizing the data that were gathered during the gameplay. This had the consequence of creating an awkward schedule that required more than one academic week for completion.

This awkwardness of the schedule led to a switch to a five-day curriculum plan for *Gray Anatomy*. Rather than having an analysis and synthesis day following each of the two game days, there is only one analysis day following

two straight game days. It is postulated that this change will have dual benefits. The first benefit is to create a schedule that works within a single academic week. The second benefit is to create a more focused analysis opportunity.

Curriculum Focus

Another issue that has been addressed for *Gray Anatomy* was the focus on integrating the different content areas more meaningfully. *Alien Contact!* can be implemented as a math curriculum, an ELA curriculum, or a combination of math and ELA. The decision to split the combined curriculum and only implement that math or ELA content areas was made in order to facilitate the ability to recruit individual teachers for the project. If a math teacher wished to implement *Alien Contact!*, however, there was no corresponding ELA teacher to conduct those sections of the curriculum, so it would be more difficult to recruit teachers. The focus for Gray will be on an integrated math and ELA curriculum rather than on separate math and ELA. This is in line with skills that students need in their future work, which is interdisciplinary. It also significantly reduces logistical problems or need for so much technical support of setting up two different games.

Teacher Involvement

Finally, there is discussion about how to get the teachers themselves more involved in the delivery of the curriculum rather than having it be something that the research team comes in and does. It was never intended that the research team would teach the content itself, as the future of AR lies in its ability to be a seamless part of the learning environment run by the in-service teachers. With implementations of *Alien Contact!* it has been necessary for the research team to play a relatively large role in managing the content. In order to mitigate this for *Gray Anatomy*

implementations, the game will be played fully with teachers before the students play so they themselves are engaged in situated learning and learn the process involved. This has the indirect benefit of getting buy-in from the teachers both for the technology and for the process of situated learning. Second, the HARP team is considering ways (both technological and non-technological) to have teachers gather feedback from students after the first outdoor day so they can more closely track individual student's progress and give them formative feedback to improve their experience for the second outdoor day.

CONCLUSION

The development and deployment of AR technologies is still in its early stages. Since these types of curricula incorporate nascent technology, taking the long view about their potential for student learning is appropriate. As Dede (2005) asks when discussing the learning styles associated with "Millennial" students, "What new forms of neomillennial learning styles might emerging media enable?" (p. 8). We know that students will increasingly bring learning strengths and preferences to the classroom derived from the ever more sophisticated and pervasive use of cell phones. This trend implies that instructional designs merging physical and virtual environments hold great promise for building on learners' emerging skills and inclinations. Our early research is promising in demonstrating AR can enhance student motivation, involvement, and excitement; and our current studies are examining the extent to which learning outcomes are enhanced over comparable control curricula.

As a field, instructional designers are at the beginning of identifying best practices for developing effective AR curricula. Systematically building on findings from early studies such as our work will not only improve later AR cur-

ricula, but also may lead to improvements in the technology itself, particularly as AR moves to its eventual target device, the cell phone. By migrating this emerging interactive medium from custom, school-supported PDA/GPS technologies to standardized, commercial-provider-supported, cell phone technologies, educators can realize the advantages of using ubiquitous, powerful devices students could bring from their homes to classroom settings.

AR can reach its full potential only when this leveraging of student-owned technologies is realized. Any instructional design that depends on school-based personnel maintaining and managing complex, custom sets of equipment has inherent weaknesses. Maintenance and management is time consuming, and the equipment is prone to obsolescence; the total cost of ownership by the school system is substantial when this includes initial purchase, maintenance, technical personnel, and replacement costs. Beyond those issues, if educators are responsible for equipment evolution, this will dramatically slow the advance of AR technologies. Compared to large telecommunications companies rapidly enhancing their equipment to gain market share in the lucrative cell phone market, educators have neither the technical capacity nor the competitive incentives to rapidly improve AR devices.

We estimate that, within a year or two, the next generation of cell phones can deliver the types of AR developed in our studies. Such a migration in AR infrastructure will require a substantial shift in how teachers and administrators treat cell phone usage in school settings. At present, many educators see cell phones as a barrier to effective instruction because of their potential to distract students' attention and to facilitate cheating. Once schools go beyond banning cell phones, or reluctantly accepting smart phone technology as a necessary evil, to instead developing ways to incorporate these powerful devices for the improvement of student learning, then educators

will have a commercially supported learning infrastructure with which students are already familiar and fluent, paid for and maintained external to education, and available for learning inside of classrooms and out. AR is a fulcrum for leveraging this evolution.

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Section III

Tools and Technologies

This section presents an extensive treatment of various tools and technologies existing in the field of instructional design that practitioners and academics alike must rely on to develop new techniques. These chapters enlighten readers about fundamental research on the many methods used to facilitate and enhance the integration of this worldwide phenomenon by exploring software and hardware developments and their applications—an increasingly pertinent research arena. It is through these rigorously researched chapters that the reader is provided with countless examples of the up-and-coming tools and technologies emerging from the field of instructional design.

Chapter 3.1

Cognitive Architecture and Instructional Design in a Multimedia Context

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ABSTRACT

Our knowledge of human cognitive architecture has advanced dramatically in the last few decades. In turn, that knowledge has implications for instructional design in multimedia contexts. In this chapter, we will analyse human cognitive architecture within an evolutionary framework. That framework can be used as a base for cognitive load theory that uses human cognitive architecture to provide testable hypotheses concerning instructional design issues. Human cognition can be

characterised as a natural information processing system. The core of such systems can be described using 5 principles: (a) information store principle, (b) borrowing principle and reorganizing principle, (c) randomness as genesis principle, (d) narrow limits of change principle, and (e) environment organizing and linking principle. These 5 principles lead directly to the instructional effects generated by cognitive load theory. Some of these effects are concerned with multimedia learning. The particular ones discussed in the chapter are the split-attention, modality, redundancy, element interactivity, and expertise reversal effects.

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INTRODUCTION

Instructional design recommendations not based on our knowledge of human cognitive architecture are likely to be limited in their effectiveness or may even have negative consequences. In this chapter, we will use an evolutionary approach to human cognition (see Sweller 2003; Sweller 2004; Sweller and Sweller 2006). Evolution by natural selection can be used to determine categories of knowledge that humans are particularly adept at gaining because we have evolved to acquire that knowledge. Furthermore, the basic logic that underlies evolutionary biology is shared by human cognition and so can be used to analyse our cognitive processes. Those cognitive processes, in turn, determine the effectiveness of particular instructional procedures. We will begin by discussing two categories of knowledge from an evolutionary perspective.

BIOLOGICALLY PRIMARY AND BIOLOGICALLY SECONDARY KNOWLEDGE

Geary (2007) divides knowledge into biologically primary knowledge that we have evolved to acquire easily and automatically and biologically secondary knowledge that relies on primary knowledge but that we have not evolved to acquire. Examples of activities driven by primary knowledge are listening and speaking our first language, recognising faces, using general problem solving techniques and engaging in basic social relations. We have evolved over millennia to acquire massive amounts of knowledge associated with these activities easily, quickly and without conscious effort. We can acquire biologically primary knowledge simply by being immersed in a normal human society. Explicit instruction is unnecessary.

In contrast, biologically secondary knowledge tends to be associated with a more advanced stage

of development of civilization. It has only been required since the rise of civilisation and so we have not evolved to acquire specific examples of biologically secondary knowledge. We can acquire such knowledge using biologically primary knowledge but it is acquired relatively slowly and with conscious effort. In contrast to biologically primary knowledge, biologically secondary knowledge requires explicit instruction and conscious effort on the part of learners. The bulk of knowledge acquired in educational institutions such as schools consists of biologically secondary knowledge.

HUMAN COGNITIVE ARCHITECTURE WHEN DEALING WITH BIOLOGICALLY SECONDARY KNOWLEDGE

There is a basic logic associated with the acquisition of biologically secondary knowledge and that logic is identical to the logic that underlies the processes of evolution by natural selection. Both are examples of natural information processing systems (Sweller & Sweller, 2006). There are many ways of describing that logic. In this chapter we will use five basic principles.

Information Store Principle

In order to function, natural information processing systems require a massive store of information used to govern activity. In the case of human cognition, long-term memory provides that store. The well-known work of De Groot (1965) and Chase and Simon (1973) on the knowledge chess masters have for board configurations taken from real games provides evidence for the importance of long-term memory for most facets of cognition, including problem solving. A genome provides the same function for evolution by natural selection.

Borrowing and Reorganising Principle

Acquiring a massive store of information requires an efficient acquisition procedure. In the case of the human cognitive system, that procedure involves borrowing and reorganising information from the long-term store of other individuals by imitating what they do, listening to what they say and reading what they write. The information obtained is combined with previous information resulting in reorganisation. Findings based on cognitive load theory provide evidence for the importance of the borrowing and reorganising principle (e.g. Sweller, 2003, 2004). How cognitive load theory suggests instruction should be organised to facilitate the borrowing of information is discussed below. During sexual reproduction, evolution by natural selection uses the borrowing and reorganising principle to allow a genome to acquire large amounts of information that is necessarily reorganised during the process.

Randomness as Genesis Principle

While information is best acquired by using the borrowing and reorganising principle, that information must be created in the first instance. In genetics, random mutation is the ultimate source of all biological variation and so is the genesis of all biological novelty. In human cognition, information is created via the randomness as genesis principle during problem solving. In order to generate a problem solving move, we must use a combination of information held in long-term memory and a random generate and test for effectiveness procedure. If at any point while solving a problem, two or more moves are available to us, and if we do not have information in long-term memory indicating which move might be best, we must randomly generate one of the moves and test to see what effect it has. To the extent to which information is not available in long-term memory, no other procedure has been

identified to generate moves other than random generate and test. That process is the ultimate source of all novel information we create just as random mutation is the ultimate source of all biological variation.

Narrow Limits of Change Principle

Since the creation of novel information requires a random generate and test procedure, mechanisms are required to ensure that randomly generated information, most of which is dysfunctional, does not destroy the functionality of the information store. Our cognitive system achieves this end by ensuring that all changes to the store are small and incremental by requiring information to first be processed by a limited capacity, limited duration working memory. Evidence for the limited capacity of working memory comes from the well-known work of Miller (1956) while evidence for its limited duration comes from Peterson and Peterson (1959). It must be emphasised that the limitations of working memory only apply to novel information to which the randomness as genesis principle applies. Changes to a genome require random mutation, are governed by the epigenetic system and also are slow and incremental.

Environmental Organising and Linking Principle

The limitations of working memory disappear when it processes organised information from long-term memory. When dealing with familiar information, working memory has neither capacity nor duration limits. Evidence for the altered characteristics of working memory when dealing with well-learned information comes from Ericsson and Kintsch's (1995) work on long-term working memory. We can hold huge amounts of familiar information in working memory for indefinite periods. That material can be used to organise information from our environment and link our activities appropriately to the environ-

ment. It provides the ultimate justification for our cognitive system. Similarly, the epigenetic system determines how information stored in DNA is used to govern biological activity.

INSTRUCTIONAL CONSEQUENCES

There are instructional consequences that follow from the manner in which our cognitive structures are organised to process information. The first and most obvious implication is that the purpose of instruction is to alter the information store – long-term memory. If nothing has changed in long-term memory, nothing has been learned. The second implication is that the best way to alter long-term memory is via the borrowing and reorganising principle. Wherever possible, we should present information to students rather than have them search for the information themselves. The third implication is that when presenting information to learners, we should organise that information in a manner that takes into account the characteristics of human cognitive architecture. For instruction to be effective, the narrow limits of change principle is paramount. Instruction has to be designed in such a way that the limitations of working memory are overcome by, for instance, minimising extraneous cognitive load. By minimising unnecessary working memory load, essential information can be stored in long-term memory and in turn, that information will increase the effective capacity of working memory via the environmental organising and linking principle. That principle permits humans to readily engage in very complex activities.

Cognitive load theory has used this architecture to devise a variety of instructional procedures. Some of those procedures are directly concerned with the presentation of information within a multimedia framework. In this chapter, we focus on three cognitive load effects concerned with aspects of multimedia presentation of information: the

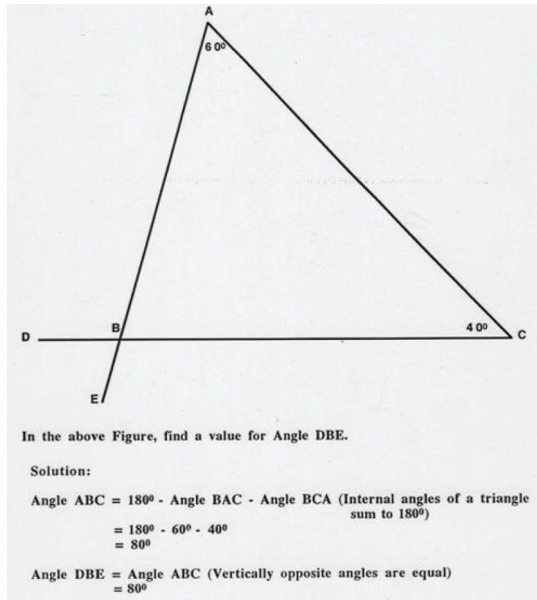
split-attention effect, the redundancy effect and the modality effect.

The Split-Attention Effect

Split-attention occurs when learners have to mentally integrate two or more sources of physically or temporally disparate information and each source of information is essential for understanding the material. The working memory load imposed by the need to mentally integrate the disparate sources of information interferes with learning. Consider a conventionally structured geometry worked example consisting of a diagram and its associated solution statements (see Figure 1). The diagram alone does not communicate the solution to the problem. The statements, in turn, are incomprehensible until they have been integrated with the diagram. Learners must mentally integrate the two sources of information (the diagram and the statements) in order to understand them. This process can be cognitively demanding, especially for a novice learner, thus imposing a cognitive load that is extraneous simply because of the particular format used.

Research into split-attention was initially conducted by Tarmizi and Sweller (1988) who looked into the effectiveness of worked examples on learning geometry. Previous research had demonstrated that worked examples were highly effective for learning algebra (Cooper & Sweller, 1987; Sweller & Cooper, 1985) and in other mathematical-related domains (Zhu & Simon, 1987). However, Tarmizi and Sweller found that in comparison to conventional problem-solving strategies, worked examples did not enhance performance in geometry. They argued that the requirement due to the format of the worked examples to mentally integrate the two sources of information (diagram and textual solutions) must have imposed an increase in cognitive load that prevented cognitive resources to be used for learning. In subsequent experiments, Tarmizi and

Figure 1. Conventionally structured geometry worked example consisting of a diagram and its associated solution statements



Sweller demonstrated that learners who studied integrated worked examples (see Figure 2) performed better than learners who followed a conventional problem solving strategy during acquisition.

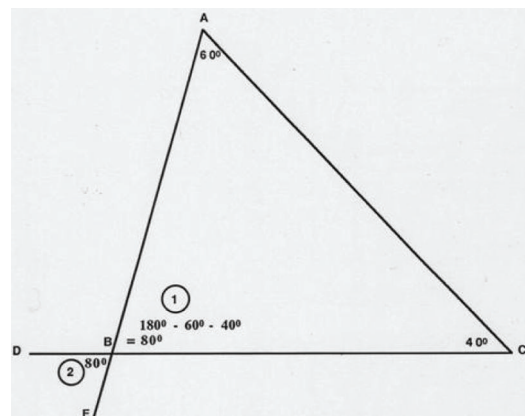
Subsequent research sought to test the hypothesis that if multiple sources of information were integrated, the need for learners to engage in mental integration would be obviated thus freeing cognitive resources for learning. The Tarmizi and Sweller findings were replicated by Sweller, Chandler, Tierney, and Cooper (1990) in the domain of coordinate geometry, by Ward and Sweller (1990) in the domain of physics, by Chandler and Sweller (1991) using instructional materials designed for electrical apprentices, and by Sweller and Chandler (1994) and Chandler and Sweller (1996) investigating learning in a computer environment. This line of research has been extended to language learning. In a series of experiments designed to test the split attention effect, Yeung, Jin and Sweller (1998) found that explanatory notes integrated with reading pas-

sages, by reducing cognitive load related to search for meaning, improved reading comprehension for both fifth grade first language pupils and inexperienced learners of English as a second language (ESL). Together, these findings in different domains generate the expectation that training conditions comparing split-attention and integrated formats will yield results demonstrating the superiority of the integrated format. This phenomenon is known as the split-attention effect.

Various forms of different sources of information can lead to split-attention: text and text, text and mathematical equations, or different forms of multimedia. Any instructional material that contains more than one source of information is potentially a context for integrating split-source information. Split-attention will frequently occur in a multimedia context as there will always be at least two sources of information involved.

The split-attention studies mentioned so far deal with sources that are physically separate and have engaged learners in the visual medium only. Whether the cause of split-attention is text and a diagram, or computer and a manual, the different sources of information are physically separate in a manner that requires visual and cognitive search that imposes an extraneous load. However, physical separation is not the only form of separation that generates unnecessary cognitive

Figure 2. Integrated worked example



load. Multiple sources of information that must be integrated before they can be understood can also be separated in time, resulting in temporal separation. The consequences of temporal rather than spatial versions of the split-attention effect have been largely carried out by Mayer and his colleagues who have extended the effect to include sound (Mayer & Anderson, 1991, 1992; Mayer & Sims, 1994; Moreno & Mayer, 1999). This body of work demonstrates that learners who received information simultaneously, that is integrated narration and animation outperformed learners who received non-integrated instructions (narration and animation separated temporally).

In summary, the split-attention effect has been demonstrated in many studies using a wide variety of materials and participants under many conditions (see Ayres & Sweller, 2005 for a detailed review). The presence of this effect has implications for instructional design in a multimedia context where there will always be at least two sources of information.

Split-attention effect and instructional design. The split-attention effect has both theoretical and practical implications. From a theoretical perspective, the results provide evidence that minimising extraneous cognitive load benefits learning. From a practical perspective, the results provide some instructional guidelines for dealing with multiple sources of information. One guideline is that where instruction includes multiple sources of information that must be integrated in order to make sense, those sources of information should be both physically and temporally integrated in order to reduce extraneous cognitive load. This guideline should have the potential to improve multimedia instruction substantially. However, considerable care must be taken when physically integrating disparate sources of information as there are conditions under which simply integrating all text onto a diagram will have negative rather than positive effects on learning (see Ayres & Sweller, 2005).

One condition under which integrated instructions do not have positive effects on learning is when the multiple sources of information are intelligible in isolation. For example, physically integrating a diagram with statements that merely redescribe the diagram has negative, not positive effects on learning due to the redundancy effect (see next section). If all sources of information are intelligible in isolation and redundant, elimination of redundancy rather than physical integration should be undertaken. Thus, analysing the relation between multiple sources of information prior to physical integration is important.

Another condition under which integrated instructions are not beneficial is when the learning materials do not involve high element interactivity (e.g. Sweller 1994) where element interactivity refers to the number of elements that must be simultaneously processed in working memory because they interact. Low element interactivity material consists of elements that can be processed individually because they do not interact. Since the elements can be processed individually, they impose a low load on working memory and such material is described as having a low intrinsic cognitive load. In contrast, the elements of high element interactivity material, because they interact, must be processed simultaneously in working memory if the material is to be understood. Such material has a high intrinsic cognitive load. A diagram and related text that have few interacting elements and therefore are easily understood are unlikely to impose an extraneous cognitive load due to split-attention. There is no real benefit in physically integrating the different sources of information as they can be easily learned even when presented in a split-source format.

A further factor to consider when integrating different sources of information is learner characteristics that interact with material characteristics. Material that is not intelligible in isolation and high in element interactivity for low knowledge learners may be intelligible in isolation and low

in element interactivity for learners with more knowledge. For high knowledge individuals, physical integration may be harmful because of the redundancy effect (Yeung, Jin & Sweller, 1998).

The Redundancy Effect

The redundancy effect occurs when additional information presented to learners results in negative rather than positive effects on learning. It can be obtained in one of two ways. First, when identical information is presented in two or more different forms or media, such as pictures and words, or words in both auditory and written form, if one of these forms is redundant then the elimination of that form may result in enhanced learning resulting in the redundancy effect. Second, when additional information is presented in an attempt to enhance or elaborate information, if the additional explanations or elaborations are redundant then the exclusion of that additional information may enhance learning providing another example of the effect. There is overlap between these two forms in that the same information presented in a different medium may be essentially an elaboration. Nevertheless, the distinction is real in that some elaborations use the same medium while others use different media. In both instances, the effect is the same: redundant information can interfere with learning.

The redundancy effect was probably first demonstrated by Miller (1937) and subsequently by various researchers (e.g., Reder & Anderson, 1980, 1982; Solman, Singh & Kehoe, 1992). However, these researchers did not explain the effect in terms of cognitive load theory. Cognitive load theory suggests that processing redundant information with essential information increases working memory load, which interferes with the transfer of information to long term memory. Removing redundant information eliminates the requirement to process information that is not essential to learning. Consider instruction on the flow of blood in the heart, lungs, and body. Frequently,

it will consist of a diagram of the heart, lungs, and body with arrows indicating the direction of the blood flowing the veins and arteries. In addition, text consisting of statements such as, "The blood entering the aorta is pumped back into the body", or "Blood from the lungs flows into the left atrium." In contrast to the geometry example given earlier, the diagram is self-contained and intelligible. It shows by means of arrows and labelling, that blood entering the aorta is pumped back into the body and that blood from the lungs flows into the left atrium. The text in this case is redundant since it merely repeats the same information albeit in a different form. In addition, when such redundant text is integrated with the diagram by being placed at appropriate locations on the diagram, the text is not only redundant, it is also unavoidable. Learners looking at the diagram are very likely to read the text as well. In contrast, if the text is below or next to the diagram rather than integrated with the diagram, it is much easier to ignore. Using the biology material mentioned earlier, Chandler and Sweller (1991) compared the performance of learners under the conditions of integrated instruction, split-attention instruction, and diagram without text instruction. The best condition was the diagram without text instruction indicating that redundant instructional material should be eliminated.

In contrast to inexperienced language learners, senior undergraduate students and high-ability ESL learners, when reading passages integrated with vocabulary explanations, found that the information about the meanings of many words was redundant but hard to ignore (Yeung, Jin & Sweller, 1998). Consequently, for those experienced learners, explanatory notes with an integrated format led to lower scores of reading comprehension in comparison with the conventional text plus a separate vocabulary list. It appears that, although explanatory notes using an integrated format within passages may be helpful for those learners with less expertise to reduce the split attention effect, this format may not be suitable for readers with high

language proficiency because of the redundancy effect. Diao and Sweller (2007) further examined the redundancy effect in the context of educational multimedia designed for learners of English as a foreign language (EFL). In their study, Chinese EFL learners using simultaneous presentations of spoken and written text reported having a higher mental load and produced lower scores in both word decoding and reading comprehension than did those using materials presented in written form only. The findings support an earlier study of Japanese EFL learners (Hirai, 1999), which claimed that the listening rate was far behind the reading rate for less proficient learners. When the aim is to teach novice EFL learner to read, such poor audio-visual correspondence may cause a redundancy effect in the presentations comprising both identical auditory and written text.

Since the Chandler and Sweller (1991) findings, the redundancy effect has been demonstrated in a variety of contexts. It is not just the diagrams and redundant text that can be used to demonstrate the redundancy effect. While diagrams are frequently more intelligible than the equivalent text, there are instances where any one of diagrams, the presence of equipment, or auditory information have been found to be redundant (see Sweller 2005 for experimental evidence). In other words, what is redundant depends on what is being taught.

Redundancy effect and instructional design. As is the case with the split-attention effect, the redundancy effect has been demonstrated in many studies using a wide variety of materials and participants under many conditions. In practical terms, the redundancy effect provides a simple guideline for instructional design: eliminate any redundant material in whatever form presented to learners and any redundant activity that instruction may encourage learners to engage in. However, this guideline alone does not indicate exactly what material may or may not be redundant. This guiding principle needs to be considered in conjunction with cognitive load theory. The theory can be used to provide guidance concerning the conditions that

determine redundancy and hence what material is likely to be redundant. For instance, in deciding whether text should be added to a diagram, the instructional designer needs to consider several factors. Is the diagram intelligible on its own? If so, the text may be redundant. Does the text provide essential information? If so, it is not likely to be redundant and should be retained. Is there a high level of element interactivity within the text, that is, to understand one element, one must consider many other elements at the same time? If so, as far as possible, diagrams should not be presented with the text to avoid the risk of overloading working memory. Another factor to consider is learner expertise. Whether information is high in element interactivity and whether it is intelligible on its own depends largely on the learner. Information that is intelligible for more expert learners may not make sense to novices who require additional explanatory material. In short, whether or not additional material is redundant can be determined by considering the cognitive load implications of that material in the context of learner expertise.

The Modality Effect

Studies documenting the split-attention and redundancy effects have provided evidence to indicate that the manner in which information is presented will affect how well it is learnt and remembered. Another effect that has important implications for instructional design, especially in multi-media learning is the modality effect. The modality effect occurs when information presented in a mixed mode (partly visual and partly auditory) is more effective than when the same information is presented in a single mode (either visually or in auditory form alone). For example, consider a typical geometry problem consisting of a diagram and associated statements (Figure 1). Conventionally, the diagram and the associated statements are visually presented. However, although the diagram has to be presented visually,

the associated statements can be presented visually or orally. There is evidence to show that students learn better when the associated statements are narrated rather than presented visually.

According to cognitive load theory, many instructional materials and techniques may be ineffective because they ignore the limitations of human working memory and impose a heavy cognitive load. This type of load is referred to as extraneous cognitive load and has been the main concern of cognitive theorists whose focus has been on devising alternatives to those conventional instructional designs and procedures that were developed without taking into consideration the structure of human memory.

Theoretically, there are two ways in which extraneous cognitive load can be manipulated. First, instructional procedures can alleviate extraneous cognitive load by formatting instructional material in such a way that minimises cognitive activities that are unnecessary to learning so that cognitive resources can be freed to concentrate on activities essential to learning. The split attention and redundancy effects discussed above fall into this category.

The consequences of extraneous cognitive load can also be alleviated by increasing effective working memory capacity. Working memory was initially considered a single entity. More recent research has indicated that working memory may consist of multiple processors rather than a single processor (Baddeley, 1992; Schneider & Detweiler, 1987). These multiple stores, processors, channels, or streams (the terminology varies among researchers) are frequently associated with the separate processing of visual-spatial and oral material. For example, Baddeley's model of working memory (Baddeley, 1986, 1992, 1999) divides working memory into a visuo-spatial sketch pad that processes visually based information such as diagrams and pictures, and a phonological loop that processes auditory information.

There is considerable evidence to suggest that the visuo-spatial sketch pad and the phonological

loop process different types of information independently, at least to some extent. If the two systems are relatively independent, the total amount of information that can be processed by working memory may be determined by the mode (auditory or visual) of presentation. It may be possible to increase effective working memory capacity by presenting information in a mixed visual and auditory mode rather than a single mode.

Low & Sweller (2005) provided a discussion of research evidence to support the notion that working memory can be subdivided into partially independent processors consisting of an auditory working memory system to deal with verbal material and a visual working memory system to deal with diagrammatical/pictorial information. Since the two processors deal with appropriate information independently to some extent, it is plausible that a mixed mode of presentation can increase the amount of information that can be processed in working memory. In a detailed review of the experimental literature, Penney (1989) provided two different lines of evidence demonstrating an appreciable increase in effective working memory capacity by employing both visual and auditory, rather than a single processor. One line of evidence shows improved ability to perform two concurrent tasks when information was presented in a partly audio, partly visual format, rather than in either single format. The other line of evidence demonstrates improved memory when information was presented to two sensory modalities rather than one. As previously indicated, the occurrence of increased working memory capacity due to the employment of a dual, rather than a single mode of presentation, is termed the modality effect. (See Low & Sweller, 2005 for a discussion of research demonstrating the modality effect).

If effective working memory can be increased by using dual-modality presentation techniques, theoretically, this procedure may be just as effective in facilitating learning as physically integrating two sources of visually presented information. The instructional version of the modality effect

can be considered to stem from the split-attention effect. It occurs under split-attention conditions when a written source of information that must be integrated with another source of visually presented information such as a diagram, is instead presented in auditory rather than visual mode. The instructional modality effect is obtained when a dual mode presentation is superior to a visual only, split-attention presentation.

Modality effect and instructional design. The instructional predictions that flow from the experimental work on the modality effect are straightforward. Assume instruction that includes a diagram and text that are unintelligible unless they are mentally integrated. A geometry diagram and associated text provide one of many examples. From a cognitive load theory perspective, the modality effect can be explained by assuming the memory load due to a diagram (or picture) with text presentation induces a high load in the visual working memory system because both sources of information are processed in this system. In contrast, the diagram and narration version induces a lower load in visual working memory because auditory and visual information are each processed in their respective systems. Therefore, the total load induced by this version is spread between the visual and the auditory components in the working memory system. In other words, integration of the audio and visual information may not overload working memory if its capacity is effectively expanded by using a dual-mode presentation.

Using the cognitive load framework as a theoretical base, Mousavi, Low, and Sweller (1995) tested for the modality effect using split-attention geometry materials consisting of a diagram and its associated statements. It is obvious that a geometry diagram must be presented in visual form. However, the textual information could be presented in either visual (written) or auditory form. A visually presented diagram and auditorially presented text may increase effective working memory and so facilitate learning over conditions

where visual working memory alone must be used to process all of the information. In a series of experiments, Mousavi et al. obtained this result. Audio-visual instructions were consistently superior to visual-visual instructions, demonstrating the modality effect. Furthermore, strong evidence was obtained indicating that the effect was due to working memory considerations, not merely due to the physical fact that auditory and visual signals can be received simultaneously while two visual signals (e.g. from a diagram and separate text) cannot be perceived simultaneously but must be attended to successively. The effect was retained even when the geometric diagram and its associated text were presented successively rather than simultaneously in both the audio-visual and visual-visual conditions. Remembering and using a previously presented statement while looking at a diagram is easier when the statement is spoken rather than written.

Tindall-Ford, Chandler, and Sweller (1997) replicated the basic, modality effect finding in another series of experiments with electrical engineering instructional materials. In addition, these experiments differentiated between materials that were low or high in element interactivity. Tindall-Ford et al. predicted that low element interactivity material with its low intrinsic cognitive load would not demonstrate the modality effect because increasing effective working memory would be irrelevant under conditions where the information that had to be processed did not strain working memory capacity. The modality effect was obtained with high but not low element interactive materials. In addition, assessment of comparative cognitive load using subjective ratings (see Paas & Van Merriënboer, 1993) indicated that cognitive load was higher under visual-visual than under audio-visual conditions, but only when the instructional material was high in element interactivity. Jeung, Chandler & Sweller (1997) found that the modality effect was enhanced when visual indicators were used to indicate to learners which parts of complex information were being

referred to by the spoken text. Leahy, Chandler and Sweller (2003) demonstrated the modality principle but also found that the modality effect could only be obtained under split-attention conditions where the information of both modalities was essential for understanding. The effect was not obtained under redundancy conditions where one modality could be understood in isolation and the other was redundant in that it presented the same information in a different form.

The importance of split-attention conditions (i.e. with both sources of information essential for understanding) rather than redundancy conditions (both sources of information independently intelligible) for the modality effect can be seen from the work on the expertise reversal effect. Expertise reversal occurs when instructional techniques that are highly effective with inexperienced learners lose their effectiveness and may even have negative consequences when used with more experienced learners. Information in a dual-mode presentation may become redundant when presented to more experienced learners. Kalyuga, Chandler, and Sweller (2000) demonstrated that if experienced learners attend to redundant auditory explanations, learning might be inhibited. In a set of experiments with instructions on using industrial manufacturing machinery, inexperienced learners in a domain clearly benefited most from studying a visually presented diagram combined with simultaneously presented auditory explanations. After additional training, the relative advantage of the narration disappeared whereas the effectiveness of the diagram-only condition increased. When the same students became even more experienced after further intensive training in the subject area, the diagram-only condition was far superior to the diagram with narration condition, reversing the advantage of the dual-mode presentation previously obtained.

The modality effect is especially important in the context of multimedia learning because the instructional medium involves different presentation modes and sensory modalities. Multimedia

instruction is becoming increasingly popular and findings associated with the modality effect that can be interpreted within a cognitive load framework can provide a coherent theoretical base for multimedia investigations and applications. Indeed, in a number of web-based instructional studies, Mayer and his colleagues have demonstrated that students performed better on tests of problem solving transfer when scientific explanations were presented as pictures and narration rather than as pictures and on-screen text (Mayer & Moreno, 1998; Moreno & Mayer, 1999; Moreno, Mayer, Spires, & Lester, 2001). According to the researchers, such results are consistent with dual information processing theory. When pictures and words are both presented visually, the visual processor can become overloaded but the auditory processor is unused. When words are narrated, they can be dealt with in the auditory processor, thereby leaving the visual processor to deal with the pictures only. Thus, the use of narrated animation reassigns some of the essential processing from the overloaded visual processor to the underloaded auditory processor. Unlike the earlier research that used book-based materials, the work of Mayer, Moreno and their colleagues used on-screen materials.

More recently, Brünken, Steinbacher, Plass, and Leutner (2002) replicated the modality effect in two different multimedia learning environments while using a dual-task approach to measure cognitive load. Learners' performance on a visual secondary reaction time task was taken as a direct measure of the cognitive load induced by multimedia instruction. Brünken et al. found evidence that the differences in learning outcome demonstrated by the modality effect are related to different levels of cognitive load induced by the different presentation formats of the learning material. Specifically, they found that an emphasis on visual presentation of material resulted in a decrement on a visual secondary task, indicating an overload of the visual processor. In further work, Brünken, Plass, and Leutner (2004) again

reproduced the modality effect while measuring cognitive load using a dual-task methodology. In this work, the secondary task was auditory instead of visual and there was a decrement in performance on the auditory secondary task when the primary task placed an emphasis on the auditory processor.

CONCLUSION

The split-attention, redundancy, and modality effects discussed in this chapter can be explained by cognitive load theory. In turn, instructional predictions that flow from these effects provide a theoretical base leading to practical applications for e-learning and multimedia presentations. The results associated with the modality effect provide a new instructional procedure. Under split-attention conditions, rather than physically integrating disparate sources of information, learning may be facilitated by presenting a written source of information in auditory mode. While care must be taken to ensure the auditory material is essential and not redundant and that the instructional material is sufficiently complex to warrant the use of a technique that reduces cognitive load, under appropriate circumstances, the instructional gains can be large.

FUTURE RESEARCH DIRECTIONS

To this point, cognitive load theory has primarily been concerned with the borrowing and reorganising principle – how instructors should organise visual and aural information to maximise learning. Less attention has been paid to the initial creation of information where the randomness as genesis principle has primacy. Human creativity has been recognised as an important field of study for a very long time. That recognition has not been associated with a commensurate advance in knowledge. Bluntly, the field of creativity has never been integrated with our knowledge of human cognitive

architecture and it can be argued, as a consequence, has been unable to generate usable information.

The cognitive architecture outlined in this chapter may have the potential to begin a rectification of this state of affairs. By accepting that the randomness as genesis principle is the source of novel information and by considering the interactions of this principle with knowledge held in long-term memory, it may be possible to generate instructional recommendations concerning human creativity. Theoretical work is commencing on this project.

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Chapter 3.2

Simulating Teaching Experience with Role-Play

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ABSTRACT

This chapter discusses the design and use of simulated teaching experiences contextualized through role-play in a multi-user virtual environment as a means of providing pre-service teachers with pedagogical and instructional experiences that are increasingly difficult for university programs to provide. It illustrates the underlying pragmatic theory of communication that supports this model of simulated experience as well as research methods that we suggest can aid in understanding the complex learning that stem from actor and student interaction. The goal of this chapter is to provide an instructional design model of simulated role-

play experience that emerged from a design-based research project as a means of supporting the development.

INTRODUCTION

Every Tuesday, Wednesday, and Friday, when the signal emits clearly from transmitters hidden on thousands of planets, moons, and asteroids and reaches Earth, a tall, blonde man named Calron logs onto the OTAK. Once in the computer system, his digital self materializes in the central world, which is filled with numerous other figures, representing children from several continents. Calron is not from Earth; he is from the distant

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world of Atlantis. A member of a secret Council, he seeks to improve the quality of life on both planets through scientific inquiry aided by his friends on earth.

Calron types greetings to several elementary and middle school aged students, calling them by name from his past experiences with them during the previous six months. He asks several questions about their learning activities in the space and how students think their work is helping people on both Atlantis and Earth. Students pester him with questions about the Archfall book, which introduces them to the story and problems of the world of Atlantis. He answers sometimes specifically, sometimes vaguely; taking notes about which students he has told what information, so that he and other members of the Council can refer back to it in the future. When students ask which Quests they should complete next as these are the main learning activities in the 3-D space, he nudges them towards those that he and the Council feel can best help the respective planets. Figure 1 presents an image of Calron as he appears in the book that accompanies the digital world.

Figure 1. Calron, a pedagogical agent and Atlantan Council member in Quest Atlantis



Calron is not really an alien from a distant planet. Instead a simulated character role-played by a pre-service teacher. The experience of being Calron embeds the pre-service teacher within what it is to be a teacher by simulating several of the roles and responsibilities of teaching. Being a Council Member provides learners with a live action digital simulation of the pedagogical roles that teachers engage in every day that range from coaching to facilitating and even dramatic acting. While the activity furthers student experience related to the narrative that supports the project, it provides a valuable set of interactions that will increasingly interact with their students in interactive digital spaces that simulate the learning environments that currently consist of whiteboards and desks.

The Challenge for Teacher Training

With the increased need for trained teachers that continues to trouble schools in many U.S. states (Matus, 2005) as well as countries worldwide, teacher training institutions are increasingly turning to distance learning applications to provide simulated field experiences that mirror those that students would traditionally receive by teaching with a mentor teacher in a physical classroom (Lehman & Richardson, 2004; Simpson, 2006). In addition, there have been calls by the government, professional teaching organizations, parents and the media to improve the training of teachers to include knowledge about the latest research findings and knowledge about best practices in education (NEA, 2004; PreventionAction, 2007). While the technological solutions continue to multiply, a number of problems exist that call for solutions that involve the use of digital simulations. The use of such simulations has shown some promise for providing rich, meaningful field experiences to pre-service teachers that can prepare them for their future work as day-to-day professionals and learners (Aldrich, 2003; Squire, 2004; Thiagarajan, 1996).

Viewing the development of a simulated digital teaching experience through the lens of pure simulation (or simulation games) can be aided by adopting a theoretical stance that does not accept a single historical, Kuhnian paradigmatic stance (i.e. positivist/empiricist vs. contextualist vs. relativist) (Bernstein, 1983; Hollis, 1994). This frees the designer or researcher from a view of a simulated experience that provides only a narrow glimpse into teacher or learner experience. Instead, this chapter proposes examining the design or educational value of a simulated experience employing a pragmatic theoretical view that takes communication as the core function of human activity can provide a holistic means of developing a more complete picture of teaching and learning. Early work in the area of pragmatic theory and research centered on the idea that the development of theory and its accompanying research should be geared towards the development of new means of teaching and learning that could be readily employing in educational settings (Dewey, 1925, 1938).

This chapter frames both a theoretical and methodological perspective for understanding, assessing, and teaching using simulated role-play from the pragmatic Theory of Communicative Action (CA) (Habermas, 1981a) in several ways. First, it identifies the core issues and problems inherent in many existing teacher preparation systems. Further, we explore and critique the splintered, underlying theoretical stances that guide the development of many face-to-face and simulated teaching experiences and explain the means by which the theory can provide a more holistic view of the nature of simulated experiences for teacher preparation, learning, and assessment. Finally, we provide an example of a simulated teaching experience and future directions for this form of simulated role-play experience in educational settings.

BACKGROUND

Issues, Controversies, Problems

Teacher Field Experiences

As the number of teachers needed in public schools increases, the number of available locations for pre-service teacher experiences has not concurrently increased (Simpson, 2006). While the use of digital simulations and other forms of technology such as computer-mediated communication, digital video, and video conferencing systems have shown some promise for addressing this shortage of face-to-face field experiences, Simpson (2006) notes several challenges to using field experiences delivered at a distance:

1. Field experience in distance delivered teacher education programs is brief; this may stem from administrative limitations such as a limited number of school sites. Others difficulties in these experiences come the fact that instructors have found it challenging to include all the relevant knowledge about pedagogical practices and specific area content knowledge (i.e. mathematics) that researchers have found necessary to ensuring a quality education for distance students.
2. Young (1998) notes that a central issue related to providing a range of pre-service field experience is that a consequence of many newly shortened programs is that experience is often in a single school and that this solitary experience can be an inadequate model for a future teacher.
3. It is also often difficult for teacher education institutions to find a sufficient number of schools in which to place their students and expert teachers with which to pair them.
4. While ensuring that there are sufficient schools for pre-service teacher, assuring quality experiences is yet another problem.

Ishler, Edens, & Berry (1996) and Howey (1996) found that educational institutions delivering pre-service teacher education have little supervision over local school sites. Therefore, ensuring that the mentor teachers are modeling best practice is difficult or not done. As they are limited to the use of local schools or schools within a reasonable traveling distance, those schools and teachers that may best model teaching are not used.

Reconnecting Theory and Practice

Work related to Jurgen Habermas' (1981a; 1981b) Theory of Communicative Action (CA) is geared towards developing practical means of understanding and improving what is at the center of the both this theory and teaching practice: human communication towards a goal. In instructional settings, such communicative goals range from those of the teacher such as conveying strategic content information (i.e. Lansing is the capital of Michigan), to eliciting responses from students that confirm understanding, and further into areas of negotiating or enforcing societal normative rules (i.e. you should not hit your peers). The learning goals that teachers have for their students may come from state curriculum or from personal goals established for individual students, but each is communicated either directly through such actions as writing them on the chalk board or implicitly through the goals of the specific activities and linkages to assessment.

These goals as communicative actions (i.e. discursive speech acts, textual discourse) generally have one of four purposes. The first goal is generally to convey objective, empirical knowledge or fact commonly accepted in the present as valid by society such as information found in standardized tests. However, this actually includes two different types of communication 1.) teleological or strategic action which relates to technical, in which empirical knowledge deemed by the individual

to be useful, is leveraged during 2.) constative speech acts or conversation to further develop and critique the theoretical understandings of speaker and hearer. A third possible goal is to provide socially valid normative understandings that have been generated through past consensus within socially or culturally shared experience such as social rules such as legal or moral conceptions through normatively regulated action. Lastly, the speaker may be attempting to express some internal state or "lifeworld" understanding towards the goal of taking some future action such as a direction to do something, known as dramaturgical action (Habermas, 1981a; Habermas & Cooke, 2002). According to Habermas, what underlies all of these different forms of communicative actions is intersubjective agreement between speaker and hearer. This theory has several implications for the development of educational simulations that are intended to provide pre-service teachers with practice geared towards the multiple communicative actions that they are expected to engage in within their future classrooms.

The Limits of Simulations with Communicative Action

The limitation that faces traditional simulations when viewed through the lens of Communicative Action is that only the pre-service teacher/student and simulated system are present. Why this is problematic is that the system cannot participate in conversation and critical discourse in which the validity of the assertions made by the student can be examined. Even more problematic is that the student must tacitly accept the validity of all claims made by the system because it remains static in the face of critique and cannot engage in a back and forth conversation towards consensus about the validity of the information communicated through the technological structure of the simulation.

For example, if the student teacher finds the system's communication about the appropriate

means for disciplining a child in the classroom to be inappropriate when they throw a piece of paper, the system often still only recognizes one correct, valid answer (i.e. give the student a verbal warning) because of the scripted nature of many educational simulations and simulation games. The participant in the simulation cannot engage in conversation with the system and state their critique of the communicated approach because the simulation engages in purely strategic action in which there are set rules for valid communication behaviors that, in a human, would have been accepted as useful knowledge for how to act in a classroom. The learner may imagine instances in which the proposed strategy for acting would be inappropriate; however, they have no recourse to conversation with the system about the validity of the required strategy. Their only option is to refuse to participate in the simulated experience.

This problem resulted in the idea that it should be possible to leverage technology to mitigate the major problems faced by student teachers in the current teacher training programs:

1. distance of the teacher from their pre-service experience,
2. the limitations placed on the amount of structured or unstructured communications,
3. the amount of critical impact they could have on the students in a limited time period, and
4. the possibility of a poor quality teaching simulated face-to-face instructional experience.

However, the question remained as to how the one could develop a simulated teaching experience that would provide pre-service teachers with a flexible system in which there were opportunities for the participant to engage with real students in to simulate the communicative actions that are present in day-to-day teaching.

Quest Atlantis: A Simulated Conceptual Play Space

An initiative within the National Science Foundation and MacArthur Foundation supported Quest Atlantis (QA) project was developed in order to provide students with a digital science-inquiry experience using a multi-user virtual environment (MUVE) (Barab, Warren, & Ingram-Goble, 2008; Barab et al., 2007). Within the foundational narrative that situates student activities and provides a rationale for students to work within the OTAK, a simulated computer simulation of the distant world of Atlantis, there are a number of characters who drive the learning activities and story which comes in the form of novels and comic books (Warren, 2005, 2006b). These characters introduce new meta-storylines, explain new digital developments within the 3-D environment, and provide brief background stories to situate the “Quests” that students complete in order to earn rewards and prestige.

The Need to Build Narrative Supports

One of the primary complaints from the 4th, 5th and 6th grade public school learners that emerged from informal and semi-structured interviews related to the narrative that supports QA. Specifically, they noted that there was a lack of interaction with the main characters that otherwise engaged them in the stories that framed the learning activities and drive their actions in the 3-D space (Dodge et al., In Press; Warren, 2006c). Therefore, it was determined that project team members should role play the six main characters a few hours a week to provide student participants with the opportunity to interact directly with the fictional characters as a means of enriching their experience with and knowledge of the supporting narrative as it evolved.

At the same time the team was developing the initial solution to this problem, the problem of a lack of suitable pre-service teacher sites for field

experiences was noted to the designers during an unrelated meeting. As a result of this limitation, many pre-service teachers in the state of Indiana were placed in schools out of state as far away as Cincinnati, Ohio, Louisville, Kentucky, and Chicago, Illinois. This resulted in round-trip travel times ranging from two to five hours in some instances. The challenge was mainly due to a systemic state geographical challenge that resulted in a lack of urban centers near teacher preparation universities. Those centers near the universities tended to be rural or lacked sufficiently high student populations to meet the need for mentor teachers and classrooms for field experiences. For those pre-service teachers that intended to teach in urban area, the opportunity to practice in such settings was lacking and further, many of the rural schools were burdened with high pre-service teacher to mentor teacher ratio (Warren, 2006a). This led to a large number of students who spent only a few hours in the classroom as students before they were given their own classes as professionals after graduation.

Upon this discovery, it was determined that in order to address both the need for student interaction with the fictional characters and pre-service teacher need for interaction with real students, it was determined recruit undergraduate students in the pre-service education program to work in a simulated field experience called The Council Actors.

SOLUTIONS AND RECOMMENDATIONS

Design Solution

In order to recruit teachers for the program, The Council Actors program was conceived as an independent study course to provide a simulated field experience to pre-service teachers. The main benefit of this solution was perceived to be that it would give the pre-service teachers an opportu-

nity to interact with students on a daily basis in a way similar to how they would once they had their own classrooms upon graduation in terms of developing effective communication. Further, through role-play, they would be able to experience the dramatics/acting as teacher/scaffolding student learning, which Habermas (1981a; 1981b) would frame as “dramaturgical action.” Actors also interact with and instruct students by providing both explicit, realistic expectations for acting in a safe, 3-D space while adding richness to student experience by communicating the story that drives their activity in the project worlds. Training the Council Actors was conducted by master teachers and project staff and was conducted similarly to mentoring that is commonly done in public schools and teacher education programs.

Requirements of the Council Actor Simulation

Council Actors were required to complete a number of weekly requirements in order to meet their own field experience needs as well as those of the students they would work with in the 3-D worlds. The following are the explicit requirements provided to Council Actors for working in the QA worlds that would provide them with high levels of contact with students while still ensuring coordination of teaching efforts across the team.

1. **Interaction:** The Actor will interact with kids or otherwise be in the space at least 6 hours per week.
2. **Feedback:** Actors will give feedback on Council suggested and Community Quests during their down time in the space.
3. **Staff Meeting:** Actors will attend a Council Actor staff meeting approximately one hour per week and engage in team planning.
4. **Council Meeting:** At least one time per month, all Actors will meet in the digital Council Chamber within Quest Atlantis for 30-45 minutes per week.

5. **Web logs (blogs):** The Actors submit blog entries for their characters 1-2 times per week under the guidance of two project members with expertise in this area. This allows them to approve all blog submissions and post them in the appropriate space while ensuring for narrative consistency.

In addition to these guidelines for role-playing the character and character responsibilities; there were also two other key guidelines or pre-requisites. These are: the Actor has reviewed the novel at length and has also reviewed the individualized character sheet for their particular character. The findings that stemmed from the staff meetings in which the Actors told their stories of interacting with students impacted each new iteration of the reified requirements document and provided insight into the building of tacit knowledge of the pre-service teachers and staff members over time.

Transfer in the Simulation

The Guide to Simulations and Games for Education and Training (Horn, 1977) defines the term simulation as a method of representing physical reality. Further, Horn also note that the essence of the social system interaction must also be represented, not just the physical. Therefore, simulations are used to replicate essential aspects of reality so it may be better understood and/or controlled. In addition, this definition sees user control as an important feature of a simulation, positing that the user must be an active participant in an experiential learning activity, whether physical, such as flying a plane, or social, such as engaging in a debate about substantive international topics in the forum of a simulated United Nations.

However, this may not be a complete conception as Baudrillard (1993) notes:

The systems of reference for production, signification, the affect, substance, and history, all this equivalence to a 'real' content, loading the

sign with the burden of 'utility,' with gravity – its form of representative equivalence – all this is over with...simulation, in the sense that, from now on, signs are exchanged against each other rather than against the real (Baudrillard, 1993, p.6-7). " At this point, differences between the real object and its reference or sign can no longer be discriminated between, making their value equivalent. (Baudrillard, 1994, p. 6)

If we accept this concept, then the reality represented by a simulation can be accepted as being the same as that in a different context outside the simulation. In a learning setting, this gains importance because it discounts the argument that both the classroom setting and the work students do in classroom contexts must be authentic in the sense that it is exactly the same as the work they will be expected to do in the future for it to be of value. From Baudrillard's argument, work completed by students in a simulation (e.g. as a flight simulator) and the work that students may complete in another context (e.g. flying a real plane) need not be an exact match and both have authentic value. This is because humans already understand the exchange of the real for the referential and value the practice of the referential equally in terms of future use. Therefore, learners do not need to complete the exact same task in order to perceive how the simulated task and accompanying practices have value. Thus, simulated experiences such as a role-play have transfer to alternate contexts and work activities.

The Council Actors simulation provides the pre-service teacher learners with control of the major features of communicative action ranging from the strategic in which they post web logs that are used to convey "facts" about the Atlantian planet just as they will write dates and events for the American Revolution on the chalkboard. The learners have control over what they choose to reveal, the instructional methods by which they convey information such as social norms, or negotiate meaning and understanding through

constative communication within the simulated space that is QA. By providing the pre-service teachers with control over the social system that in many ways mimics the learning and normative aspects of the classroom, we provide them with a simulated experience that leads to transfer to their future teaching experience. The Actors experience simulates many of the interpersonal conflicts that arise between students, rule enforcement, and pedagogical moments that are part of the everyday classroom.

Simulating the Council: Balancing Narrative and Learning

The role of a Council Actor was revealed to be complex as the Actors began to engage with students in the space. Therefore, as we reported our findings in the staff meetings, we determined that being an Actor would require a number of guidelines for pre-service teachers to follow in order to preserve the numerous narratives that exist in Quest Atlantis. This scaffold was necessary, not only for the narratives to remain intact, but also provided a structure to the overall experience and commitment required of the pre-service teachers.

In other words, while there were a number of different roles that the pre-service teachers were expected to engage in; there was also a need for a semi-structured experience for the pre-service teacher that they could refer back to in times of trouble. This highlights both a limitation and a key opportunity of using the role-play design in that the guidelines above are listed as minimums for participation. In contrast, the upper limits of the amount of time spent would be defined by the pre-service teachers as restricted by their other school and social commitments. With a different group of role-players, such as credentialed teachers hired to spend considerably more time in the QA space than the pre-service teachers can afford, it may be possible to substantially increase the potential interactions between the teachers, students, and narrative. This would then result in high satisfac-

tion among the QA student participants, but would eliminate the pre-service experience and benefit.

The Role(-play) of the Pre-Service Teacher

One important part that emerged was that the primary role of the pre-service teacher is to nudge students towards using the learning affordances (Gibson, 1977) of the space such as the text of Quests, Actor blogs, and other digital tools for learning. These encouragements provide students with the opportunity to interact with the narrative/characters, which they express an interest in doing through their constative communications with the Council Actors. These “nudges” can be used to direct students towards particular Quests that are of special interest to the Council Actors due to fictional events on Atlantis. These moments of interaction act as opportunities for the teacher actor to engage in the form of validity claim negotiation between teacher and student that we believe is necessary for understanding to occur. For instance, a typical interaction may emerge:

Calron:*So what is your favorite world in Quest Atlantis?*

Student:*I like Culture.*

Calron:*What do you like in Culture world?*

Student:*The stuff about music is my favorite*

Calron:*Have you looked at the Quest about Unidad's favorite song?*

Student:*No*

Calron:*I think it would be a good one if you like music*

Student:*Thks*

While this is a typical type of interaction in which the Actor pushes a student who may not be completing the main learning activity in QA, which are Quests, they also act in several other ways such as providing understanding of group norms by referring the I-BURST rules that govern behavior in the space while another role is to provide students with feedback. Council Actors review different learning activities such as com-

Simulating Teaching Experience with Role-Play

munity or teacher Quests and provide feedback that has a clear Atlantian view of the problem and solution, while still connecting their work to the real world and its impact on the distant world. They also have the opportunity to help guide class activities in conjunction with teachers. This allows the pre-service teacher, with the help of a QA staff member or teacher, to practice grading and giving feedback that are two important responsibilities of teachers on a day-to-day basis.

Tension: Non-Explicit Direction

A major challenge that emerged with this working within this form of simulated teaching experience is that Council Actors must avoid being overly explicit in their answers as it may lock the narrative in ways that makes it difficult to scaffold for other Actors or may limit future development. QA novels such as *Archfall in the Two Worlds, One Fate* series provide a good example of the non-explicit kinds of interactions that could serve as a model of the kinds of interaction that should be used when acting as a Council member. The novels act as strong references for Actor behavior, knowledge, background information, and context as the Actor seeks to provide students with learning experiences in the 3-D worlds. The cover of *Archfall* is presented in Figure 2 and showcases Kerbe and Alim, two of the Council members, surrounded by the Arch of Wisdom.

In instances where narrative-shifts may occur as a result of interaction with students, it is necessary for not only a detailed description of the situation to be kept; but for a decision to be made on whether to acknowledge the shift or to attempt to minimize it. In either case, the narrative would be used as the primary reference.

Tension: Providing Cognitive Challenge

Another major challenge was that Council Actors are expected to avoid overly didactic, explicit instructional interactions in which they tell students the answer to specific questions about how to complete a learning task. Cognitive challenge

Figure 2. Archfall cover image



questions rather than direct answers work better because they encourage students to critically examine their problem and seek their own solution. Questions such as: “Why did you decide to do that?” or “Have you thought about X?” serve as to challenge the student participants to come to their own conclusions and solutions without being led directly to them.

Tension: Empowering Learners Through the System

Finally, we wanted to avoid presenting the Council a group as all-knowing, perfect avatars of virtue lest we destroy one of the things that kids like about them which is that they are flawed and somewhat like themselves. There should be instances when the Council member just does not know the answer and recommends that the Questers ask their friends, their teachers, or explore more on their own. By engaging in strong instructional methods that empower the learners, we hoped that the pre-service teachers would learn how to encourage self-direction and ability to master the necessary skills to effectively communicate within the QA

system towards the goal of understanding their world through inquiry. One of the means by which we provided the Actors with guidance about these Council members was to develop “templates” or “style sheets” similar to those that are used in role playing games like White Wolf’s *Mage: The Awakening*. These style sheets provide the Actors with the core information about the character’s values, experiences that are in the background of the narrative, physical, social, and mental attributes, as well as their personal beliefs in relationship to the Social Commitments which are central to the Quest Atlantis moral and ethical system that supports student activity. Figure 3 shows part of Calron’s template that includes an example of this guide that is provided to the Actors.

RESEARCHING A SIMULATED TEACHING EXPERIENCE

While working to develop substantial methods for research into complex environments that include simulations, games, MUVES, and blends of these continues, we generated several suggestions for addressing issues of learning, attitude, and other important educational and psychological constructs relevant to the effectiveness of a simulated experience in this format. Empirical forms of research such as survey and pre-posttest methods should be employed to provide part of the picture of pre-service attitudes towards learning based on design methods, issues of self-efficacy, and understanding of instructional methods.

Figure 3. Style sheet for Calron character

PERSONALITY			
Name: Calron		Nature: Artist	
Current Pseudonym: Green Man		Demeanor: Architect	
Previous Pseudonyms: Khel		Concept: Big brother	
Titles: Journeyman		Affiliations: Architecture Guild, Council	
MEMORY			
Regional Origin: Paquat Nas (Burning Sands)		Natural affinity: Art, architecture, music	
DOB: 6-7-1978		Place of Birth: Zi	
Occupation: Architect/artist		Place of residence: Underside	
Social commitment: Creative expression		Regret: Fails to tell Salik how he feels	
ATTRIBUTES			
Physical	Social	Mental	
Strength ●●●●○○○	Charisma ●●●●●●●	Perception ●●●●●●○	
Dexterity ●●●●●●○	Manipulation ●●●○○○○	Intelligence ●●●●●●○	
Stamina ●●●●●●○	Appearance ●●●●●○○	Wits/Wisdom ●●●●●○○	
ABILITIES			
Talents	Skills	Knowledge	
Drawing ●●●●●●●	Architecture ●●●○○○○	Literature ●●●●●○○	
Sculpt ●●●●●●○	Dance ●●●●●●●	Poetry ●●●●●●○	
Write prose ●●●●●○○	Story tell ●●●●●○○	History ●●●●●○○	
Write poetry ●●●●●○○	○○○○○○○○○	Politics ●●●●●●●	
○○○○○○○○○	○○○○○○○○○	Psychology ●●●○○○○○	
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○○○○○○○○○	○○○○○○○○○	○○○○○○○○○	
ADVANTAGES			
Passions/Quests	Typ 1-4	Friends	Commitments
_____	_____	Lan ●●○○○○○	Creative express. ●●●●●
_____	_____	Salik ●●●●●●○	Environment A. ●●○○○
_____	_____	Alim ●●●●●●●	Personal Agency ●●●●●
_____	_____	Unidad ●●●○○○○	Diversity Aff. ●●○○○
_____	_____	Kerbe ●●○○○○○	Social Resp. ●●●●●
_____	_____	Tia ●○○○○○○○	Healthy Comm. ●●○○○
_____	_____	○○○○○○○○○	Compass. Wisd. ●○○○
_____	_____	○○○○○○○○○	○○○○○
Merits/Flaws			
_____ Easily enraptured ●●●○○		_____ Very creative ●●●●○	

However, in order to provide a more complete picture when examining a role-play simulation, we recommend that other methods that can delve more deeply into the socially negotiated and individual experiences of the pre-service teachers should also be employed. These include, but are not limited to, qualitative methods that generate data which can be used to revise the design of such a simulated teaching experience and may provide a lens by which we can better understand and improve more naturalistic pre-service experiences in face-to-face settings. Most importantly, these methods center the researcher as a co-participant in the learning experience and therefore provide a means to empower the pre-service teacher in areas of student management, communication, and problem solving before they take over their own classroom. The most important research methods we employed were those that forced self-examination of Actors and sharing of those insights and challenges that emerged as we worked through the use of the simulated experience. The information that emerged from these discussions resulted in the highest positive impact redesigns to the experience over time and generated effective rule sets to govern role-play.

The Emancipatory Interest

In terms of social science research, the Emancipatory Interest is a concept that violates the underpinnings of traditional empirical research (Gall, Borg, & Gall, 1996), but was very important as we sought to include CA as a grounding theory for both the design of the learning experience for the pre-service teachers and staff as well as the research methods that were employed. The idea of observer as objective outsider is abandoned in favor of inserting the researcher, not only as participant-observer in the social learning and acting processes, culture, and immersive forms of life of the local community, but as an active proponent and advocate for effecting social change

and empowerment (Lather & Smithies, 1997; Leistyna, Lavanez, & Nelson, 2004).

From a researcher point of view, this becoming part of the community allows for honest communication by the participants of their individual understandings that bind their actions and knowledge of their meanings in the context of the social science perspective. Further, by engaging a dialogue between researcher-participant and study-participant, as well as the community, problems and solutions are identified and generated by the Council Actor members themselves, which leads to empowerment in the present context and empowerment to solve problems in future situations (Leistyna et al., 2004) and therefore transfer of the simulated experience to their prospective professional teaching experience.

The Emancipatory Interest fundamentally changes the purpose of research from observing or describing and then reporting a change made over time in a community to a purpose that involves the researcher empowering community members to identify and work towards solutions as they reacquire power from the digital system and reintegrate it into the community through purposeful communicative action. So, how do we study a simulated role-play from the perspective of both emancipating the participants and understanding the impact of such a design on the communicative actions that form the basis of instruction and learning?

Hermeneutic and Phenomenological Approaches

In order to address the idea that instruction and learning are communicative actions with the goal of emancipating both instructor and learner, there are several methodological approaches that can be leveraged. Two in particular are the hermeneutics and phenomenology (Bernstein, 1983). Both offer a number of benefits for social sciences research in terms of moving to a situated conception of

knowledge that are important for developing a simulated teaching experience like the Council Actors. First, these stances view knowledge as tied to context and situated within the individuals experience with it. Knowledge, understanding and experience occur concurrently and from these come meaning. “(U)nderstanding must be conceived as a part of the process of the coming into being of meaning” (Gadamer quoted in Bernstein, 1983, p. 125). Therefore, the process of research in social sciences from this perspective must study the process by which individuals come to understand situated knowledge and derive meaning from it.

Challenges to Such Approaches

However, both forms of research have both been criticized on a number of fronts including charges that they lead to relativism in which there is no fundamental truth or knowledge, they have a lack of usefulness for social science research due to their descriptive nature, and they require a substantial length of time to conduct a proper research study using such methods (Bernstein, 1976, 1983). The first and second criticisms are well-founded concerns as misapplied hermeneutic methods can lead to overly specific, completely relativistic information that adds nothing to the body of research knowledge. However, if such methods are used to describe the experiences and understandings of several people to provide a larger picture of the situation through the lived practices of the Council Actor pre-service teacher participants, the story of a culture and its forms of life may be used for formative and diagnostic purposes, much like more traditional, empiricist methods of research. The descriptive nature of hermeneutic research methods is more beneficial than Positivist paradigms for such diagnostic and formative purposes because it they allow for the identification of problems and solutions as conceived and phrased by the participants rather

than decontextualized yes or no answers to narrow hypothetical questions.

Further, in modern conceptions of these research methods, the researcher often becomes a part of the community and acts as a co-participant in the research and learning processes of the culture under study, which is important within the context of the Council Actors where the pre-service teachers and staff act as participant in, designer of, and researcher of the simulated experience. This helps to overcome the commonly perceived “Ivory Tower” problem in which the researcher is viewed as an outsider telling the community what is wrong and prescribing an alien approach to solve a perceived problem. In the context of hermeneutic research, the researcher is instead viewed as a co-worker who is developing solutions in conjunction with the local community and solutions are phrased in terms of what the community members themselves propose (Carspecken, 1996; Denzin & Lincoln, 2003). In the case of the Council Actors, the researcher is always also an Actor themselves who can act as a modeler of appropriate communication and teaching with students in the digital worlds.

FUTURE TRENDS

As the population of the world continues to grow, the need for trained teachers who can walk into the classroom and understand how to effectively communicate in order for students to learn and grow. Concurrently, the opportunities for pre-service teachers to engage with students before they take over their own classrooms continue to decline in many areas (Simpson, 2006). Role plays have already been found to be valuable as learning tools in military applications (Nieborg, 2005), flight simulations, and other instances in which there are fairly low-levels of complexity to the computers simulated behavior, because the artificial intelligence, while improving rapidly, lacks the responsiveness of true combat

or flight situations that become more complex exponentially in compressed time periods. This is also true in standard classrooms, especially with K-12 students who behave differently from day to day based on myriad factors that come from home, interpersonal relationships that implode in the hallway on the way to class, and the daily foibles of self-image that change with the surging hormones of the individual student.

In the future, providing pre-service teachers with simulated role-plays in which they act as the teacher acts can provide them with authentic expectations of the kinds of student behaviors, questions, and challenges that they will face in the classroom on a day-to-day basis once they take over their first class room. Just as we would prefer that the pilot of a \$30 million fighter jet has had experience overcoming the common and uncommon problems that arise mid-flight and can react effectively to the humans that fly the enemy fighters, we want our pre-service teachers to be prepared for the unpredictable human challenges in a situated fashion more closely mimics what they will encounter in a way that simulations are only now beginning to address. With our children's minds and education, we would prefer that future educators that may decide that teaching just is not for them decide this based on realistic expectations that stem from realistic interactions with students well before they take over their own classroom. As role-plays like this become more common, we can expect to find better trained teachers who are more readily able to start teaching on the first day of school and fewer who wash out of the profession after two years because they did not know how difficult it can really be to teach every day.

Every day, the number of communication tools splinter and rapidly expand in multiple forms where students use tools ranging from text messaging Facebook and Second Life to those we have not yet conceived. Each new form of structural communication (using technology as a vehicle) conveys information that allows students to rapidly coordinate their learning actions in groups,

negotiate understanding through interpersonal, constative speech acts, and come to understanding of their relationships to societal norms. These pre-service teachers, many of whom already use these tools themselves, will need to be experts at communicating with technology and understand how the tool deforms or alters student understanding so that they can adapt their own instruction to meet the needs of a new kind of student.

CONCLUSION

As the need for qualified teachers with real world experience working with students rises throughout the world and the opportunities for meaningful practice the art of teaching and interacting with students decline due to population shifts, increases, and declines, cost of training, and low participation of existing teachers in mentoring programs, the need for simulated teaching experiences will concurrently increase over the come decades. As this need increases, innovated instructional and learning methods are increasing access to student populations using communication tools embedded in online simulations and game products ranging from Second Life to Quest Atlantis that have their own existing or emerging storylines that require human support to maintain. Role play in these simulated learning environments provides opportunities for pre-service teachers to engage in meaningful pedagogical contact with the students that they may in the future teach so that they can understand the limitations, difficulties, and instructional affordances of technologies as a means of communicating meaningful learning experiences from a variety of educational paradigms from objectivism to contextualist or relativist world views.

Just as importantly, these simulated role-plays provide pre-service teachers with opportunities to understand how today's learners use technology to communicate. From a communicative action perspective, understanding how the structural

communications that are mediated by technologies like Facebook and Second Life deform or otherwise alter student knowledge and action is going to be increasingly important as they are further integrated in educational settings. Knowing how to overcome the misunderstandings that arise from technological mediation through pedagogical action is going to be one of the core skills of many instructors as technology plays an ever more important role in teaching and learning. By allowing the pre-service teacher to safely engage in the everyday communicative actions that make up teaching that range from negotiation and construction of knowledge to communication of student roles and norms, role play simulations have the potential to help mold instructors that are better prepared to face a rapidly changing classroom environment.

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KEY TERMS AND DEFINITIONS

Field Experience: Activity that typically takes place in an authentic school or educational environment where an individual may practice and observe methods associated with a particular role—primarily applies to teacher field experience which is a requirement of the in-service teacher prior to graduation.

In-Service Teacher: Individuals who are licensed teachers and currently teaching.

Learning: The internalization of knowledge; may be directed (and therefore defined as instruction) or may be ill-structured and/or unanticipated in informal settings.

Narrative: Otherwise known as a retelling or story in which commonly includes elements such as plot, exposition (beginning), rising action (conflict), climax (turning point), falling action (wrap-up), and resolution (conclusion).

Play Space: An environment where incidental learning may occur, where meaningfully directed learning may occur; but where the majority of ex-

perience is ill-structured and without meaningful goals or objectives.

Pre-Service Teacher: Individuals in teacher education programs who have not yet been awarded their initial teaching license.

Role-Play: The act of portraying an entity other than oneself. An immersive role-play would require an investment into the character such as that of a professional actor in a particular part.

Simulated Character: A non-real character with a deeply developed back-story. Simulated characters include a core set of engagement and activity rules that encourage adherence to the ‘spirit’ of the character.

Simulation: An experience that interactively models some part of reality for a user.

Teacher Experience: The act and art of being in the role of a teacher. Activities are not limited to teaching, but also include mentoring, coaching, facilitating, reviewing and observation.

Virtual Worlds: Imaginary virtual persistent environments where individuals can use an avatar to interact with other avatars and virtual objects.

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Chapter 3.3

Impact of Podcasts as Professional Learning: Teacher Created, Student Created, and Professional Development Podcasts

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ABSTRACT

Until now, research on podcasting in education mostly examined teacher created podcasts in K-12 and higher education. This paper explores podcasts in professional learning across several genres of podcasts. Using a popular typology of podcasts, teacher created, student created and professional development podcasts (King & Gura, 2007), this paper compares, contrasts and reveals the potential of multiple educational contexts and instructional strategies, formative instructional design, interdisciplinary strategies, formal and informal learning, and effective uses of data gathering methods. The significance of the study extends from not only the extensive reach of the data gathering and

production, but also the robust research model, formative and dynamic instructional design for staff development and recommendations for podcasting research strategies.

INTRODUCTION AND NEED

Since 2004, Internet-based new media formats have soared. Prolific Internet use has generated public desires and expectations to be *content creators*. Opportunities such as political and personal blogs and independent podcasts of all flavors as well as ever-popular YouTube® videos flash across users' screens and minds, creating the expectation of self as a new media communicator (Walch & Lafferty, 2006). It is through the recent

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advent of convenient and free Web 2.0 technologies, such as blogs, podcasts and vlogs, and Free Open Source Software (FOSS) (Rajendran & Venkataraman, 2009) that people of all ages and backgrounds are claiming their place and voice on the Web (Frontline, 2008). The great value of podcasting, a new media technology, for education is the ease of custom and inexpensive design, truly flexible, “anytime, anywhere” delivery format. Since 2005, anyone with access to a computer, Internet and a \$10 microphone can freely record, edit, and distribute audio content worldwide. Similarly, anyone with Internet access can hear these archived digital audios on computers or mobile devices, 24/7.

Widespread social and instructional adoption of podcasting has occurred since 2006, including adoption for formal and informal learning. With this increased use, educators and researchers need greater understanding of podcast-related instructional applications, data gathering opportunities, impact, scalability and scope of reach, instructional design, and research opportunities (eSchool News, 2008; King & Gura, 2007; Williams, 2008). For example, there are numerous free data gathering resources to couple with podcast use and yet no mention in the literature as to how schools might use it to demonstrate impact of their programs and services or instructors for formative improvement of curriculum, let alone recommended strategies for educators’ reporting of them. Research studies may also provide recommendations for the design of additional action- based research and inquiry in robust and systematic ways (Devaney, 2008).

By analyzing findings from three related podcast studies, this paper provides a macro research perspective and recommendations in these areas. The work collectively addresses the impact of podcasts on professional learning and uses King and Gura’s podcast typology (2007) as a framework for comparison and differentiation. This paper presents findings, discussion and interpretation of results for the following research questions:

(1) What is the use and potential for podcasting in multiple educational contexts? (2) What instructional strategies are used in the podcast? (3) How is formative instructional design utilized in the podcasts? (4) What interdisciplinary strategies are used? (5) What is learned about uses and formats of formal and informal learning? And (6) What effective uses of data gathering methods are recommended from these studies? The popular typology of podcasts, teacher-created, student-created and professional development podcasts is used in three studies examining the following productions: UEGE, TTPOD/PFT, and DLPOD (see Figure 1).

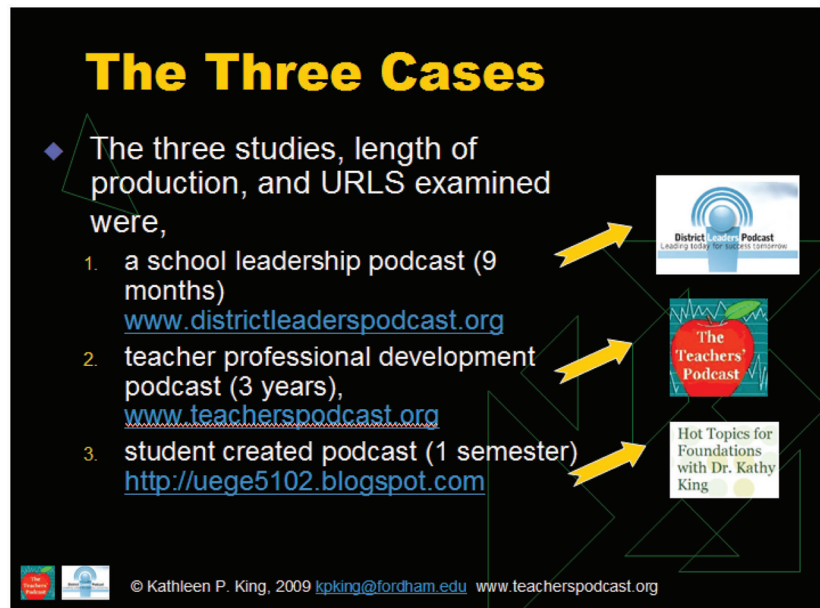
THEORETICAL BASES

Major theoretical underpinnings of this research include formative evaluation and continuous improvement of instructional design, research design and methods, podcasting and new media as instruction, podcasting typology, and informal learning.

Formative Evaluation Informing Instructional Design

Critical to the approach of this study is that educators can formatively design and evaluate instruction (Caffarella, 2001). Continuous improvement via data gathering, analysis and interpretation provides powerful means to proactively and dynamically chart the course of successful learning as many educators have demonstrated (Jonassen et al., 2003; Wlodkowski & Ginsberg, 1995). Broader and substantial research methodologies frame our thinking for instructional design, inquiry and data collection. These core frameworks include Denzin and Lincoln (2008a, 2008b) on qualitative research, Gall, Borg, and Gall (1996) on statistics and research design, and Hinchey (2008) on action research.

Figure 1. The three cases: podcasts studied



Research Methods (as a Theoretical Frame)

With action research as a vital model of research in many teacher education programs today, instructors engaging in instructional improvement using podcasts may go further and conduct action research inquiries. Even if research is not formally pursued, educators collect data and use student responses in informal research for guiding instructional design (Denzin & Lincoln, 2008; Hinchey, 2008). This article examines three different educational podcasting studies, therefore understanding the framework of research methodologies and decision making are important foundations for our discussion (Gall, Borg, & Gall, 1996).

In the field of instructional technology among diverse populations, action (Hinchey, 2008) and mixed-methods research (Creswell, 1998; Glaser & Strauss, 1967; Tashakkori & Teddlie, 1998) have been effective strategies across numerous studies (Jonassen et al., 2003). Analyzing the studies at hand for their research methods provides greater understanding of what educators currently do

for data gathering and research in educational podcasting. In addition, it provides a basis for recommendations for more systematic and deeper inquiry, which can improve student learning, and advance the field's future.

Podcasting and Instruction

Podcasting distributes digital recordings via Really Simply Syndication—feeds (RSS-feeds). That is, individuals record audio content with computers or digital recorders, post it on the Internet on a publicly available server, create XML script RSS-feed to string it together and deliver the episodes. Teachers and students, now podcasters, visit the podcast directories on the Internet and add their information to the searchable databases (King, 2008). Potential listeners visit the search for topics on the web or visit the directories, review descriptions, select and directly listen to or download the files.

Expert authors carefully and specifically applied the technical definition of podcasts to their work (Walch & Lafferty, 2006). They define

podcasts as audio (and video) new media products hosted on servers and scripted with an XML/RSS feed, utilizing push technologies. This definition distinguishes podcasts from web-based audio or video posts which are not syndicated, cannot be “subscribed” to, nor automatically delivered to listeners/learners.

Listeners may also port podcasts over to portable devices such as MP3 players, iPods, or some cell phones for mobile convenience (Richardson, 2006; Williams, 2008). This option allows listeners to choose not only *when* they want to listen, but also *where*. The rich podcasting medium reaches most people with Internet access; therefore, it provides a platform for instruction from diverse perspectives.

Essential to framing our research, design and teaching efforts are understandings of education in a pluralistic society (Greene, 1993), culturally responsive teaching (Wlodkowski & Ginsberg, 1995), and multiculturalism (Spring, 1997). When our learning space spans the globe and all 24 hours, learners may engage with people from any lifestyle who have access, thereby eliminating traditional boundaries of time, space, geography and class (Rajendran & Venkataraman, 2009). Therefore, greater skill in understanding and communicating with people different from ourselves emerges.

Podcasting Typology

King and Gura’s 2007 podcasting typology provides an effective means to differentiation among and compare educational podcasts. *Podcasting for Teachers: Using a New Technology to Revolutionize Teaching and Learning* (2007) identifies three major genres of educational podcasts: *teacher-created*, *student-created* and *professional development podcasts*.

Teacher-created podcasts represent those developed by teachers, especially for instructional purposes. These podcasts may include lectures or presentations recorded and posted as an episode in a class or subject series. In a more creative

pedagogical style, teachers may specifically plan, design and create podcasts for other instructional purposes. For example, they may develop supplementary classroom materials, distance learning, out of class or homework materials, tutorials, extension activities, etc.

Student created podcast are often developed as part of classroom assignments. From k-16 to workplace training and doctoral studies, they may be used in a plethora of ways. For instance, some teachers provide students opportunities to capture, archive and distribute their work as web-based audio or video projects, interviews, role playing or performances, historical narratives, presentations, simulations, etc. Indeed, creativity in student podcasting has been most widely seen in k-12 education, but is starting to emerge in higher education, albeit slowly. This trend may be due to different curriculum, professional development opportunities and classroom time. Nonetheless, with the growing number of Millennials or Digital Natives (Prensky, 2001) already graduating from our colleges, higher education needs to transform content expectations to be larger and in varied demanding media. Furthermore, we need post-secondary education to prepare students to be effective communicators, inventors, and analysts of digital media to guide our future. Assignments integrating critical thinking in the content area and developing innovative, creative, research grounded media exemplify the relevant learning possible with podcasts.

Professional development (PD) podcasts may be created by a variety of individuals, and organizations. These podcasting producers and hosts may include professional associations, teacher educators/professors, staff developers, schools, colleges and universities, non-profit organizations, or government agencies, and certainly teachers (that is “by teachers, *for* teachers”). Podcast-delivered PD affords much greater choice of time and space for engaging in professional learning. Indeed, the freedom shocks many educators and professionals, as they realize not only can they

choose what they want to learn, but schedule it at whim or will, and much of it is free. This new generation of PD is not much like the mandatory training or staff development we sat through previously. Instead, PD on demand allows the lifelong learner to be *in control*.

All of these forms of educational podcasting create a growing archive which is freely available. Individuals and organizations alike may select formal and informal staff development resources from this rich storehouse of content. Learning must be selected with a critical eye for credentials and expertise of the presenter. In addition, the relevance of content and integration of research, theory and practice are of prime importance for educational podcasts. However, examining these characteristics creates a vibrant, relevant opportunity for situated learning including critical thinking, lifelong learning and 21st-century learning skills (King & Gura, 2007; Partnership for 21st Century Skills, 2004; Richardson, 2006; Williams, 2006). Podcasting pursued in a contextualized, learner-centered manner can be a powerful platform for education.

Formal and Informal Learning

Familiar typologies of learning include formal, nonformal and informal learning (Coombs, 1989). By definition, informal learning is more learner-centered, goal oriented, and flexible. Informal learning's focus on context and learner is inherent to the possibilities of the approach (Schugurensky, 2000). What distinguishes informal learning is the learners' independence and connection to the contexts of daily life, including work (Livingstone, 1999; Schugurensky, 2000). The fields of adult learning and teacher practice have done much to research (Argyris & Schon, 1974), codify (Tough, 1971), and build awareness (Dewey, 1938; Livingstone, 1999; Polanyi, 1967; Tough, 1971) of this area. Instructional technologies such as new media used for professional development provide more rich opportunities for informal learning ac-

cess, use and research. Yet despite the trends of social adoption and the research opportunities, educational research has been slow to wake to this sleeping giant.

RESEARCH METHOD

This research used a cross-case, case study model, in a mixed-methods approach (Glaser & Strauss, 1967; Merriam, 1997). The case study analyzes research approaches, instructional technology innovation, and adoption. Additionally, the researcher has been podcasting for three years and thereby can be considered an expert participant observer (Creswell, 1998). She provides insight into development, use and opportunities for technology, context, and meaning of new media.

Specifically, this study was a quantitative-qualitative-quantitative sequential design (Tashakkori & Teddlie, 1998). In a Sequential Mixed Methods Analysis (SMMA), the study used 5/7 stages outlined by Onwuegbuzie and Teddlie (2003): data reduction, display, transformation, consolidation, comparison and integration. Data gathering methods included primary document examination and evaluation, collecting statistical data of podcast listener use from servers, hosting services, and statistical third-party services, blog comments, email comments, research articles and reports about the projects, website reviews, content from social networking sites, field notes, observations, and podcast directory rankings and links. Data analysis is tabulation, frequencies, and constant comparison for emergent themes pursued until theoretical saturation (Glaser & Strauss, 1967).

The three studies and length of production examined were, (1) a school leadership podcast (9 months), (2) teacher professional development podcast (3 years), and (3) student created podcast (1 semester). Figure 2 provides a comprehensive illustration of the analysis strategy. It reveals the three cases, and the sequence of data collection, and analysis.

Figure 2. Analysis strategy overview

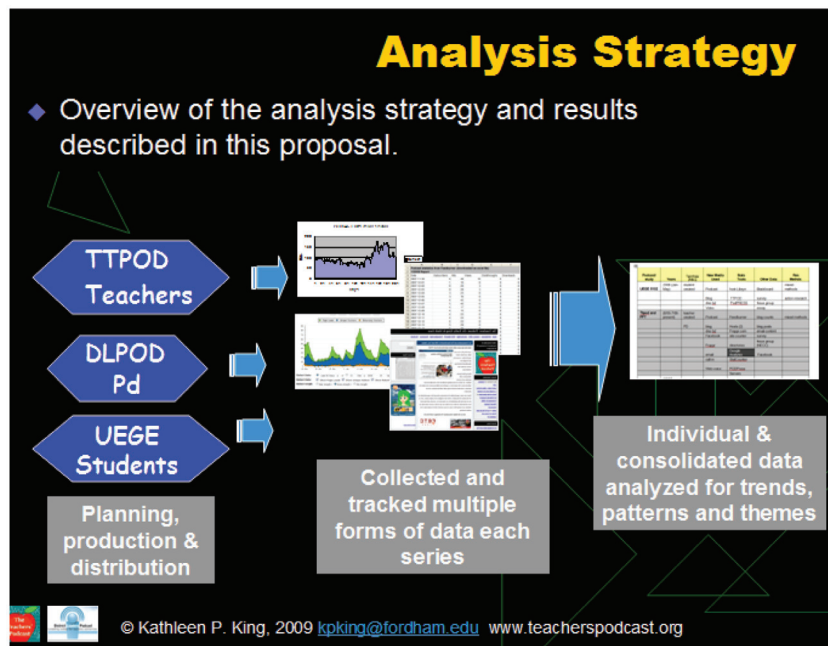


Table 1 provides the reader with the details and table of information gathered for each podcast series. It shows the categories and results used for this study. It is provided here not only to reveal the early stages of data, but also as a model of data gathering and data display (Onwuegbuzie & Teddlie, 2003) for researchers and podcasters who desire to replicate or scaffold the methods presented in this article.

FINDINGS: ANALYSIS AND DISCUSSION

Mixed methods research and action research were the predominate models describing the research methods used by the podcasts examined. Because so much data are available in quantitative format, when fully configured and accessed, many people emphasize listenership. However, many early, non-educational podcasters (2005-2007) had a strong sense of audience and rely heavily on qualitative data. When a mixed method is used, it provides a

fuller realm of inquiry. Action research provides a dynamic interaction with context, learning and development. Examining Figure 2 reveals each study using a different approach: quantitative research, mixed methods, and combined mixed-methods approach for action research.

Findings and Preliminary Analysis

Perusal of the data revealed a more varied educational contexts that might be expected. Based on the podcast series descriptions, purpose, show notes, and review of their program format many indicators were found. The settings included: staff development, direct learner instruction, independent continuing professional learning, teacher education, and student research. That is, the two broad groups of users, educators and students, used the podcasts in different settings (and in different ways to be discussed later). Specifically, educators and school leaders used podcasts for their professional development through formal efforts by their schools or in degree study, but

Table 1. Comparison educational podcast research

Podcast/ Study	Years	Typology (K&G)	New Media Used	Stats Tools	Other Data	Research Methods
UEGE 5102 (Foundations class)	2008 (Jan-May)	Student - created	Podcast Blog Discussion Board Video	Host-Libsyn TTPOD PodPRESS	Blackboard Survey Focus group Essay	Mixed-Methods Action Research
TTPOD and PFT (Teachers Pod- cast™ and Podcast for Teachers™)	(8/05-7/08-pres- ent)	Teacher -created Professional De- velopment	Podcast Blog Discussion Board Facebook Frappr e-Mail Call-in Web-voice	Feedburner Hosts (2) Frappr.com Site counter Directories Google Analyt- ics StatCounter PODPRESS Servers	Blog counts Blog posts e-Mail content Survey Focus group (NECC) Facebook	Mixed-Methods
DLPOD (District Leaders Podcast™)	(10/07-7/08-pres- ent)	Professional De- velopment	Podcast Website e-Mail Call-in	Feedburner Host-Libsyn Site counter Directories Google Analyt- ics	Focus groups StatCounter Clients PODPRESS Server	Quantitative

also in their informal continuing professional development. In addition, students used podcasts in completing lessons by direct instruction: as they were instructed to create or listen to a podcast, or as a solution to find additional information.

Educational podcasters were able to incorporate multiple instructional strategies in even one podcast episode. This finding was again more complex than may be expected, but encouraging because of the possibilities for further development. Examples of incorporating new media in empowering formats for underrepresented constituencies examples include, but are not limited to, design formats of small group dialogue, peer learning, peer review, learner created media, class presentations which are designed as global resources and instructor created media; and genres of: critical reflection, historical narrative, debate, first person narrative, storytelling, performances, and role playing. These innovative educators were keenly aware of being able to use the multiple instructional strategies in order to reach a wider range of multiple learning styles and to deliver

the message in multiple modes (King, 2008; Kolb, 1984; Williams, 2008).

Educators using podcasting of these varied genres demonstrate the value of using multiple instructional strategies to reach students more effectively. This example is from one teacher planning for student created podcasts,

In designing the course I tried to be especially sensitive and accommodating to access and equity issues (King & Griggs, 2000) and not make assumptions about 24/7 access or over familiarity with technology. One way I addressed these variables was to design varied technology options required for assignments (King, 2008).

Emergent Themes

Instructional Design and Monitoring Data. Major patterns in dynamic, learner-centered instructional design through monitoring data for learning benefits were revealed in this study (Caffarella, 2001; Jonassen et al., 2003). Such practices include developing a unique reporting format illustrated

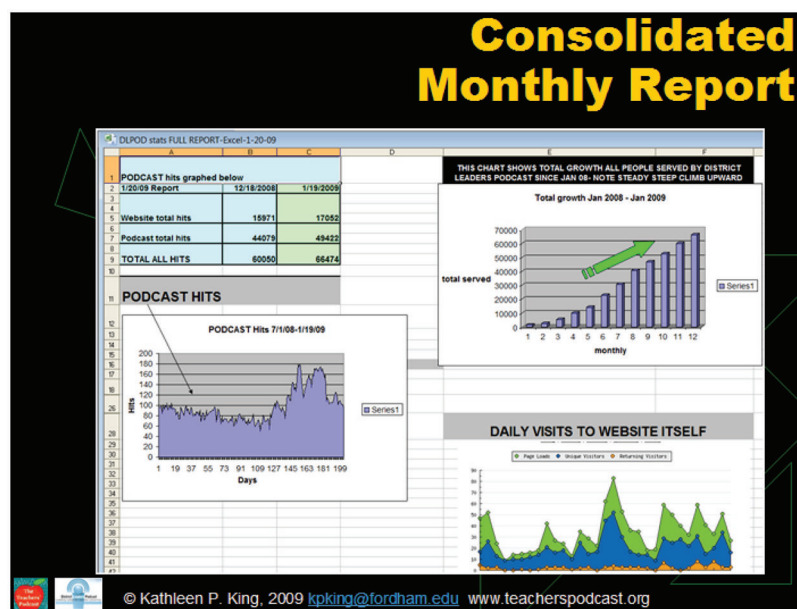
in Figure 3. Such reports integrate the research and instructional design thoroughly (action research) with statistics from multiple sources into one tracking file and a one-page snapshot report. The procedure of tracking the podcasts includes periodically gathering and downloading statistics, establishing an electronic filing and backup system to archive the data, consolidating the data, and distributing reports for programmatic and instructional improvement. Certainly such extensive data gathering practices are not the norm with traditional classroom instruction. However, the podcasting distribution system and foresight to utilize it can enable educators to include the practices into their existing instructional design routines.

One project (DLPOD) benefited from extensive prior experience of the producer. This project established a statistical reporting format from the start and the ease of production tracking was significantly different. Unfortunately, to our knowledge, no one in education has discussed or published such documents previously.

Instructional Strategies. The data also demonstrates educational podcasters using interdisciplinary strategies in their creations. While presenting content on educational technology professional development (the TTPOD series) for instance, podcast hosts also discussed, in-depth, math education, literacy education and financial literacy. Alternatively a sample student created podcast (UEGE) integrated theory, research and practice from health education, government, and philosophy.

In addition, while content standards may be easily and directly addressed with podcasts, other indirect benefits are very valuable for learners. Using these learning activities, instructors can assist learners to experience greater research skills and perspectives, validation, and freedom. Furthermore, dialogue and peer learning are powerful for critical pedagogy as these new media approaches explicitly shift the classroom focus from teacher to learner (King, 2008; Wlodkowski & Ginsberg, 1995). New media enables learners to articulate

Figure 3. Consolidated statistical monthly report



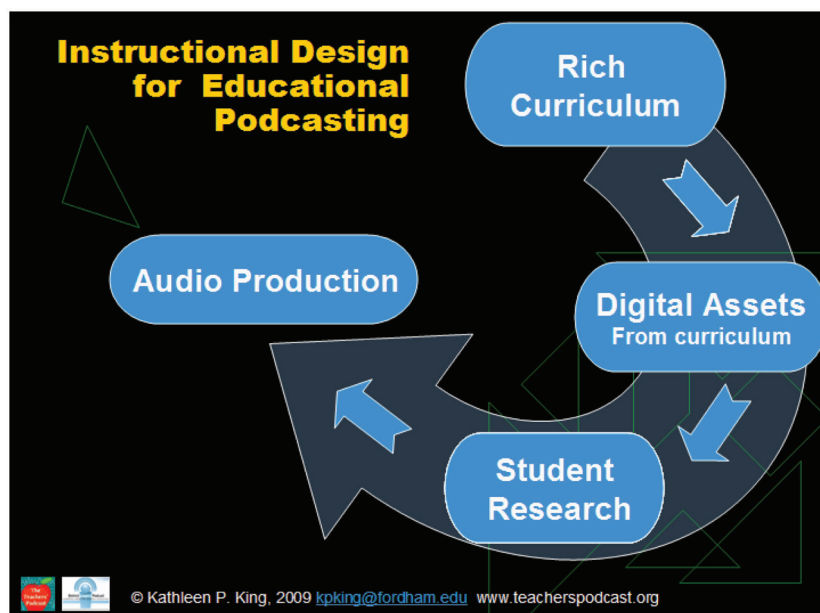
their views to their classroom and distribute them worldwide if desired (King & Gura, 2007, 2009). Alternatively, instructors can create a password protected mailbox to address learners' needs and sensitive discussions (King & Gura, 2008).

Emergent Model of Instructional Design. In considering the process of instructional design, Figure 4 illustrates a simple model which conceptually and practically guides teaching preparation and practice. While most educators use a required curriculum, they may discover additional digital and supplemental publisher resources. Building upon these and other free or FOSS media (USA Library of Congress Digital media, USA National Archives, Archive.org, Teachertube.com, Schooltube.com, etc) they may scaffold student learning to develop meaningful project based learning assignments. Using the Figure 4 model, assignments focus on student created content, such as student created podcasts, and include the full cycle of curriculum-foundation, student research and student evidence of understanding through digital media.

Contexts of Learning and Readiness. Podcasting for professional learning is pursued both in formal and informal learning settings. Therefore, while millions of downloads have occurred as educators independently decide to pursue their continued learning, some professors use the same podcasts as part of their curriculum, aka listenings, staff developers use them to deliver or extend formal learning (for example, UEGE, TTPOD).

In addition, many young adults are Digital Natives (Prensky, 2001) and use technology to communicate, socialize, and meet most of their needs with it. Undoubtedly, Digital Natives' early adoption of this technology contributes to informal learning podcasts in general like language learning podcasts, catapulting to the tops of the charts (for example, UEGE). Incorporating digital media into formal settings provides not only authentic vehicles for learning, but also provides a model and experience in using podcasts for learning purposes. In fact, in the UEGE and TTPOD data, student essays, survey responses, and listener blog and discussion board posts reveal that learners'

Figure 4. Instructional design for educational podcasting



formal learning experience using podcast transfer (Caffarella, 2001) to informal learning practices.

Educational Podcasting Research Model

Based on review of the reports and articles, I propose a model for educational podcasting research design, Figure 5. This model includes critical characteristics that aid in research design include (1) integrate research planning and instructional design, (2), decide on data gathering methods, and reevaluate periodically, (3) plan on periodic status/data reports- at least monthly, and (4) use the information for formative evaluation and improvement. This model includes detailed essential elements of sound instructional design (Caffarella, 2001) and research methodology (Denzin & Lincoln, 2008; Gall, Borg, & Gall, 1996).

For example, qualitative data from listeners such as blog comments, emails, VOIP messages, discussion boards, and social networking provide valuable data for instructional design and should

be planned for designed, data gathering routines, report protocols and analysis established from the start. TTPOD and DLPOD developed and sought these data sources vigorously to good benefit. Other formal instructional podcasts may be missing opportunities for organized research efforts in gaining direct audience feedback.

Podcasting Data Gathering Strategies and Sources. Extracted from this research, examples of free statistical tracking systems include: Feedburner PRO, PODPress (through the podcast blog site), individual server statistics, Google Analytics™, and varied extents of statistics from individual hosts such as LibSyn, Podomatic, Blubrry.com, etc. Other examples of data gathered at no cost were through the use of online surveys and website statistics trackers (Statcounter, for example) (see Figure 6). When coupled with listener data this information provides podcasters and instructors insight into how many people are listening, to what, and when (day); what content is most popular; geographical location, operating system used, time zone and URL entry point of

Figure 5. Podcasting research design model

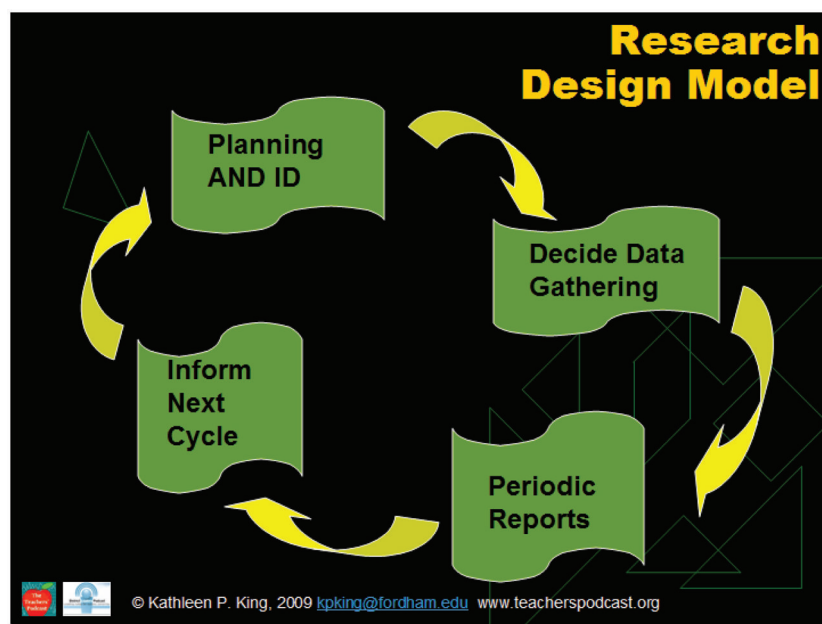


Figure 6. Gathering data on podcasting distribution

Gathering Data on Podcast Distribution

- ◆ Feedburner PRO, PODPress (through the podcast blog site, server statistics, Google Analytics™, and varied extents of statistics from individual hosts
 - (LibSyn, Podomatic, Blubrry.com, Podomatic.com, etc)
- ◆ Other examples of data gathered at no cost
 - online surveys
 - website statistics trackers (Statcounter, for example).

FeedBurner™
podomatic

1

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site visitors and listeners. Such approaches and results were evident in two of the studies reviewed.

Limitations of this Study

All studies have limitations based on their design and participant thresholds. In this research project, the limitations include that although it was a diverse set of educational podcast efforts, those studied were a convenience sample. This choice was necessary to use a unifying framework. Therefore, the author's podcasts were used, albeit this identity is disclosed, documented and described.

Establishing the boundaries of this perspective, one realizes that this is an innovative educator, well versed in instructional technology and focused on learner-centeredness, formative design and instructional research. Such an orientation provides an unusual context, but a rich source for exploring the potential of educational and research applications of podcasts with current resources. Many fields study the work of innovators in order to chart new approaches (Rogers, 2003).

Further Recommendations

Listeners engaged in using these podcasts for learning gained much from their colleagues' and podcasters' perspectives. The related blog and discussion board postings reveal impressive demonstrations of effort, depth of research, insight, public speaking, global awareness, voice, empowerment and initiative by formal and informal learners. Creating new learning communities is never easy, but using new media to support traditional classrooms can extend learning. In addition, building a virtual community of practice (Lave & Wenger, 1991; Marsick & Watkins, 2001) around a podcast resource can provide support and knowledge for educators who might have little of either. In the case of the podcasts studied here, they have variously used Facebook, blogs and now Twitter to cultivate such communities.

When using podcasts for formal and informal learning, learners are using "new media" for recreational and social uses. This technology has a great excitement and popular validation connected

to it at this time. Aside from the benefits of users' flexibility and control of time and space, educators may leverage the new media as an added attraction and incentive to engage reluctant learners. In the process learners also are invested in processes which facilitate instructional improvement. They are exposed to more content; they have access to repetition via rewind and replay functions, and depending on the instructional design perhaps engage in it more, and discover new opportunities for finding and using learning resources.

In these several ways, the podcasts enable us to deftly cultivate 21st-century skills (Partnership for 21st Century Skills, 2004, 2007). Through practice, exploration and extension assignments critical thinking, research strategies, information literacy, problem solving and collaborative learning skills may be easily incorporated (ALA, 2006).

EDUCATIONAL SIGNIFICANCE AND FUTURE RESEARCH

This research has provided greater understanding of what educators do and how they engage in formative instructional design, data gathering and research in educational podcasting. Both the reflective practitioner (Schon, 1987) and teacher as researcher (Hinchey, 2008) are familiar and essential models for professional learning because they are flexible and encourage data-supported choices in their approaches. This study provides significant connections among educational podcasting, research, instructional planning and instructional improvement in the context of continuing professional learning.

Further research is needed to continue to build upon these recommendations for more systematic and deeper inquiry which can improve student learning and advance the field further. Many free resources are available for tracking podcast listeners; educators urgently need to learn how to configure and use these services accurately and

to assist in instructional improvement, research and investigation. At this time, podcasters follow this basic process only inconsistently.

CONCLUSION

There are a multitude of opportunities to use podcasting for professional learning beyond the model of course casting which our universities seem to be enamored with today. Teacher-, and student-created, and professional development podcasts provide abundant opportunities for flexible learning which include many additional educational opportunities yet to be extensively explored. This study has revealed how one podcast series from each of three different genres of educational podcasts can extend learning experiences to many instructional strategies and learning contexts. It has revealed an interdisciplinary instructional design approach which can be used in formal and informal learning. Finally, the dynamic instructional design platform seen in these examples offers a foundation for research approaches, methods and recommendations. Still only four years into the world of podcasting, we know educational podcasting has only begun to explore its impact for professional learning.

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Chapter 3.4

Modelling Spoken Multimodal Instructional Systems

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ABSTRACT

The use of speech and spoken dialogue is a relatively recent addition to instructional systems. As, almost invariably, human instructors and students talk during teaching and training, spoken dialogue would seem to be an important factor in systems that emulate aspects of human instruction. In this chapter, the origins and state of the art of spoken multimodal instruction are described. Strengths and weaknesses of the speech modality, key roles of spoken dialogue in multimodal instruction, functional issues in current spoken teaching and training systems, commercial prospects, and some main challenges ahead are then discussed.

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INTRODUCTION

A key advantage of instructional systems is to enable instruction in the absence of a human expert or teacher. From pre-school kids to adults of all ages, everybody needs to learn and benefit from the expertise of others when doing unfamiliar tasks. The classical solution is to be helped by a *human instructor* who has two kinds of expertise: in the subject-matter in question and in effectively communicating or transferring the expertise to students. While this approach has worked for millennia, it suffers from the problem that expertise remains expensive and rare, relative to the number of those who wish to acquire or draw upon it. A language instructor in class, for instance, has little time for coaching each student individually.

An interactive instructional system, or *system instructor*, offers to supplement the human instructor's contributions to individual student learning and problem-solving. In the ideal case, the system's expertise, both subject-wise and pedagogically, is near-equivalent to that of a good human instructor. Since systems can be copied infinitely, this would enable students to work with an expert all the time, in class, at home, and elsewhere, and not just when the student has a human instructor's undivided attention in class. It is hardly controversial that removing the difficulty of access to expertise and dramatically reducing its price is a worthwhile technological goal.

The roles of speech, spoken dialogue, and conversation in instructional systems, most of which include modalities other than speech, are described and discussed. Characteristically, human instruction involves spoken conversation with students no matter whether spoken interaction is central to the instructional task or has an auxiliary role. In relative terms, speech is a newcomer in the field of instructional systems, which for a long time was characterised by typed text input/output. Spoken interaction is insufficient for most instructional purposes, however. Other interactive modalities are needed for optimising instructional effectiveness and efficiency. New modalities and modality combinations hold the additional promise of providing system instructors for *all* users no matter their perceptual or motor disabilities.

Instructional systems are defined (the second section), their history reviewed and the state of the art of spoken instructional systems are described (the third section), and conceptual architectures and component technologies are presented (the fourth section). Using a simple example, how to approach instructional systems analysis and specification is discussed (the fifth section) and a functional model of instructional interaction sketched (the sixth section). Since speech is not a catch-all for instruction, when (not) to use speech is asked and key roles of spoken dialogue are proposed (the seventh section). Examples of spoken

multimodal dialogue systems (the eighth section) and commercial prospects (the ninth section) are discussed, and some main research challenges are presented (the tenth section).

INSTRUCTIONAL SYSTEMS

By an (interactive) *instructional system*, an application whose main purpose is to teach or train the user or help the user solve a particular problem is understood. Although often combined in practical applications, these goals are somewhat different. A *teaching system* primarily teaches *understanding* of some subject-matter, such as the periodic system, basics of genetics, astronomy, planet geography, phases in the history of humanity, and so forth. A *training system* primarily trains *practical skills*, such as language skills, how to operate some artefact, play golf, or fly a commercial airliner. Teaching and training systems are aimed at long-term learning effects in the learner. By contrast, *problem-solving support systems*, such as one helping to install IP telephony on a laptop, rarely incorporate ambitions of producing long-term learning effects. If they help solve the problem at hand, they fulfil their purpose.

Aiming at long-term retention which largely depends on the amount of elaboration done on the education material, *teaching/training systems* typically focus on providing opportunity for solving or otherwise addressing as many and as different problems or issues as possible in the application domain. Key challenges in developing a good system are to make it *pose* the right challenges, *evaluate* the student's attempts to cope, *feed back* evaluations, *monitor* progress, *modify* challenge level depending on learning progress, and *stimulate* motivation to continue learning. *Problem-solving support systems* focus on system problem-solving because the user is challenged already and needs help. Problem-solving support systems thus partially reverse the roles described, so that the user poses the challenge, evaluates the

system's attempt to cope, and feeds back evaluations—but the system is still the expert.

Instructional systems need a *usable interface* for human-system interaction. In a sense, this is no different from other interactive systems like word processors or spreadsheet packages. Arguably, however, usability requirements are particularly sharp for instructional systems: nothing is more de-motivating to self-instruction than a system you cannot find out how to use; students often work alone or in small groups, lacking the usual support from colleagues at work when something is amiss; and students typically need all system functionality rather than the <20% functionality most word processor users actually use.

HISTORY AND STATE OF THE ART

Intelligent Tutoring Systems

Intelligent machines for educational purposes date back to Pressey's (1927) machine for multiple-choice tests. Computer assisted training and teaching dates back to around 1960. While the first computer-assisted instruction (CAI) or computer-assisted training (CAT) systems were fairly simple, one source of progress was incorporation of AI-techniques in the 1970s. This led Sleeman and Brown (1982) to coin the term intelligent tutoring systems (ITSs) to distinguish the new AI-based systems from simpler CAI/CAT systems.

One of the first ITSs was the WHY teaching system (Stevens & Collins, 1977) which tutors factors and causal relationships affecting rainfall. A later, well-known training system is Sherlock and its successor, Sherlock II, which tutor air force trainees in diagnosing and repairing electronic equipment (Lesgold, Katz, Greenberg, Hughes, & Eggan, 1992; Lesgold, Lajoie, Bunzo, & Eggan, 1992). These are just examples of the multitude of domains addressed by ITSs over the years.

Early Intelligent Tutoring System Interfaces

For many years, ITSs were basically GUI (graphical user interface) –based, using input from keyboard and mouse and output on screen. Screen output was to begin with typically static text and graphics followed more recently by dynamic output, such as video, animation, and virtual reality. Since human tutoring typically involves natural language interaction, GUI-based instruction also began to include typed student-system dialogue. This trend seems to have grown with advances that now enable rather sophisticated linguistic interaction.

Natural Language Interaction

Some early text-based dialogue systems are psychotherapist Eliza (Weizenbaum, 1966) and SHRDLU (Winograd, 1971), the latter enabling users to move blocks of different shape and colour around by using a vocabulary of about 50 words. Theoretical work on discourse and dialogue in the 1970s and 1980s (Grosz, 1974; Allen, 1979; Grosz & Sidner, 1986) has played a major role in advancing natural language interfaces. Spoken interaction began to gather speed around 1990. In the 1990s, most spoken dialogue systems enabled users to accomplish some task, such as making a flight reservation (Bernsen, Dybkjær, & Dybkjær, 1998) or checking bank information, but few systems were instructional. An example of the latter is the speech-only Circuit Fix-It Shop problem-solving support system (Smith 1991; Smith & Hip, 1994). The system helps debug an electric circuit and a main development goal was to model mixed-initiative dialogue. Research on spoken and multimodal interaction goes back at least to Bolt's (1980) system which combines spoken commands and pointing-gesture input.

Spoken Teaching and Training Systems

Spoken interaction made its way into ITSs in the late 1990s. For instance, Graesser et al. (2001, 2004) use talking-head output in their AutoTutor system but still rely on text input. AutoTutor teaches newtonian qualitative physics and computer literacy. The conning officer virtual environment (COVE) system is for training Navy officers to become better ship drivers (Roberts, 2000). Interaction is via graphics output and speech, the system using short spoken exchanges to coach the learner during simulation. The ship-board damage control trainer (Clark et al., 2001, 2005) also uses spoken interaction and graphics output. Students must contain the effects of fire, explosion and other critical onboard events, and receive spoken instruction and feedback. The system asks question on, for example, what to do in a particular situation and which steps to take. The user answers via speech and/or pointing to part of the vessel displayed on-screen. Teaching system ITSPOKE (Litman & Silliman, 2004) uses the WHY2-Atlas (VanLehn et al., 2002) text-based ITS as back-end. When given a problem in qualitative physics, the student types a natural-language essay answer. ITSPOKE analyses the answer and engages students in spoken dialogue to provide feedback, correct misconceptions, and elicit more complete explanations.

Since spoken dialogue systems began to go multimodal in the late 1990s, several dialogue research projects have explored spoken multimodal interaction for teaching or training. Compared to mainstream ITSs, the resulting systems tend to focus less on pedagogical aspects and more on interaction. For instance, several training applications using spoken dialogue with virtual humans have been developed at the University of Southern California. One is a mission rehearsal system for training critical decision-making skills in small-unit US Army leaders (Hill, Gratch, Marsella, Rickel, Swartout, & Traum, 2003). Another is a

negotiation trainer for military personnel who need good negotiation skills when going to war zones (Traum, Swartout, Gratch, & Marsella, 2005). Focusing on improving conversational abilities, these projects go beyond the strict task-orientation of most spoken dialogue systems, towards enabling a more open conversation within the domain. This is even more so in the European Hans Christian Andersen system for non-task-oriented conversation with the fairytale author about his life, person, and fairytales (Bernsen et al., 2004). Aimed at the 10-18 year olds, the system combines education and entertainment.

The Collagen (collaborative agent) project (<http://www.merl.com/projects/collagen/>) (Rich, Sidner, & Lesh, 2001), although fostered in the spoken multimodal tradition, goes a long way towards merging with the ITS tradition and its pedagogical emphasis. Collagen introduced a platform for building mixed-initiative assistants for a wide range of applications and with considerable software re-use. Underlying the platform is shared-plan collaborative discourse theory. The platform has been used for, for example, an agent that teaches how to operate a gas turbine and one which helps set up and program a video-cassette recorder (Rich et al., 2001). To bridge to ITSs, domain-independent pedagogical agent Paco has been developed and used for teaching students how to operate gas turbine engines (Rickel, Lesh, Rich, Sidner, & Gertner, 2002). Language training systems is another example of systems that draw on both traditions. The Colorado Literacy Tutor (Cole et al., 2003) is aimed at teaching students to read fluently and understand what they read. Talking animated head Baldi teaches vocabulary and grammar to autistic and hard-of-hearing children and helps them improve speech articulation and linguistic and phonological awareness (Massaro, 2005).

Speech in Commercial Instructional Systems

While many commercial instructional systems include text-to-speech output, there are still rather few that include speech recognition. Spoken output is primarily used to speak some text aloud. Although any text may be read aloud, most commercial instructional software providers who stress the availability of spoken output, use it for some kind of language training (cf. later). Similarly, most commercial instructional systems that recognise speech are aimed at language training.

Text-to-speech output is, for example, included in the reading, grammar, and vocabulary improvement programs from Merit Software (<http://www.meritsoftware.com>). A product from Kurzweil (<http://www.kurzweiled.com>) aims to ease and enhance the reading, writing, and learning experience of the visually impaired by speaking text aloud. Knowledge quiz software from Interactive Speech Solutions and Microsoft's Mobility Solutions for Education (<http://getccq.com>) ask questions in English while the question text is displayed in the application window. Spanish-speaking students may click a button to hear the question spoken in Spanish while still viewing the English text. Several systems from Caltrox (<http://www.caltrox.com>) use spoken output, including programs for learning multiplication tables, teaching kids to count, learn the alphabet or the spelling of words, and a text-to-speech program for training English pronunciation and vocabulary-building.

Several commercial pronunciation training systems use speech recognition, including Auralog's Tell Me More (<http://www.auralog.com>) and one from Protea Textware (<http://www.proteatextware.com.au>). These programs use the speech recogniser's recognition of the student's pronunciation of words and phrases as a basis for feedback on the pronunciation quality. Pronunciation training is used as an example in the fifth

section. Spoken dictation systems are also being used as a help for dyslectic students.

COMPONENTS AND ARCHITECTURES

In this section some basic aspects of components and architectures for ITSs and spoken multimodal dialogue are described.

Core Components of Intelligent Tutoring Systems

A typical ITS includes the following abstract components:

- The **student model** (user model) collects, stores, and updates information about the individual student for use by the teacher model. As a minimum, the model keeps track of how well the student performs over time
- The **teacher model** (pedagogical model) is a model of the teaching process adaptable to the individual student's needs. The model includes, for example, information about when to introduce a new learning topic depending on curriculum and student model information, and decides on the performance evaluation feedback to present to the student
- The **expert model** (domain model) includes information relating to what is being taught as well as a model of how an expert solves problems in the domain. This enables comparison with the student's solutions and helps identify and point out which problems of understanding and/or skills mastery the student may have
- The **user interface** presents learning material to the student and generally enables student-system interaction

These functionalities can be realised in many different architectures and may vary hugely in sophistication.

Core Components of Spoken Dialogue Systems

A typical architecture for spoken natural language dialogue includes the following modules, compare Figure 1:

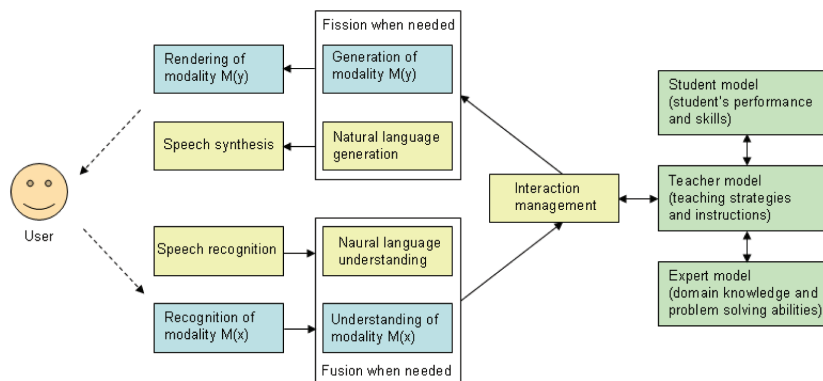
- **Speech recognition** transforms the speech signal into one or several text strings
- **Natural language understanding** extracts semantics from the recognised string(s)
- **Dialogue management** decides, based on input semantics and contextual information, which output to produce next
- **Natural language generation** prepares an output text string in accordance with the dialogue manager's decision
- **Speech synthesis** transforms the output text into a speech signal
- **Application data and business logic** provides backend information for the dialogue manager. Its contents depend on the task and domain addressed.

If interaction is text-based-only, speech recognition and synthesis are left out. If spoken

interaction is not dialogue but only, for example, un-interpreted single-word input/output as in the pronunciation trainer (the fifth section), natural language understanding and generation are left out, and spoken dialogue management reduced to more basic interaction management. Multimodal interaction requires additional input recognition and interpretation components and often also fusion of information received in different modalities and/or additional output generation and rendering components, possibly including modality fission.

Space does not allow detailed discussion of spoken dialogue system component technologies and their pros and cons (see McTear, 2004; Delgado & Araki, 2005). Briefly, instructional systems developers may use commercial or research *speech recognisers* depending on the recognisers available for the language(s) used, quality requirements, and whether commercial recognisers offer the particular features needed, for example, extraction of prosodic cues. In the large majority of practical systems, *natural language understanding* of spontaneous spoken or typed input is based on shallow (or robust) parsing which extracts key words, phrases, and possibly certain grammatical constructs from the input string for building a conceptual representation of the input, using analytical or statistical techniques, and typically being guided by transcribed corpora of the kind of dialogue the system should be able to engage

Figure 1. Conceptual architecture of a spoken multimodal instructional system



in. Deep parsing based on some comprehensive grammar fragment is generally not sufficiently robust versus recognition errors, tends to get lost in multiple input interpretations, and is not needed to obtain usable results. In most cases, *dialogue management* must be developed from scratch unless the instructional system developers are on their way to having a platform which allows partial re-use from other systems. *Natural language generation* is typically based on stored output templates which are completed at run-time based on user input details and possibly on system state properties as well. *Spoken output* may be pre-recorded human speech or—for increased flexibility—produced by free or commercial text-to-speech synthesisers which have achieved high levels of intelligibility and naturalness for several languages. Finally, application-specific data (teacher model, expert model) must be developed from scratch as must the student model unless the developers have partially reusable components from similar systems.

Summarising, the addition of spoken dialogue to instructional systems implies non-trivial investment in a family of technologies, most members of which are not simply off-the-shelf components. Even if one chooses off-the-shelf recognition and text-to-speech, and unless the application requires basic dialogue capabilities-only, one is into non-standardised software development of, and contents provision for, natural language understanding, dialogue management, and natural language generation.

Spoken Multimodal Instruction Architecture

Since ITSs are primarily characterised by the right-most backend components in Figure 1 while spoken multimodal systems are mainly characterised by the other components shown, combining the two parts produces an ITS with a spoken multimodal interface. Figure 1 simplifies input fusion which may be done at different

input processing stages, primarily at signal and semantics level. In output fission, the output decided upon by interaction management is split between output modalities, such as speech and graphics, making sure that proper temporal synchronisation is maintained (Martin, Buisine, Pitel, & Bernsen, 2006).

SYSTEM ANALYSIS AND REQUIREMENTS: A SIMPLE EXAMPLE

Instructional system development follows general software engineering principles (Sommerville, 2006), adapting these to the application at hand. Decision on whether to use speech and spoken dialogue should be made early in the lifecycle as sketched for a simple spoken multimodal training system. The example also illustrates basic student, teacher, expert, and user interface models in action. The system does not include spoken dialogue but might come to do so later.

Early lifecycle work focuses on analysing the target system and specifying requirements. For analysis and specification, consideration of a standard set of factors (Bernsen & Dybkjær, in press) which helps structure analysis and determine requirements is recommended:

1. Application type
2. User, that is, general user properties to be taken into account
3. User profile, that is, description of the target user group(s)
4. Use environment
5. Domain
6. Task or other activity
7. Interaction
8. Interaction device

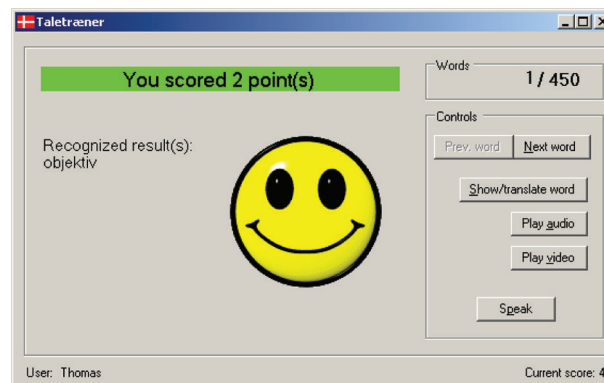
Assuming that the target application is a pronunciation trainer, how those factors might influence its specification will be sketched.

Even the most cursory target application description typically carries implications with respect to several factors. A description (1), such as “a speech recognition-based system for training immigrants in Danish single-word pronunciation” (Bernsen, Hansen, Kiilerich, & Madsen, 2006) implies the goal of improving student *skills* rather than knowledge and understanding (2) in the Danish second-language *domain* (5). Training should be in some quiet *use environment* (4), the *user profile* (3) being, if feasible, that of immigrants-in-general. Within the domain, a corpus of words which covers all Danish phonetic variations is needed. Basically, the student’s *task* (6) is to pronounce the words one-by-one. Decision on which *input/output modalities* to add to spoken single-word input and in which interactive roles (7) is less straightforward, which carries over to the choice of *interaction devices* (8). An open issue is how each training word should be presented to the student, for example, via (a) typed text, (b) an audio file of a native speaker’s pronunciation, (c) an audio/video file, (d) a semi-transparent animated human head pronouncing the word and displaying the vocal tract in action, or some or all of these. Another issue is whether to use spoken dialogue for some interactive role or if, for example, a standard GUI environment is sufficient.

In the current pronunciation trainer version, the *expert model* includes the phonetically rich

training vocabulary presented to students and algorithms for evaluating student pronunciation. The expert output is simply a set of pre-recorded text, audio and video files. An animated head is planned (Hansen, 2006). In the *student model*, basic and generalised results are distinguished between. *Basic results* are the logfiles stored each time a student pronounces a word and the system rates pronunciation quality based on phonemic similarity with a native speaker’s pronunciation of the same word. *Generalised results* are computed over basic results, for example, an accumulated numerical score for consecutive pronunciations of different words or identification of a set of pronunciation problems for a particular student. The *teacher model* is relatively simple. Since Danish single-word pronunciation has no levels of difficulty (it’s all hard!), the teacher model essentially (i) gives feedback on each pronunciation and (ii) uses student model generalisations to present pronunciation problem diagnoses and suggest remedial training exercises. Finally, the relatively simple *user interface* requires user identification through id entry (ensuring that user modelling models the right user) and enables training word selection, optional word presentation(s), word pronunciation, pronunciation quality score presentations (individual and cumulative), diagnostic feedback, and (planned) audio or video replay of the pronunciation (Figure 2).

Figure 2. Pronunciation training system with max. score Smiley emoticon feedback



Interestingly, the hardest part of pronunciation trainer development is one that tends to challenge many instructional systems, that is, to produce optimal, pedagogically meaningful student model results and teacher model feedback on performance and progress. Simply put: it tends to be easier to *evaluate* student performance quality than to *diagnose* its deficiencies and propose tailored remedial action. This is where human teachers and trainers excel, partly because their perception of student performance details is keener, and partly because their reasoning about those details is sharper than what current systems can do.

A MODEL OF INSTRUCTIONAL INTERACTION

Spoken multimodal instruction is characterised by the fact that a particular modality, speech, is used in multimodal combination. To address the potential roles of speech and spoken dialogue in instructional systems, a model of instructional interaction is needed. This section sketches a general model of a (self-) teaching or training session illustrated through reference to rather different system examples: the pronunciation trainer, case-based teaching of medical patient interviews, math training, the negotiation trainer and the Andersen system (the third section), flight simulation, and systems for teaching models in physics and ecosystems.

Expert Knowledge

Large parts of system contents and behaviour can be fixed in advance because these are independent of the input users might produce.

The developers can fix (1) the *problem space*—the words to be pronounced, a set of medical interview cases or math problems, a set of negotiation goals or flight simulation targets, or a model that should be worked upon. These example

systems are all task-oriented: the problem space is a *task space* in which the student works. Only the Andersen system has no task space because it is not task-oriented but *domain-oriented*. What the developers can fix is the person's personality, physical appearance, domain knowledge, habits, and so forth. (2) For task-oriented systems, developers can fix the nature and number of *actual problems* to be solved, such as pronouncing each word, critiquing each interview case, solving each math problem, reaching negotiation goals or simulation targets, or solving particular ecosystem problems. This cannot be done for the famous-person system because it is very much an empirical question what the students would want to learn from the person. (3) For each problem, the developers can determine the *solutions* that will be accepted as being correct and to which extent. Correct solutions may be defined either in terms of following *correct procedure* or arriving at *correct results*, or both. The famous-person system has neither correct procedure nor correct results.

User Interface

The problem space should be presented using the modalities most appropriate for the purpose, such as text, speech, video and animated-face graphics for pronunciation training, static text for medical interview cases and static math notation for math problems, giving the student time to carefully study each problem, speech and animated conversational characters for negotiation and famous-person, a haptic-visual cockpit environment for flight simulation, possibly augmented with acoustic alarms and spoken controls, and some combination of static text and static/dynamic graphics for physics and ecosystem models. Some implications are that (i) *any* modality or modality combination might be useful for problem space representation in some particular instructional system, (ii) many, if not most, problem space representations are *inherently multimodal*, and (iii) only a fraction of problem space representations have *spoken dialogue* as

main interactive modality, as in the negotiation and famous-person examples.

Student and Teacher

Now let the student be added to the model. Typically, the system is a longer-term companion which the student (4) first needs to *learn how to use* and then uses for some period of time to improve knowledge or skills. Working with the system, the student must (5) *understand the problem space* as presented, (6) *understand the problems* to solve, and (7) try to *solve the problems and present solutions*. The system must (8) *evaluate each solution* and feed back evaluations of process and/or results, (9) *generalise evaluations* of performance in order to spot patterns of difficulty in the student's problem-solving, *and present its generalisations* together with suggested remedies for removing the observed patterns of difficulty. Remedies might include special sessions for solving problems of a certain kind or increasing the level of difficulty for successful students. (9) requires observation of the individual student online and building of a model of that student's performance based on the observations made. This process is, in principle, the same for all input modalities: (mouse or hand) pointing, spontaneous speech, free text, and so forth: The system evaluates inputs one-by-one, accumulates the evaluations, spots patterns, compares training/test results over time, updates the student model, and so forth, and uses the resulting information to guide learning based on recommendations from the teacher model.

Model Variations

Finally, some model variations shall be added. Some systems might (10) distinguish between (a) *training/learning sessions* and (b) *test sessions*, for example, making (a) more free-style with ample pedagogical feedback and (b) more formal with no pedagogical feedback but with performance

scoring that enables easy comparison between test sessions over time. Some might (11) *reverse the roles of student and teacher/trainer*, the student teaching the system how to, for example, solve equations or model an ecosystem, the system asking questions in the process (Biswas, Schwartz, Leelawong, & Vye, 2005). Another interesting perspective is (12) *multi-user* teaching/training systems where several students work together.

The model needs not be fully implemented for a system to be instructional. Flight simulators, for instance, are typically just that, mission presentation, system operation instructions, and process and result feedback evaluations being provided by human instructors. Rather, the model is an ideal model aimed to include all the functionality necessary for an instructional system to enable self-training unaided by human instruction.

WHEN (NOT) TO USE SPEECH IN INSTRUCTIONAL SYSTEMS

The fifth section listed factors to consider when specifying an instructional system. The sixth section described a model of the kinds of information to be exchanged at the user interface. This provides the background for asking when (not) to use speech and spoken dialogue in teaching and training systems, in which roles, and possibly combined with other input/output modalities. A *modality* is defined in modality theory as a *particular way* of representing information in some *physical medium*. Today, the three principal media used for interacting with computers, and the corresponding human senses, are: light/vision, acoustics/hearing, and haptics (mechanical contact)/touch (Bernsen, 2002).

Strengths and Weaknesses of the Speech Modality

Speech has several modality properties that make it well-suited as a main modality in instructional

interaction, which is why speech is being widely used by human instructors. Studies of speech in multimodal contexts show that these properties are, among others, as described in Bernsen (1997) and Bernsen and Dybkjær (1999):

- Speech is a natural human modality for (1) **situated discourse** in which situation- or context-dependent information is being exchanged rapidly and spontaneously between interlocutors, each of whom can take the initiative
- Speech, and language more generally, has (2) **very high expressive potential**, so that virtually any piece of information could, in principle, be expressed in speech
- Compared to written language that evolved for non-situated information exchange, speech is more expressive due to (3) the **richness of the acoustic signal** which conveys far more than linguistic content, including emphasis, emotion, attitude, urgency, and so forth
- An acoustic modality, and unlike graphics and haptics, speech is (4) **omni-directional**
- Cognitively, speech can be effectively understood and generated in most (5) **heads-up, hands-occupied** situations, such as in the flight simulator
- Speech has (6) **high saliency**, that is, is quite attention-catching

On the negative side, the high salience of speech (6) can become a source of distraction both for the student and others. Moreover:

- Speech, being (7) **temporal and transient**, does not offer the advantages of static modalities, such as static graphics or haptic text, of allowing students free perceptual inspection of the information conveyed. That is why we found that users prefer static typed text over speech when exchanging exact, high-complexity infor-

mation and discussion summaries, whereas their discussions were all spoken conversation (Bernsen & Dybkjær 2001)

- Speech is ill-suited for expressing (8) **highly specific and detailed spatial information** like the contents of images and spatial 3D scenes, or exact spatial locations. This is why many instructional systems use static and dynamic *output* graphics, such as images, data graphics, video, or virtual and augmented reality information presentation—to complement speech or otherwise. For *input*, this is why it is useful to combine pointing gesture and speech to enable users to point to objects and events instead of trying to explain their locations in speech. For similar reasons, speech input is mostly a poor replacement for (haptic) object manipulation by hand
- Speech input and/or output must be replaced by other modalities, for example, sign language or written text, if users are (9) **hard-of-hearing** or have **speech disabilities**

These speech modality properties contribute towards explaining why the problem space of instructional systems is often dominated by non-speech modalities. Among the benchmark systems, the pronunciation trainer combines speech input with “canned” output in a GUI environment; the medical patient interview and maths systems focus on static written text (property 7), the negotiation training and Andersen systems have spoken conversation at centre-stage together with animated interface agents as both systems explore situated human discourse and the latter explores combined speech/pointing gesture as well (properties 1, 3, 8), the flight simulator space is dominated by haptic input control and augmented-reality vision but has an auxiliary role for speech (4, 5, 6, 8), and the model teaching system spaces are dominated by various forms of text and output graphics (7, 8).

Increasingly, spoken dialogue applications include output *talking faces* or *embodied animated characters* (Cassell, Sullican, Prevost, & Churchill, 2000). From one point of view, this is natural because human speech forms part of comprehensive communicative acts which include facial expression, gaze, gesture, and more; from another, some argue that the animations contribute little to instructional interaction and waste screen real-estate better used for presenting instructional task-related information; in a third view, their presence adds to instructional interaction more of the personal and expressive aspects characterising human instruction. This is an ongoing debate (Ruttkay & Pelachaud, 2004). In some cases, the animated face or agent is key to the application, for example, the semi-transparent human head demonstrating vocal tract articulation for pronunciation training, when the embodied character acts as physical training instructor; or when students learn from conversation with a life-like person from another age.

Roles of Spoken Dialogue in Instructional Systems

What are the most important roles of spoken dialogue or conversation in problem-solving-oriented instructional contexts? Given the enormous diversity of potential applications, target user populations, and so forth, and the limited number of spoken multimodal instructional systems developed so far, the best approach may be to learn from the roles of spoken dialogue in human instruction.

The question may be refined by considering a limiting case. When a human instructor is present and speech is not replaced by alternative options for situated discourse, for example, sign language, spoken teacher-student dialogue becomes possible. Given the expressivity of spoken dialogue, teacher and student will almost unavoidably talk from time to time, asking, discussing, clarifying, helping, and so forth. However, a limiting case

in which spoken dialogue is unnecessary can be defined, that is, when the instructional task is completely *self-explanatory* to the target users. A system that comes close is the Baldi language tutor which uses Baldi's talking face to improve the vocabulary of autistic and hard-of-hearing children (Massaro, 2005). Roughly, Baldi shows a screenful of, say, vegetables in static graphics, names them, asks the child to click on, for example, the zucchini, praises or gives another try, asks about another static image, and so forth, and moves on to a new screen. Baldi actually speaks to the kids and so might a human instructor, but the point is that everything is so straightforward that spoken *dialogue* is rarely needed.

Taking self-explanatory instruction as a limiting case, it is proposed that spoken dialogue may be added to instructional interaction for three main purposes, that is:

- **Task-oriented dialogue** about the core teaching or training tasks, that is, when the student solves a problem in dialogue with the system, including system feedback on the problem-solving process or solution
- **Non-task-oriented conversation**, primarily when the problem space itself is one of complex spoken dialogue or conversation but also when, for example, other tasks and solutions are less clear-cut and require discussion
- **Meta-communication** about the interaction, including handling of miscommunication, help dialogue, introductory dialogue about instruction purpose, problem space, how to use the system, and so forth

SPOKEN DIALOGUE IN MULTIMODAL INSTRUCTIONAL SYSTEMS

The seventh section identified three main roles for spoken instructional dialogue. Based on these, how far we are in exploiting spoken dialogue for multi-

modal instruction is now illustrated and discussed. Task-oriented dialogue and task-transcending conversation, meta-communication, and spoken interaction and learning gain are discussed in the eighth section.

Spoken Dialogue in Task-Solving and for Conversation

Today, nearly all instructional systems that include spoken dialogue are task-oriented and use limited *mixed-initiative* dialogue. Fully *user-directed* dialogue (no system initiative) seems unsuited for instruction while purely *system-directed* dialogue prohibits any kind of spoken intervention by the student. Limited mixed-initiative is typically obtained by carefully crafting the system's dialogue as illustrated in Figures 3 through 8. An obvious question is why these systems do not allow free mixed-initiative like in human instruction. Some reasons are:

- Speech recognition errors
- Vocabulary and (semantic) grammar
- Task and domain delimitation

Spontaneous speech recognition is error-prone, for several reasons. One is lengthy input: the longer the input the more likely misrecognition becomes. Since free initiative may encourage long input, ways must be found to reduce input length to keep misrecognition tolerably low. This can be done by carefully crafting the system's output in order to control initiative and limit input length. The alternative is to impose use of fixed spoken keywords and phrases but this increases student learning overhead and is infeasible for all but quite small-vocabulary input.

Systems allowing spontaneous speech input are often challenged as regards the sufficiency of their vocabulary and grammar. The solution is to continuously collect user input data and bootstrap the system on this data until it performs satisfactorily. This may require considerable effort. The

Figure 3. Example from (Rickle et al. 2002)

Paco: So, we succeeded in stopping engine two.
Student: Ok.
Paco: You take it from here.
Student opens fuel valve one on engine one.
Paco: Good.
Student opens the bleed valve on engine one.
Paco: That was a correct action, but I wasn't expecting you to do it now.
Paco: Let's go back to opening the fuel valves on engine one.
Student opens fuel valve two on engine one.
Paco: Great.
Student presses the engage button on engine one.
Paco: Whoops, you can't do that yet.
Student: What next?
Paco (Pointing): Press the on button on engine one.
Student presses the on button on engine one.
Paco: Good.
Student: I think I should set the throttle speed.
Paco: Right.
Student: What should the speed be?
Paco: The speed should be stop.

Figure 4. Example from (Peters et al. 2004)

Tutor: Since you had some difficulty ordering boundaries around compartments, let's work through some drills.
Tutor: I will pick a couple compartments, and you answer the questions about boundaries for each one.
Tutor: Let's start some drills with primary boundaries, and then move on to the secondary boundaries.
Tutor: Let's assume there is a fire here, in 3-220-2-Q.
Tutor: What are the primary bulkheads you should use for setting boundaries on compartment 3-220-2-Q?
Student: Primary forward two two zero primary aft two five four.
Tutor: Great job. Those are both right.

Figure 5. Example from (Litman and Silliman, 2004)

ITSPOKE: I didn't understand. What force acts on all objects within close proximity to earth?
 Student: uh the force of gravity
 ITSPOKE: Fine. Besides the Earth's gravitational force, are there any other forces acting on the person, keys, and elevator after the release?
 Student: no
 ITSPOKE: Yep. Thus, keep in mind that after the release, the only force on the person, keys, and elevator is the force of gravity. If gravity is the only force acting on an object, will it be moving or staying still?
 Student: it will be moving

Figure 6. Example from (Forbes-Riley and Litman, 2006); hand annotated emotions in square brackets

Tutor: So, when you add forces together, besides the magnitudes of the forces, what must you also consider?
 Student: direct- direction (ASR: the truck in direction) [correct, uncertain, non-frustrated/angry]
 Tutor: Yes. [...] The vector sum of the forces acting on the body is also equal to the mass of the body multiplied by its acceleration. What is another term for the vector sum of forces acting on a body?
 Student: net force (ASR: net force) [correct, neutral, non-frustrated/angry]
 Tutor: That's super. Another term for the resultant force is the net force. In this relationship, what is the direction of the net force applied to a body and the direction of the body's acceleration?
 Student: same same same (ASR: seems same type seems) [correct, certain, frustrated/angry]

Figure 7. Example from (Traum et al. 2005)

C(aptain): Hello Doctor Perez.
 D(octor): Hello.
 C: I have orders to move this clinic to another location.
 D: You want to move the clinic?
 C: Yes
 DECREASES SOLIDARITY: captain endorses undesired act 'run-clinic-there'
 D: Look at these people!
 D: we need to help them.
 C: It is not safe here, we can't protect
 DECREASES CREDIBILITY: captain asserted unbelieved (but possible) state 'patients-unsafe-here' 'patients-unsafe-here' could be established by captain's act of 'planned-attack'
 D: Protect me? Protect me from what?
 D: Are you going to attack?
 C: Yes
 DECREASES SOLIDARITY: captain committed to perform undesired act 'planned-attack'

Figure 8. Example from (Bernsen and Dybkjær, 2005)

Child: what is your favourite fairytale?
 HCA: I like several of my fairytales very much. One of my favourites is the ugly duckling. The ugly duckling is not accepted by the other ducks and animals because it looks different. It has a hard time of suffering and troubles. Eventually it wishes only to die till it discovers that it is in fact a beautiful swan. The point is that if you are different then you will get bullied.
 Child: can you dance?
 HCA: Sorry
 Child: can you do the moonwalk?
 HCA: I am sorry but i still don't understand. Maybe you are talking about one of the many things i still don't know about
 Child: what games do you like to play?
 HCA: My favourite childhood game was to play theatre...

more open the domain is the more data is needed. Clear and clearly communicated task and domain delimitation is crucial, so that the student knows exactly what the system can and cannot conduct dialogue about. Inappropriate delimitation runs a high risk that users address out-of-domain issues, creating recognition and grammar problems (Bernsen et al., 1998). The system's last defence is meta-communication which is difficult to engineer and always disturbs dialogue smoothness (the eighth section).

Figures 3 through 8 show instructional dialogue engineering aimed at minimising interaction problems. System questions are typically closed either through explicitly listing the answers to choose among (e.g., last tutor output in Figure 5) or by inviting short specific answers (e.g., first tutor questions in Figures 4 and 5, second in Figure 6). If the output invites student *initiative*, the tacit assumption is that the system will remain in control. Thus, in Figure 3, Paco offers initiative with little risk because the answer involves haptic screen graphics action rather than complex oral explanation. The Figure 7 dialogue is higher-risk because it opens up towards conversation. There is still a task to solve, however, that is, to convince the doctor that he must move. Figure 8 goes further by showing real conversation with the fairytale author. Since there is no instructional task, the developers can only control student input by making the character try to gently constrain the domains and topics of conversation.

Smooth and cooperative dialogues are major goals in most task-oriented applications, instructional or otherwise. Student cooperativity can be taken for granted as long as the student wishes to learn and manages to find out what (not) to talk to the system about. However, good human instructors are not merely cooperative in an extended Gricean sense of being to-the-point, taking into account student's background knowledge, and so forth (Grice, 1975; Bernsen et al., 1996) but re-phrase and re-explain when needed, never leave the student behind, tune the level of diffi-

culty to the individual, and motivate and encourage even if the student has not got it yet. This is non-trivial pedagogical art even for human tutors. Evaluative feedback may be given in many different ways. It may be simple like the smiling or sad emoticon face for pronunciation training (Figure 2) which only reflects the quality of the most recent pronunciation, comment nicely on the most recent student action (Figure 3), or be general as in Figure 4 where the system explains why the student gets the next task. The Figure 7 system gives no explicit feedback on student performance. Rather, the performance measure is how willing to cooperate the doctor becomes.

Good instruction draws on many information sources, including awareness of students' cognitive and emotional states. Still in its infancy, multimodal emotion recognition and generation is a popular research area today. In the speech modality, prosody delivers cues to the speaker's emotional, cognitive, and volitional states, potentially informing the tutor that the student is uncertain, lost, frustrated, or saddened by repeated failure, compare the hand-annotations in Figure 6. Vocal expression of emotional state has been investigated for decades (Scherer, 2003). Among the problems in recognising emotions from speech is that emotions rarely come in a pure full-blown form (Batliner, Fischer, Huber, Spilker, & Nöth, 2003) but must be recognised through cues expressed not only prosodically but also linguistically. These cues may contribute to detecting trouble in human-computer dialogue (Batliner et al., 2003). Also in instructional systems, emotion detection is considered important and is actively being researched. For instance, studies indicate that student emotions of frustration and anger correlate with system performance, in particular speech recognition problems (Rotaru & Litman, 2006), and ongoing work addresses how student emotion can be automatically detected and used in tutoring dialogue (Ai, Litman, Forbes-Riley, Rotaru, Tetreault, & Purandare, 2006).

Cognitive modelling is another source of good instruction which manages to select the striking example, or the successful analogy, based on detailed understanding of the student's background knowledge and interests. Training of the social skill of seeing things from the other person's perspective and acting accordingly during negotiation is illustrated in Figure 7 which shows part of a dialogue-turning-bad between a military officer and a virtual doctor. The doctor includes substantial cognitive modelling based on negotiation theory. Regarding the cognitive aspects of student certainty and correctness which are particularly important to instructional systems, studies show that tutors respond differently to student certainty and uncertainty, respectively (Liscombe, Hirschberg, & Venditti, 2005), and that there is a correlation between uncertainty/incorrectness and recognition problems (Rotaru & Litman, 2006), which indicates the importance of asking questions at the right level of difficulty.

The factors mentioned are just some of those that will continue to challenge developers of spoken multimodal instructional systems and their components for a long time to come.

Spoken Dialogue for Meta-Communication

The third role for spoken dialogue is for meta-communication, or communication about the communication (interaction) itself, which may be required throughout an instructional session. Under meta-communication repetition, correction, clarification, help dialogue and everything to do with introducing the system, its instructional purpose and use are included. Some types of meta-communication are hard to cope with in today's spoken dialogue systems and better error recovery strategies are very much in demand (Bohus & Rudnicky, 2008).

User-requested repetition signals failure to hear or understand what the system said and can usually be handled with a vocabulary that covers

the ways in which users might phrase the request. However, understanding failure cannot always be remedied by verbatim repetition. This problem is better avoided through careful output design than resolved on-line. *System-requested repetition* is easy to do and may work if the request is due to simple recognition failure of words and concepts known to the system. However, verbatim user repetition will not work if the input is out-of-vocabulary, grammar, or domain. It remains hard for systems to make these distinctions, which is probably why, as remarked by McTear (2008), much spoken dialogue miscommunication research has focused on speech recognition rather than other error sources. For these other sources, more active strategies are needed, such as asking the user to re-phrase, asking a new question (first system turn, Figure 6) or, like in Figure 8, stepwise nudging the user to change topic or relinquish initiative.

In general, it is worse for the system to misunderstand the user than to fail to understand and ask for repetition or re-phrasing. The former often makes the system appear silly and the user may initiate correction dialogue which can be difficult to handle. Linguistically and conceptually, *correction input* is more diverse than repetition requests, and the system may have to relate the input to what was said several turns back. Moreover, as systems aspire to interpret new types of input information, such as student emotion, new sources of misunderstanding must be dealt with. *System-initiated correction* is ubiquitous in instructional discourse, compare Paco's turns 4 and 7 (Figure 3), and its non-meta-communication complement, confirmation, is well illustrated in Figures 3 through 6. In fact, constructive and motivating correction and confirmation design is a major part of instructional systems development. Figure 4 illustrates careful generalised corrective feedback design. Arguably, the main problem is to flexibly handle student input which is not quite right and not quite wrong either.

Clarification is typically a difficult kind of meta-communication dialogue. Clarification requests may require explanation of virtually anything mentioned during dialogue. The best strategy is to try to prevent user clarification requests by design, that is, by sticking to core-task, core-domain terminology, and explaining everything necessary before the student asks. However, this is easier said than done even when the system is being designed for students having well-defined prior knowledge and skills. Everybody can forget the meaning of some technical term but the system can easily make a nuisance of itself by explaining all technical terms as it goes along. Unless the user's potential clarification needs are obvious, this problem has no easy solution and becomes harder the less task-oriented the system is, the wider the domains it covers, and the less is known about the student population. Somehow, future systems must be aware of their own ignorance as illustrated in Figure 8. System requests for clarification are part-and-parcel of instructional discourse but remain hard to do. It is symptomatic that there are no examples in Figures 3 through 8.

Student *requests for help* may concern how to solve a task or operate a device or the system itself. General context-*independent* help is fairly easy to design and may be compared to what is found in GUI help menus. Context-*dependent* help is often more difficult because the task- or discourse context must be taken into account. In Figure 3, having been corrected, the student requests context-dependent help on how to continue from the present state. Since the task context is well-defined, all the system has to do is inform about the next correct action in the context. While help dialogue is generally useful, there is more hesitation in recommending spoken dialogue for introducing the system, its instructional purpose, and use. Speech is sub-optimal for lengthy and complex explanation and, since students typically use the system for a while, an electronic manual is often preferable.

Spoken Interaction and Learning Gain

Instruction is all about learning gain. One-to-one human tutoring seems to be very effective compared to classroom sessions. Although sophisticated instructional systems do not achieve the same learning gain as good human tutors, they seem to do better than classroom teaching (Graesser, Person, Lu, Jeon, & McDaniel, 2005).

Regarding the speech modality, it has been explored if speech recognition problems affect learning gain. Empirical studies have not been able to show negative effects on learning (Pon-Barry, Clark, Bratt, Schultz, & Peters, 2004; Litman & Forbes-Riley, 2005), although recognition problems may cause frustration and affect perceived usability and motivation to use the system.

The impact on learning gain of spoken output quality, including pre-recorded human speech versus synthetic speech, has been investigated by Forbes-Riley, Litman, Silliman, and Tetreault (2006) in the context of ITSPOKE (the third section). Learning gain was not influenced by voice quality but this may be due to the fact that the spoken text was also displayed on-screen. This question seems to require more investigation. However, as synthetic voices improve, any negative effects are likely to disappear anyway.

Also the comparative question of learning gain with spoken versus typed text interaction remains an open one (Pon-Barry et al., 2004). A study by Litman et al. (2006) suggests higher learning gain for spoken human-human tutoring compared to written interaction whereas results for human-computer tutoring are less clear.

Learning gain is probably also strongly related to teaching strategy. Aiming at instructional systems, various studies of human tutoring address what makes a good teacher and which factors influence learning gain. Nevertheless, it remains an open question whether instructional systems should behave in the same ways as human teachers do. Thus, du Boulay and Luckin (2001) review

comparisons of human and computer tutors and of teaching strategies, such as the Socratic approach, and including, for example, how to deal with errors and how to provide feedback. Some examples of what has been investigated are: Jackson, Person, and Graesser (2004) examined the relationship between dialogue moves and student learning using AutoTutor (the third section). In line with previous research, they found that students who received more pumps and hints and played the active part in knowledge construction learned more than those who received more prompts and assertions from a tutor who controlled knowledge construction. Core, Moore, and Zinn (2003) looked at initiative using two different teaching strategies and, somewhat surprisingly, found that there is no direct relationship between initiative and learning.

CONCLUSION

Commercial spoken multimodal instructional systems are still rather few, and systems using spoken dialogue in some role or other are fewer still. This no doubt reflects the more general fact that *spontaneous speech* dialogue systems have entered the market only recently, where they are being used to help solve limited tasks of various (non-instructional) kinds. Arguably, most instructional systems which include spoken dialogue, will have to handle spontaneous spoken input because it is unrealistic to demand that students learn and remember lengthy sets of fixed keywords and phrases whilst engaged in learning or training things that are difficult enough in themselves. However, with spontaneous speech dialogue systems having entered the market, the technology would seem likely to spread across a wide range of application areas, including instructional systems.

The research systems that have been seen provide a useful indication of how far we are. With the technologies illustrated in Figures 3 through 8, it is possible, today, to build useful spontaneous speech, mixed-initiative, multimodal or unimodal

teaching, and training systems for many different purposes. Today's research systems are typically sufficiently rich in content to allow realistic training or teaching but rarely have the robustness required of commercial systems.

However, several factors seem likely to slow down the proliferation of spontaneous spoken multimodal instructional systems in the near future.

One such factor is speech recognition technology. Recognisers sometimes misrecognise and, although this may not influence learning gain, it is known to cause frustration. Thus, companies might be cautious launching applications which include spontaneous speech dialogue. The first computer games with spoken input have not received unanimous acclaim partly because of recognition errors, and the car industry keeps launching spoken keyword-based navigation and other systems rather than spontaneous speech technology. Another factor which was elaborated in in the fourth section is that adding spontaneous spoken dialogue to instructional systems has relatively high entry costs for researchers and industrial developers alike. The family of technologies required include several components which are poorly standardised as well as being rich in application-specific contents, both of which factors contribute to making development expensive and risky. Thirdly, the market is not necessarily willing to pay a lot for the great opportunity to improve everyone's skills and knowledge through self-training and self-teaching supported by the kinds of spoken dialogue which are ubiquitous in human instruction.

FUTURE RESEARCH DIRECTIONS

It has been argued that the technologies already exist for including spoken dialogue in a wide range of multimodal instructional systems. To see why the research challenges ahead remain massive, five main reasons why there is still a way to go

before system instructors can replace good human instructors have been pointed out.

1. Most current spoken dialogue instructional systems address knowledge and skills for which it is relatively easy to determine if the student's problem solving process and/or result is correct. The demands on the system's spoken dialogue capabilities are likely to increase strongly with more open-ended systems where there is no single correct answer and discussion and argumentation is key.
2. Large-domain "real" conversation, as opposed to more or less tightly constrained and primarily system-directed, task-oriented spoken dialogue, is challenged but not conquered by the Andersen system (Figure 8). Human-human conversation follows a multitude of often subtle and sub-consciously practiced principles many of which still have to be demonstrated in running applications.
3. The negotiation trainer (Figure 7) illustrates the tip of another iceberg, that is, that of emulating human communicative cognition, emotion, and volition as it works as an integrated whole, often sub-consciously, during dialogue and conversation.
4. To a larger or smaller extent, human instructors rely on *vision* for watching student task performance, facial expression, gaze, and so forth. The problems still facing machine vision research imply that most instructional systems must manage without emulating most aspects of human vision for some time to come.
5. Even if it may appear simple to enable natural multimodal student input using, for example, speech and 2D (surface) or 3D pointing gesture, this is not the case. The complexity of the multimodal fusion tasks that humans effortlessly accomplish are only now being discovered (Martin et al., 2006).

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Chapter 3.5

Applying the ADDIE Model to Online Instruction

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ABSTRACT

This chapter assembles best ideas and practices from successful online instructors and recent literature. Suggestions include strategies for online class design, syllabus development, and online class facilitation, which provide successful tips for both new and experienced online instructors. This chapter also incorporates additional ideas, tips, and tricks gathered since the paper was originally published in the October 2004 issues of the *International Journal of Instructional Technology and Distance Learning* as “Tips and Tricks for Teaching Online: How to Teach Like a Pro!”

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INTRODUCTION

Online education has quickly become a widespread and accepted mode of instruction among higher education institutions throughout the world. Although many faculty who teach traditional courses now embrace some teaching methods popularized by online education such as incorporating online quizzes and discussion boards, some instructors may still feel intimidated when asked to develop a course offered entirely online. Even the best lecturers may find that teaching online leads to feelings of inadequacy and being ill-prepared. While providing training, offering tools for ePedagogy, and sharing success stories are good ways to build faculty confidence, solid

instructional course design is still a necessary process for quality online instruction.

The ADDIE model, described by Molenda (2003) as “a colloquial term used to describe a systematic approach to instructional development, virtually synonymous with instructional systems development” (p. 34), is a generic instructional design model that provides an organized process for developing instructional materials. This systematic model is a five-step process that can be used for both traditional and online instruction. The five steps, analysis, design, develop, implement, and evaluate, provide an ideal framework to discuss solid instructional design techniques for online education. In addition to this discussion, this manuscript offers tips and tricks for designing and teaching an online course, gathered from conversations and interviews with online instructors, current literature, conference presentations, and the authors’ personal experiences as distance educators.

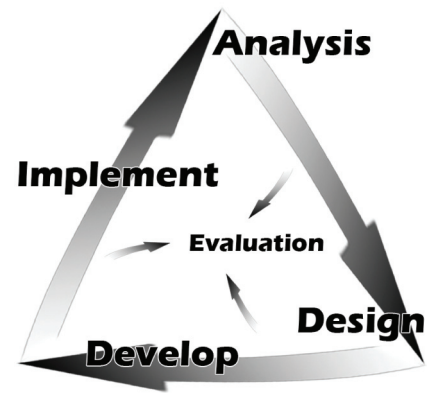
ANALYSIS

The analysis phase, though one of the most essential in the ADDIE model, is often overlooked. Like any significant project, excitement to get started often overtakes methodical planning, and the eagerness to see the finished results can put relevancy and quality at risk. Undertaking something as involved as developing an online course demands careful analysis. For the purpose of this book, we divided the phase into three segments: analysis of the learners, analysis of the course (including its goals and learning objectives), and analysis of the online delivery medium.

Analysis of the Learners

In this part of the analysis phase, the course designer or design team should perform an audience analysis to provide focus on the learners, their needs, and their learning preferences. In

Figure 1. The ADDIE model



fact, Olgren (1998) reminds us that “if learning is the goal of education, then knowledge about how people learn should be a central ingredient in course design” (p. 77). The course developer should examine ways in which online learners are similar to learners in traditionally offered courses and how they are different as this also leads to an understanding of audience needs within the course. As far as demographics, Gilbert (2001) describes a typical online student as being over 25, employed, a caregiver, and already with some amount of higher education experience (p. 74). However, the demographics are changing at many institutions as more online courses are being offered and traditional full-time students are electing to take online courses as part of their regular course load. Therefore, both andragogical (adult learning theory) and pedagogical methods of course design as well as some mix of experiential, problem-based, and constructivist approaches to learning should be considered.

Students enrolled in online courses often have different expectations than when enrolled in traditional courses. These expectations, described by Lansdell (2001), include increased levels of feedback, increased attention, and additional resources to help them learn (as cited by VanSickle, 2003). In response to meeting these expectations, alternative methods of instruction and class facilitation have evolved to support student cohesiveness and

encourage learning. To successfully challenge the online student, increased communication is required between instructor and student (White, 2000). While much of that communication is created in the later phases of the ADDIE model, a careful analysis of the required communication elements will ensure that the intended communication is on target and appropriate for the audience at hand.

Analysis of the Course

In most cases, online courses are not new to the institutional curriculum but existing courses which are being created for a new medium. Therefore, course goals and learning objectives already exist and may not need modification. However, since the course developer will be, in essence, recreating the course from the ground up, the course developer should review the learning objectives for the course and how that relates to other courses and the overall program curriculum. A working knowledge of the goals and objectives is a must as these will be the guiding principles for all content creation.

The course developer should seek answers to the following questions: Why does this course exist? What does it seek to accomplish? Who is the course for? What are the learning objectives? In what ways does this course fulfill degree requirements? The answers to these questions provide the proper perspective in the following instructional design phases as well as provide a working set of priorities to be used in course design and development.

Analysis of the Online Delivery Medium

Online courses, being a relatively new medium of instruction, have yet to achieve a universally understood definition. It is helpful for the course developer and others involved in formulating a working definition of online delivery. For example,

for the authors, online delivery is assumed to have the following characteristics:

- The course is held online during a regularly defined class semester or quarter or an established amount of weeks.
- The course is broken up into separate learning modules.
- Student participation is required within a set time period—each content module is presented with a given start and end time.
- Learning takes place as students synthesize the prepared material and interact in class discussions with peers and the instructor(s) within the required time period described above.

Online course delivery offers exciting possibilities, as well as frustrating limitations. Without an analysis of the delivery medium, the online course can result in what Fraser (1998) calls “shovelware”—content that is simply moved from one medium to another without regard for the capabilities of that medium. To fully understand the concept, consider Fraser’s (1999) analogy: “When the motion picture was invented, early practitioners saw it primarily as a means of distributing existing material, such as stage performances. It was some time before movies were recognized as a new medium with expressive possibilities, which while overlapping existing media, went far beyond anything previously attainable” (p. B8). Could you imagine Star Wars as a stage performance? Just as film transformed storytelling, online education is reshaping education.

DESIGN

The design phase begins to organize strategies and goals that were formulated in the analysis phase. It also provides details which enhance the course delivery process. Brewer, DeJonge, and Stout (2001) found that course planning and prepara-

tion directly influences course effectiveness and really hinder student learning.

Before designing an online course, it is helpful for instructors to view existing courses already offered online. Not only does this familiarize the course developer with the basic components of an online course, it usually inspires ideas that generate excitement about the design process. A Web search can find open examples, but may be limited since most courses are located within password protected courseware management systems. However, there are two open initiatives which can be readily accessed: the MIT's Open Courseware (ocw.mit.edu) and Carnegie Mellon's Open Learning Initiative (www.cmu.edu/oli); both Websites offer many courses in various disciplines that can help instructors with their own course design. A third, The University of California Berkeley, provides online material in the form of Webcasts and enhanced podcasts (<http://Webcast.berkeley.edu/courses>).

The design phase is most analogous to that of the creation of a blueprint, a plan for construction that helps guide all involved toward the intended outcome. For online instruction, that blueprint is the course syllabus. The syllabus is the heart of the design phase; careful preparation of the syllabus prepares the learning environment and discourages confusion and miscommunication. For this phase, the major components are examined within the framework of a typical online course syllabus.

Ko and Rossen (2004) relate the syllabus to a course contract and observe that new online instructors do not usually include enough information. McIsaac and Craft (2003) term the syllabus as the roadmap for the course and remind us that students will be frustrated if they try to work ahead only to find out the syllabus has changed within the course. They suggest having a structured syllabus available before the course starts so students can be prepared for course expectations.

Within the syllabus, student expectations should be clearly defined along with well-written directions relating to course activities. These

expectations should be stated in the opening orientation material as well as in the course syllabus. Preparation includes clear definitions of the following within the syllabus: contact information, course objectives, attendance requirements, a late work policy, the course schedule, orientation aids, grading scales and rubrics, communication practices, technology policies and overall course design.

Contact Information

The syllabus should include administrative information such as available office times, phone number and e-mail address, and preferred mode(s) of contacts. However, unlike a traditional course, instructors should be very clear about "online office hours," or hours of unavailability. Boettcher and Conrad (1999) suggest an online instructor not be available 24 hours a day to students, but establish a framework for turnaround response. This framework should offer recommendations for how long a student should expect to wait before repeating an e-mail request that has gone unanswered and as Jarmon (1999) suggests, how quickly students should expect a response.

If there is a specific time when the instructor will be online, he or she should include a "fastback" time, or online office hours. A fastback time is a time period when students can expect a quicker than normal e-mail response, usually within the hour or soon after the message is received. Many instructors offer online office hours where they enter the class chatroom and wait for questions. It is often reported by instructors that students under-utilize this time of interaction, choosing to send e-mail as their questions arise, rather than waiting until a prescribed time in the future.

An alternative to using the virtual office hour for questions is to use the chatroom for social conversation. A virtual social experience helps create a closer bond with instructor and classmates, and strengthens the learning community. This is a form of a "cyber sandbox" as described

by Palloff and Pratt (1999). The cyber sandbox is defined as a generic discussion area for students to just hang out and talk about movies, jobs or other interests. The creation of a social outlet not only helps keep regular class discussions on topic, but Palloff and Pratt (1999) found that the social connection promotes group cohesion.

Course Objectives

Well-defined course objectives, derived from the analysis phase, are an important element to be published in any course syllabus. However, clearly stated objectives are even more imperative as students do not have the opportunity to participate in “first day of class syllabus discussions” so common in many traditional courses (Jarmon, 1999). The communication of course objectives is also important because in an online course, much of the responsibility for learning is placed upon the student. Failure to properly inform the student of the objectives leaves them feeling confused and puzzled about assignments, and moreover, where the entire course is headed.

Attendance Requirements

Attendance requirements should be clearly stated, as attendance is necessary for successful online learning communities. Palloff and Pratt (2001) advise, “If clear guidelines are not presented, students can become confused and disorganized and the learning process will suffer” (p. 28). The online learning community requires students to take active roles in helping each other learn (Boettcher & Conrad, 1999). Students who do not participate not only cheat themselves, but also those in the learning community.

If instructors expect good participation, then the requirements must be clearly defined. Ko and Rossen (2004) observed that when students were not graded, their participation was less than adequate. In fact, some students may think that if they take an online course, they can take a vaca-

tion and still catch up with their coursework upon their return or do a few modules ahead of time before they leave. While online courses do allow for flexibility, students must participate regularly with their instructor and classmates. Students may ask if they can post ahead of the other students or take the course on a self-paced schedule. Because of the prevalence of this question, online instructors should have a policy regarding early posting and state it clearly in the syllabus.

Participation in online courses is inherently different from traditional courses. Students do not automatically understand how to participate in online courses. Course participation requirements should be defined in the syllabus and with each assignment. Where possible, assignments should be grouped into familiar categories such as class discussion, Web searches, quizzes, reading assignments, and so forth. Creating a sample discussion, or model, may increase students’ understanding of the participation requirement and how credit is assigned.

Late Work Policy

A policy for late assignment submissions and missed exams should be created. Students who are not actively participating in the learning community are not supporting other students. Because of this interdependence, some instructors have a “no late work accepted policy,” while others assign reduced credit. Another option is to create alternative assignments or exams for past due work. To facilitate course management, these alternative assignments could be offered at the end of the course for those who missed assignments during the normal time period.

Course Schedule

One of the most important elements of an online syllabus is the course schedule. The course schedule defines each learning module with beginning dates and due dates, assigned read-

ing, assessment, and other activities. The course schedule becomes the course map for the student and should be included with the course syllabus and placed redundantly throughout the course. In fact, Ko and Rossen (2004) assert that “in an online environment, redundancy is often better than elegant succinctness” (p.76). If the Website or course management system allows linking from the syllabus, then link each course content module to the schedule making it readily available to the student. Students should be encouraged to print out and carefully follow their course schedules. Similarly, Johnson (2003) suggests that instructors should also “keep a schedule of activities for themselves: when to interact with students, when to respond to questions, when to grade assignments, and when to give feedback on performance” (p. 112).

The instructor should allow for flexibility and revisions of the schedule based on the progress and needs of the class but should avoid adding additional assignments not covered in the course syllabus. Careful consideration of course assignments should be given before the course starts to be sure that students meet the required learning objectives (Table 1).

Orientation Aids

Orientation notes for success in the class should be available for the student (Jarmon, 1999). This may include hints for time management and

good study practice. Frequently asked questions (FAQ) support self-help in answering questions (Jarmon, 1999) as it allows students to look for information before e-mailing the instructor. In fact, McCormack and Jones (1998) suggest an FAQ can significantly reduce questions. One doesn’t need all the questions or answers up front, as over time as questions arise and answers are provided, a comprehensive FAQ will emerge that can be utilized in future semesters.

Grading Scales/Rubrics

Grading scales and rubrics should be defined for each assignment. If the courseware management system allows, each assignment could be linked to the rubric for clarity. When group assignments are utilized, instructors should use a grading rubric for the students to grade each other as well as the entire group. This motivates students to participate and provides for equity in group work grading. It is also helpful if the instructor assigns groups or teams the first time as the class should get to know each other before self-selection is allowed.

Communication Practices

An inbox consistently full of e-mail will be overwhelming to most instructors. Therefore, it is important to include in the syllabus, guidelines for class behavior and posting to the discussion boards, e-mail protocols, and assignment submis-

Table 1. Sample online course schedule

Sample Online Course Schedule				
Session	Date Begins	Content	Assignments	Due Date
1	January 15	Chapter 1 of text	Post Introductions to Class Discussion	January 21
2	January 22	Chapters 2-3 of text	Class Discussion	January 28
3	January 29	Chapter 4 of text	Class Discussion	February 4
			Outside Reading Summary	
			Review for Exam	
4	February 5	Exam I over Chapters 1-4	Exam I open 3 days only Feb 11-13	February 13

sion procedures. Establishing e-mail protocols and communication guidelines will assist the instructor in classroom management. Many instructors require the course session number or identifier in the subject line so that the e-mail related to the course can be filtered to a separate mailbox. If students need immediate attention, the word “Help” should be placed into the subject line so the instructor knows to open that e-mail first, assuring prompt instructor response.

Many instructors create individual e-mail sub-folders for each online student. E-mail that has been answered or graded can be filed away, providing for a record of all course correspondence. Another tip for instructors is to read their mail backwards from newest received to oldest. In many cases, students have solved their problems so that earlier questions become irrelevant. Students may also be asked to use their institutional e-mail address so that instructors are not confused by address changes mid-term or are forced to deal with bounced mail from full inboxes.

Technology Policies

Technology policies should be stated in the syllabus directing students to a helpdesk or resource other than the instructor for technology difficulties. Additionally, instructors should encourage students to create draft postings of assignments in a word processor and save them before posting to the class. This will minimize spelling and grammar mistakes and provide a backup copy for the student in case of technical problems. Students should also be reminded to save all work on a computer hard drive and to a removable device, such as a floppy disk or USB flash drive. Saving work to a USB drive allows the student portability between home, office, and campus systems, and a chance of recovery if systems go down. Finally, students should be instructed to monitor spam filters that may prohibit them from receiving their online course e-mail.

Course Design

The online course design should provide an intuitive navigation path for the student. Students should be able to locate the syllabus, calendar, assignments, and other required activities quickly. Individual content items can be easily identified for the student by adding a consistent icon each time it is used. For example, each time a reading assignment is presented, an icon of a book could be used. Using the same colors and design for similar items will aid the student as well. As a final suggestion, each module of content should have an overview page for organizing the unit of material (Hirumi, 2003).

DEVELOPMENT

Development is a rewarding phase in that the results are concrete and visible. The development stage will include a review of the course objectives, an analysis of the textbook, content module development and content chunking, the creation of content, the development of learning objects, student assessment and additional resources. As a side note, development is also a stage where faculty members may be the most dependent upon outside assistance due to the skilled creation of graphical and multimedia elements commonly found in online courses. In every other stage, even though coaching and mentoring are highly recommended, faculty are usually capable of completing the requirements alone and with skills that are already within their repertoire.

Course Objectives

The online course objectives should be clearly identified within the analysis phase and built into the syllabus in the design phase, and now robustly used to guide the course developer during the development stage. Each lesson unit should be designed with the overall course objectives

in mind and the objectives should be stated at the beginning of each lesson unit informing the student of the content to be covered. The learning outcomes of the lesson unit should also match the course objectives and appropriate degree objectives, where applicable. Methodologies for assessing these objectives can be altered for the online classroom. If any activities such as the use of online group collaboration or asynchronous class discussion will be needed to meet course objectives, they should be identified in this phase.

Textbook

The textbook is an important asset for an online course. The instructor should examine the text from the perspective of online delivery and understand that in most cases, the text will be a primary source for content delivery. The text should be a strong, stand-alone resource for the course and ideally offer ancillary support for the student such as Website links and review quizzes. In many cases, textbooks will provide additional resources for both faculty and students. Textbooks that offer the instructor assistance in the form of a CD-ROM, test bank, lecture outlines, PowerPoint slides, or Website material give added support in creating an online course. Some textbooks published by Prentice Hall, Irwin-McGraw Hill, and others, offer these licensed resources free-of-charge should the instructor adopt the text. Other textbooks offer course cartridges of content that import directly into courseware management systems like Blackboard or WebCT.

Instructors are sometimes reluctant, when transitioning a course from traditional to online, to adopt a new textbook, but if the result is easier course conversion, they usually concur. The course text book should be chosen early enough in the process for the instructor to become familiar with the contents of the textbook, and, of course, should support the core objectives of the course. Changes in the text may require extensive changes in the supporting course content. Additionally, if

the instructor should decide to change textbooks, all of the publishers' licensed or copyrighted material must be removed from the course and replaced with content from the new text or from other sources. It is advisable to clearly document each resource with its original source so that it can be easily found should it need to be removed down the line.

Lesson or Module Unit

When designing the course schedule, the course should be broken into lesson units. These are often one-week periods, but can be shorter or longer, depending upon the course. Ideally, a good lesson unit has many parts such as introduction, session objectives, reading assignments, instructional content, handouts, class discussion, written assignments, quizzes and exams, and a unit summary.

The flow of the course should be intuitive, transitioning from week-to-week, or session-to-session without the student feeling lost or isolated in the process. The total number of sessions in the course has a great impact on the course design. Just adding or eliminating as few as two sessions can lead to total course redesign. If the number of course sessions changes often, consider using smaller content chunks (see "Content Chunking") that can be combined into a single unit. Redundancy of key course information is important.

Each learning module should contain a checklist to facilitate student completion. This should be "print ready" so that students can print and read them offline. Course content that presents an easy-to-find and understandable checklist will save numerous e-mails later from students inquiring about due dates and pleading for deadline extensions.

Content Chunking

Content chunking is more of an instructional design process, rather than a theory. It uses modular design in the delivery of online content. Each

“chunk” of material is broken into small, understandable lessons or vignettes for the students to absorb. An example of chunking would be to break apart a lecture (that would amount to five written pages for example) covering several topics into smaller pieces (perhaps one or two pages each). The entire lecture, if left un-chunked, would be a tedious Webpage to scroll through, and more importantly, too much information to absorb in one session. Instead, the concept of content chunking would break the lecture into perhaps five or six smaller concepts. When a lecture is broken into topics or ideas and put on separate pages, research shows the student is more likely to understand the content. In the online format, students can navigate through the session exercising personal preferences; for example, to skip the lecture and take the quiz first. It is to their best benefit if the content is organized and easy to move through logically.

Quality course content should be a constant concern for the institution. Course content contributes highly to the success of students and the online education program. Course content can be obtained from several methods such as purchasing from peer institutions or for-profit entities. However, most of the pioneering institutions in online education use internal sources for content creation.

Content Creation

Using rich media such as online graphical models and video can be impressive but is time consuming and expensive. Text-based content is easy to create, but cumbersome for the student to read, especially if it cannot be printed. Often, online students will print out the lectures and highlight or mark the text as they read; therefore, text-based lectures should be designed with this in mind.

Some institutions have created a style guide for the development of online courses. A style guide recommends colors, font styles, icon usage, and the placement of certain institutional information

in each of the courses. This consistency throughout the program conveys institutional ownership and endorsement of the courses and the materials in these courses. More importantly, it allows students to find the material they are looking for quickly and without unnecessary inquiries to the course instructor.

Along with the guidelines for a consistent look and feel, the style guide may also suggest the format in which the course material is presented. The institution often recommends an instructional design theory for the creation of course materials and publishes this in the style guide along with examples. When students are presented with a familiar learning unit layout, they are more able to focus on the content and learning objectives, which should increase student learning.

Learning Objects

In regard to online learning objects and interactive learning elements, there are three options: buy, borrow, or build with the latter consuming the most of this section. Should a faculty member elect to buy or borrow an element, module or course, there are many choices now readily available. While they may not be *exactly* what the faculty member had in mind from the analysis and Design stages, textbook publishers and online content brokers offer many choices, although some disciplines may be better represented than others. In the borrow category, learning object repositories such as MERLOT and Wisc-Online provide the course designer with peer-reviewed modules and most are free.

So what exactly are learning objects? According to the IEEE Learning Standards Committee (2001), a learning object is “any entity, digital or non-digital, which can be used, re-used or referenced during technology-supported learning.” Many free resources for learning objects are available online, or learning objects can be developed specifically for each course. The following is a list of repositories:

- Apple Learning Interchange: <http://ali.apple.com/ali/resources.shtml>
- Campus Alberta Repository of Educational Objects: <http://www.careo.ca/>
- The Connexions Project at Rice University: <http://cnx.rice.edu>
- Multimedia Educational Resource for Learning and Online Teaching (MERLOT): <http://www.merlot.org>
- Wisc-Online Learning Object Project: <http://www.wisconline.org>

For many faculty, the choice to build from scratch is the option they elect to exercise frequently. The creation is often team-based, where one or more instructors partner with one or more instructional designers and/or graphical designers. Team-based approaches help alleviate the need for support by spreading the burden across multiple individuals with multiple talents. Team-based courses can also allow for improved course content and more complete materials due to the broader range of expertise and experiences from multiple individuals.

Assessment

The distance element of online education adds a unique twist to assessment of student learning. The online platform and ubiquity of technology among students affords the course developer a host of electronic tools. Online assessment tools are usually provided with a courseware management system as well as commercial vendors such as:

- **Questionmark:** Questionmark Perception (<http://www.questionmark.com>)
- **Respondus:** Respondus (<http://www.respondus.com/>)
- **Software Secure:** Securexam (<http://www.softwaresecure.com/>)

These vendors support high stakes testing with products that do not allow students to print exams

or open additional browser windows; however, there are many ways around these safeguards such as secondary computers, digital cameras, and countless other ways to beat the system.

Obviously, the proctored testing environment provided by having all the students in a single location under the direct supervision of the course instructor is difficult to duplicate online. Some institutions, especially those with local audiences, still require on-campus proctoring of exams or work with institutions within testing consortia to provide such services. While this is an option, it does not really fit within the ideal of a completely online and time-flexible course. Therefore, many course developers have looked for alternative assessments and opportunities to examine student learning with alternatives to traditional testing methodologies. One suggested method is called authentic assessment which is defined as “a form of assessment in which students are asked to perform real-world tasks that demonstrate meaningful application of essential knowledge and skills” (Mueller, 2006). This method works exceptionally well in online environments and should be considered whenever possible. A good resource can be found at jonathan.mueller.faculty.noctrl.edu/toolbox/Index.htm.

Provision of the grading rubrics used for scoring assessments within the course material is also highly recommended. Students should be aware of grading criteria and allowed to self-evaluate wherever possible. One commendable practice is to have student pre-score their work and submit their assessment along with their work at the time of submission. This allows the faculty member to focus discussion on points of disagreement, helping guide students to better critical evaluation and awareness of their own work.

Additional Resources

In the connected world of the Internet, outside resources are easily built-in to the course. Linking to Websites and online resources is obvious. Other

resources, such as library resources, online reserve materials, and institutional support resources such as a writing center and tutoring centers provide students with just-in-time resources and referrals. Even referrals and links to technical support and helpdesk resources may be provided to the students where course developers anticipate certain technical tasks might prove challenging to students.

IMPLEMENTATION

The next phase, implementation, includes opening the course and initiating instruction. An enthusiastic and engaging opening week of class is a great way to start the course. This time period is fragile; disruptions or unnecessary interferences may set a tone that stifles learning for the remainder of the course. It is important to create an initial impression that will stimulate the development of the learning community and nurture the students to maturity. Hirumi (2003) suggests the following goals for students in the first week of the course:

- Have a good understanding of course requirements and expectations,
- Can locate and interpret relevant policies and procedures,
- Are confident in their ability to use various tools and course features, and
- Can identify challenges associated with and discuss strategies for facilitating virtual teamwork” (p. 87).

The course should begin with a welcoming e-mail and announcement, instructions for class-wide introductions, emphasis on the syllabus, a tone of excellence established, and nurturing the learning community.

Welcome E-Mail and Announcement

Moore, Winograd and Lange (2001) offer several tips for the first session of class: send a welcome

e-mail that invites the students to join the class, telephone students who do not appear the first week, and duplicate your welcome e-mail in a class announcement if the course management system allows. The announcement should also encourage students to regularly check their e-mail. The first week should have fewer assignments to allow students to post introductions and get to know each other. Technical issues should be resolved immediately.

Introductions

The instructor should spend time getting to know the students individually during the first week of class and encourage students to do the same. An introductory discussion inviting the participants to share something in particular with the group is a successful strategy for building learning community. The instructor should participate heavily in this discussion (being careful not to dominate) and should respond to one or two comments in each student’s introductory posting. Ko and Rossen (2004) suggest the “initial postings in the discussion forum, your first messages sent to all by e-mail or listserv, or the greeting you post on your course home page will do much to set the tone and expectations for your course. These ‘first words’ can also provide models of online communication for your students” (p. 189). To assist with personal connection, the instructor should print out the introductory discussion and keep it near the computer for reference. When responding to a student’s question, the instructor should occasionally refer to the discussion and reference a personal note to the student such as “How is your son who plays college baseball doing this season?” The discussion following the question, leads the student to feel as though he or she is talking one-on-one with the instructor.

Offering an icebreaker in the first session, such as “share your silliest moment in college” or “name the animal you most identify with,” helps to alleviate nervousness and provides insights to

the fellow students' personalities. Several good icebreakers that also provide an instructor with student information include the VARK learning styles (<http://www.vark-learn.com/english/index.asp>) and the Keirsey temperament sorter (<http://www.keirsey.com>). The Kingdomality profiler (<http://www.kingdomality.com>) provides not only a medieval vocational assessment, but is fun and generates discussion. Each of these Websites offers instant feedback, and the students can post their results and a short paragraph whether they agree or disagree. Many other Websites allow students to discover their commonalities and similarities and can be found with a simple Internet search.

Emphasize the Syllabus

A great tip for the first class session is to create a syllabus quiz or scavenger hunt that “teaches students how to navigate your course” (Schweizer, 1999, p. 11). Next, offering bonus points to assess syllabus comprehension is a successful way of engaging the student in the first class session. Encouraging students to review the syllabus more thoroughly can alleviate confusion later in the course as they familiarize themselves with the course requirements. For example, an art appreciation course requires outside visits to an art museum. This requirement is clearly listed in the syllabus; however, students sometimes want to visit a Web museum instead. This is type of question should be clarified with a syllabus quiz to alleviate any disappointment, confusion, or scheduling conflicts.

Establish a Tone of Excellence

The first several weeks also set the tone for academic participation. Instructors should grade discussions/assignments stringently in the first few assignment cycles. Establish a tone of excellence early and encourage students to do their best. “Students want to receive timely and personal feedback” (Boettcher & Conrad, 1999, p. 97) early

in the course because they may not be able to assess their progress as easily online (Boaz, 1999).

Nurturing the Learning Community.

As the course progresses, the learning community will still require nurturing from the instructor. A learning community becomes self-sufficient when an instructor provides ample communication, facilitates the discussion board, treats each student as an individual, adds emotion and belonging, responds quickly to questions, models required behavior, creates appropriately sized groups, and clearly outlines expectations for group activities.

Provide Ample Communication

Online students are eager for communication as it is “the foundation of successful distance learning courses” (Johnson, 2003, p. 113). In fact, Johnson (2003) also suggests that communication throughout the course “must be ongoing, regular, continuous, and easy” (Johnson, 2003, p. 113). Lack of instructor-student communication early on will create a negative learning community, thus debilitating the learning process. Instructors should use class-wide announcements, group e-mails, and chat archives to facilitate accessible, public communication in the online course. As the course continues, students should be encouraged to facilitate the discussion and assume some of the roles previously controlled by the instructor.

Communication must be both reflective and proactive. Many courses use class-wide journals or summaries to bring closure to modules. Sending out class-wide summation, introduction, and transitional e-mails at the end of each module, wrapping up the previous content, and introducing the next module provides for a sense of transition. Reminding the students of requirements for the current module, such as projects or exam dates, is helpful to the students and it only takes about 10 minutes a week for either of these tasks. Proactive communication yields fewer questions,

saving dozens of hours answering the questions individually. Johnson (2003) recommends that students should be taught to communicate early any questions or confusion they may have due to the lack of body language available in the online environment. Instructors cannot see looks of confusion or frustration.

Instructors should keep their interaction with the class as accessible as possible. Using the “Course Announcement” area frequently for reminders and duplicating important information in e-mails will increase open communication and provide the entire class access to the information. It is also important to communicate to students each time grades are posted. This creates a “don’t call me, I’ll call you” communication pattern for grade information and alleviates individual e-mails from students requesting grades on their assignments. Students will quickly realize the instructor will post a notification when grades are posted, so requests are unnecessary. Within that communication, students should be reminded to contact the instructor if they notice a missing grade. This places the responsibility back with the student for finding and submitting any missing work.

Facilitate the Discussion Board

Bischoff (2000) reminds us that “the key to online education’s effectiveness lies in large part with the facilitator” (p. 58). Likewise, for class discussion to be successful, the instructor should become a facilitator and review discussions without controlling them. Many online instructors have found that too much activity can be as harmful as none at all. This particular role of the facilitator in the online classroom can be difficult for a traditional instructor. A traditional instructor may be accustomed to dominating or controlling the discussion through lecture; however, in an online class, all students have equal opportunity to participate in the discussion and may outside of the instructor’s influence. It takes a good deal of time for some instructors to feel truly comfortable in allowing

the discussion to take place without their intervention; experience will eventually guide them.

For good discussion board facilitation, the instructor should randomly reply to students and provide prompt explanations or further comments regarding the topic of discussion. Johnson (2003) found that “when a professor shows interest in discussions by commenting on students’ ideas and insights, students feel valued and encouraged to participate more” (p. 113). The instructor should provide feedback in the discussion even if it is merely a “cheerleading” comment, redirection, or guideline submission. The instructor should intervene when the discussion seems to be struggling or headed the wrong way (Palloff & Pratt, 2001), but should not over-participate in the discussion, as this will be considered stifling and restrictive. Some instructors prompt absentee or “lurker” students with a gentle reminder e-mail or telephone call. According to Bischoff, (2000), “A phone call may prove more timely and effective” (p. 70) in helping a student engage in the discussion.

Many instructors assign assistant facilitators and summarizers for each discussion session, providing opportunities for different kinds of student involvement. Other instructors use “coaching teams” made up of students or tutors as the first line of support, then invite the students to ask the instructor for clarification or further assistance. Under favorable circumstances, the “discussion will end in acceptance of different opinions, respect for well-supported beliefs, and improved problem-solving skills” (Brewer et al., 2001, p. 109). McIsaac and Craft (2003) remind us that class discussions should take place after the reading assignments; students may also need to be reminded of this before they participate.

Treat Each Student as an Individual

Instructors should value individual contributions and “treat their students as unique” (White, 2000, p. 11). A simple technique is to use the students’ preferred names or nicknames in all correspon-

dence. It is also important to add positive emotion and visual cues. The online environment can be limiting when the communication is mostly text-based. Typing the cues in an e-mail can serve the same purpose as nodding a head in agreement or offering a welcoming smile as would occur in a traditional course.

Add Emotion and Belonging

When online learning is facilitated incorrectly, students can feel isolated and cheated. This could lead to feelings of separation and disappointment that negatively impact learning. White (2000) advises that “a positive emotional climate can serve as a frame of reference for online students activities and will therefore shape individual expectancies, attitudes, feelings, and behaviors throughout a program” (p. 7). Since there are no visual clues in the online classroom, one suggestion for communication is to type out the emotion expressed in parentheses (*smile*) or to include emoticons, such as:-) for happiness or:-0 for surprise or dismay. It is also possible to describe body language in e-mail. Salmon (2002) offers this example: “When I read your message, I jumped for joy” (p. 150). This descriptive effort shows the students the instructor’s personality and positively stimulates the online community. It is also beneficial, as Hiss (2000) suggests, for online instructors to remember to keep their sense of humor.

Respond Quickly

Time delays in a threaded discussion can be frustrating for students. This is especially true if a response was misunderstood and students have attempted to clarify. Instructors should try to post daily or on a regular schedule that has been communicated to the students. Some instructors create homework discussion threads for content support, which provides a forum for students to help each other.

Model Behavior

Instructors who engage students in collaborative groups should facilitate development of social skills. This begins at the onset of the course when the learning community is formed and students recognize the online classroom as a safe place to interact. Group skills should be modeled by the instructor and outlined in the course syllabus. For example, if a two paragraph introduction is expected, the instructor should model that in their own introduction to the class.

Create Appropriately Sized Groups

Most students enjoy the online social interaction and find that it encourages their learning experience. Independently minded students discover that the asynchronous nature of the course enables them to participate more readily than in the face-to-face classroom. In creating groups, Ko and Rossen (2004) recommend that instructors divide students into groups instead of allowing students to pick their own. Students may find it difficult to meet online and form groups quickly. Many instructors search the introductory material to find common elements among students to hasten group cohesion.

Groups should not be too large or too small. The most effective group size appears to be four students per group. Utilizing these suggestions, groupwork should begin early to promote a positive learning experience in the classroom. The actual process for completing the project should be outlined by the instructor, but the final outcome should be the group’s responsibility.

EVALUATION

The final stage of online instruction is for evaluation and assessment. Evaluation is a rewarding experience where one can observe learning occurring in the minds of students and reminds many

instructors why they choose this as their career. Evaluation is a time of reflection and satisfaction for a job well done. At this stage, instructors should assess each student's performance against course objectives, including what worked well and what should be improved. This is often accomplished by evaluating the course with a "best practices" online course rubric, keeping a journal and by soliciting feedback on instruction and course content.

Online Course Rubrics

With faculty teaching online for over a decade, online course rubrics have been developed to help evaluate quality in online courses. These rubrics examine best practices for design, requirements for interaction, and attempt to measure the overall quality of the course. Currently, there are several excellent rubrics but we can thoroughly recommend the following: California State University Chico's Rubric for Online Instruction (www.csuchico.edu/celt/roi/index.html), Blackboard's Exemplary Course Rubric (www.connections.blackboard.com/), and Quality Matters (www.qualitymatters.org).

Keep a Journal

Self-examination with contemplative thought is a successful approach for course improvement. A recommended practice is to keep a journal that records items that should be redesigned or altered the next time the course is taught. The instructor should make notes of assignments that worked well and those that were difficult, and critically evaluate the effectiveness of content and instruction.

Solicit Student Feedback on Instruction

Student feedback improves instruction. A good place to gather the feedback is inside the course management system. It is helpful to survey for student feedback during the course, not just at the

end with course evaluations. The instructor can develop a discussion thread for students to post feedback about the course anonymously, including possible suggestions for improvement. If a student does offer feedback, the instructor should acknowledge the feedback and be appreciative for the remarks.

Feedback instruments should provide the students with a way to communicate what they like the best or least about the course instruction. Schwartz and White (2000) suggest a mid-course feedback process by enlisting a student volunteer to send an e-mail message to the class soliciting feedback. They also suggest the following questions be used, encouraging honesty and participation:

- List three areas that are working well in this course
- List three ways to improve the class. (p. 175)

The student volunteer would gather the messages, remove names, and send them to the instructor. If possible, course changes in response to students' comments will allow students to feel empowered through taking an active role in their education. The feedback should also be used to change subsequent courses taught.

Solicit Student Feedback on Course Content

All online instructors should look for possible course revisions. Course content should never remain static. Moore et al. (2001) propose that "because online course design and teaching are so new, evaluating the effectiveness of your course and then refining it based on the results of that evaluation become imperative" (p. 12.3). If using end-of-course summary feedback, the instructor must receive this feedback in time to reevaluate the course for the next semester and modify, if necessary. Another possibility is an end-of-session discussion regarding the focus of the next session,

thus allowing for minor course revisions even as the course continues to be taught.

CONCLUSION

Online teaching has brought a new modality to education. It has also brought frustration and anxiety to instructors attempting this new method of instructing students. Moore et al. (2001) shared that “one faculty member who had only just finished her course online said it was like diving into a great chasm, blindfolded” (p. 11.3). Instructors who are comfortable with the traditional methods for teaching in the classroom may still struggle to engage students over the Internet. While many of the same techniques apply, teaching online requires additional techniques for success. The ADDIE instructional model provides a basic path for developing and teaching an online course: analyze the course objectives and audience; design and develop the materials and activities; implement the course materials and encourage learning, and finally, evaluate the effectiveness. In the online classroom, the environment is prepared with a carefully designed syllabus and policies and the learning community is nurtured to grow and become self-sufficient. By utilizing these strategies for teaching online effectively, an instructor will engage the online learner, nurture a successful learning community, and alleviate the frustration and fear that goes along with teaching online.

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Chapter 3.6

E-Learning with Wikis, Weblogs and Discussion Forums: An Empirical Survey about the Past, the Presence and the Future

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ABSTRACT

This chapter explores how social software tools can offer support for innovative learning methods and instructional design in general and those related to self-organized learning in an academic context in particular. In the first section the theoretical basis for the integration of wikis, discussion forums and weblogs in the context of learning are discussed. The second part presents the results of an empirical survey conducted by the authors and explores the usage of typical social software tools which support learning from a student's perspective. The chapter concludes that social software tools have the potential to be a fitting technology in a teaching and learning environment.

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INTRODUCTION

One major task of higher education is to train students for the requirements of their future work in order to apply and adapt their knowledge to specific workplace-related requirements and settings. Due to the ongoing pressure on enterprises to cut costs, the periods of vocational adjustment in a company will become shorter and shorter.

On the one hand the rising pressure of innovation and the fast-paced development in the economy results in increased demand for continuous employee training. On the other, growing global competition forces enterprises to use available resources very economically, so that employee training is considered to be necessary and desired even though it is conducted under considerable time and cost pressure (Köllinger, 2002).

According to these goals, the settings of the education must be changed adequately. "While most of higher education still ascribes to traditional models of instruction and learning, the workplace is characterized by rapid changes and emergent demands that require individuals to learn and adapt in situ and on the job without the guidance of educational authorities" (Sharma & Fiedler, 2004, p. 543).

In the field of higher education, it has become an important goal to develop "digital literacy" and educate learners as competent users and participants in a knowledge based society (Kerres, 2007), but it can be assumed that there is a new generation of students, the "digital natives", who are accustomed to the digital and internet technology (Prenksy, 2001).

Oblinger and Oblinger (2005) characterise next generation students (called "n-gen", for Net-Generation) as digitally literate, highly internet savvy, connected via networked media, used to immediate responses, preferring experiential learning, highly social, preferring to work in teams, craving interactivity in image rich environments and having a preference for structure rather than ambiguity.

According to a study conducted by Lenhart and Madden (2005), half of all teens in the USA may be considered as "content creators" by using applications that provide easy-to-use templates to create personal web spaces.

Classical face-to-face learning is seen as rigid and synchronous and it promotes one-way (teacher-to-student) communication. Thus it is not surprising that more and more students are opting for web-based education, as a more flexible and asynchronous mode (Aggarwal & Legon, 2006).

The higher education system should provide answers to this new generation of students who enter the system with different background and skills. They are highly influenced by social networking experiences and able to create and publish on the internet (Resnick, 2002).

Educators and teachers therefore have to consider the implications of these developments for the future design of their courses and lectures.

In 2002 a new term, "Social Software", entered the stage to refer to a new generation of internet applications. One focus of this new generation is the collaboration of people in sharing information in new ways such as social networking sites, wikis, communication tools and folksonomies (Richter & Koch, 2007).

Wikis, weblogs and discussion forums will play a central role in the new context so the areas of application and possibilities will enlarge enormously. It can be assumed that this will also have considerable influence on learning and the usage of these instruments as learning tools.

The paper presents the results of an empirical survey in order to highlight the benefits of the above mentioned web-based social software tools from the student's point of view. 268 first-semester students, all in the first term of their studies) at Austrian Universities from different study programs took part in this survey. The students were asked to use one or more of these tools as a learning tool. The participation in this survey was voluntary.

The presentation of the results of this survey is divided into three parts: first the usage of the tools by the students (before they started with their studies), secondly the experiences the students had made with the tools during the study and, thirdly, the potential future usage.

The paper concludes with a discussion of the results of this survey in contrast with other empirical studies already published. Also the limitations of this survey and ideas for further research are pointed out.

THEORETICAL FRAMEWORK

This part refers to the necessary theoretical background required for the following empirical

study. Especially the areas of “Social Software” and “Learning” are addressed.

Social Software

The term „social software” emerged and came into use in 2002 and is generally attributed to Clay Shirky. Shirky, a writer and teacher on the social implications of internet technology, defines social software simply as “software that supports group interaction” (Shirky, 2003).

Another definition of social software can be found in Coates (Coates, 2005) who refers to social software as “Software that supports, extends, or derives added value from human social behaviour”.

Users are no longer mere readers, audiences or consumers. They have the ability to become active producers of content. Users can act in user and producer positions and they can rapidly change the position.

Nowadays the term “Social Software” is closely related to the “Web 2.0”. The term “Web 2.0” was introduced by Tim O’Reilly, who suggested the following definition: “Web 2.0 is the network as platform, spanning all connected devices; Web 2.0 applications are those that make the most of the intrinsic advantages of that platform: delivering software as a continually updated service that gets better the more people use it, consuming and remixing data from multiple sources, including individual users, while providing their own data and services in a form that allows remixing by others, creating network effects through an ‘architecture of participation,’ and going beyond the page metaphor of Web 1.0 to deliver rich user experiences” (O’Reilly, 2005).

Web 2.0 technologies such as blogs, wikis, podcasts, and RSS feeds or discussion forums have been dubbed “Social Software” because they are perceived as being especially connected and allowing users to develop Web content collaboratively and publicly (Alexander, 2006).

Until now the internet (Web 1.0) has one big disadvantage: it is easy to get information in it, but it is quite complicated and inconvenient to act as an author and take part in the development of contents. Web 2.0 should enable all internet users to actively take part in the further development of the internet. Everyone should be able to contribute easily. The focus of Web 2.0 is on the behaviour of the user. It should empower people to communicate and collaborate and contribute and participate.

This growing phenomenon is very interesting and ought to be examined carefully, in order to understand how the web is evolving and how this continuously regenerative cycle of performance and technological innovation empowers “learning by sharing” (Thijssen & Vernooij, 2002).

Based on the key principle of “architecture of participation”, social software can be seen as part of the Web 2.0. Wikis, weblogs and discussion forums are tools that are seen as social software applications and were selected for further research and the empirical study presented below.

Related Empirical Research

Institutions in the field of higher education have made efforts to introduce various IT-supported learning tools in the daily routine of students and lecturers (Evans & Sadler-Smith 2006; Aggarwal & Legon, 2006; McGill, Nicol, Littlejohn, Grier-son, Juster & Ion, 2005; Dooley & Wickersham, 2007; Duffy & Bruns, 2006).

Published results of the usage of weblogs in the prolearn-project (www.prolearn-project.org) have shown that a large majority of respondents considers personalization and adaptation of the learning environment as important and crucial factors. Learning should be individualized to become more effective and efficient. Personalization is a key element of the learning process, and specific problems need specific solutions, as students differ greatly in their backgrounds and capabilities.

Learning materials are typically too general in order to cover a very wide range of purposes and personal learning needs. Compared to classical learning personalization can be the most important added value that e-learning can offer. With it, education can be optimised and adjusted to various working conditions and needs, because students have different goals, interests, motivation levels, learning skills and endurance (Klamma, Chatti, Duval, Fiedler, Hummel & Hvannberg et al., 2006).

Chao (2007) explored the potential uses of wikis in the field of software engineering (38 participants), especially for software project team collaboration and communication. Overall, twenty-five students agreed and one student disagreed (two neutral) that wiki is a good tool for project collaboration. Concerning the applications of wikis, more than twenty-three students found that a wiki is a good tool for maintaining a group diary, managing user stories (project requirements), and project tracking and reporting. While a majority of students found that a wiki is a good tool for updating a project plan, managing acceptance tests, defect tracking, and developing user document, there was also a significant number of students who disagreed (Chao, 2007).

First results using wikis for collaborative writing (about 40 participants) also reported similar results. In this study students used wikis to write articles partly together with the lecturer.

After early problems with software usage software and writing contributions in the wiki, students were able to write articles by themselves or in teams. The motivation among students was on different levels, so the lecturer had to increase it during lessons. Other students, however, were highly motivated and were creating the contents and added them to the wikis (Bendel, 2007).

Constructivism and Learning - Presentation of the Learning Model

From a constructivist point of view learning focuses on the learning process by looking at the

construction of knowledge by an individual. As a consequence there is a recommendation to align (Holmes, Tangney, FitzGibbon, Savage & Mehan, 2001; Du S. & Wagner, 2005; Jonassen, Mayes T. & McAleese R., 1993) learning environments, especially in the academic context, with associate complex learning objectives to constructivist learning principles. Learning is not seen as a transmission of content and knowledge to a passive learner. Constructivism views learning as an active and constructive process which is based on the current understanding of the learner. Learning is embedded in a social context and a certain situation (Schulmeister, 2005).

The constructivist approach shifts learning from instruction-design-centered to a learner-centered learning and teaching mode. The role of the educator changes from directing the learner towards supporting and coaching him/her.

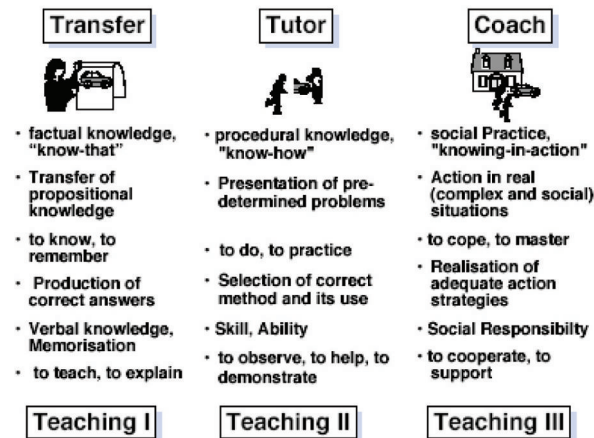
Baumgartner et al. (2004) have suggested three different prototypical modes of learning and teaching. These three different modes of learning and teaching are neutral to specific so they can be applied across all subject domains. Therefore, each teaching model can be used to teach e.g. sociology subjects as well as for teaching e.g. technical sciences. Learning can be portrayed as an iterative process that can subsequently be subdivided into different phases which are summarized in Figure 1:

In particular, these three different prototypical modes for learning encompass the following:

Learning/Teaching I: Transferring Knowledge

At the starting point the learner needs to be provided with abstract knowledge to lay the theoretical foundations and to understand relevant signposts, road markings and orientation points. This kind of factual knowledge is static and has little value by itself in real and complex situations. It merely serves as a shortcut to prevent pitfalls and to help to organize his/her learning experiences.

Figure 1. Prototypical modes of learning and teaching (Baumgartner, 2004)



The knowledge of the student is based on knowledge possessed by the teacher. Students have to learn what teachers ask them to learn. The teacher has the responsibility to make the knowledge transfer as easy as possible.

Learning/Teaching II: Acquiring, Compiling, Gathering Knowledge

In this section of the individual learning career, the student actually applies the abstract knowledge and gathers own experiences. In order to limit the action and reflection possibilities, the learner interacts within a somewhat restricted, artificial environment, which is reduced in complexity and easy to control by the teacher. To provide feedback, the learning environment is designed to include relevant devices where students can deposit their interim products and teachers can inspect it.

The emphasis in this model lies on the learning process of the student. Teachers try to help the students overcome wrong assumptions, wrong learning attitudes and assist in the reflection process of the subject domain.

Teaching III: Developing, Inventing, Constructing Knowledge

Teacher and learner work together to master problems. This model includes problem generation and/or invention. The environment is constructed in such a way that it represents, at least in certain aspects, reality or reality in a constrained form. This model includes two-way communication on equal terms, using either linguistic representations or other adequate kinds of language.

Teaching III has strong links to constructivism. From a constructivist point of view learning is considered as an active process in which people construct their knowledge by relating it to their previous experiences in complex and real situations in life. In their practical lives people are confronted with unique, unpredictable situations whose inherent problems are not readily observable (Baumgartner, 2004).

Constructivism does not represent a distinct theoretical position in the field of education. There exist some different approaches, thus constructivism can be understood as a continuum. For learning the two streams "communal constructivism" and "social constructivism" are essential (Pountney, Parr & Whittaker, 2002).

The social constructivism regards learning as a social process. Reality cannot be discovered, it does not exist prior to its social invention. Thus knowledge is also a human product, and is socially and culturally constructed. This means that knowledge is socially co-constructed, which is a negotiation process by the individuals with other individuals and with their environment. Social constructivists accept the existence of an “inter subjectivity” as a shared understanding about a knowledge object among individuals. Social constructivism stresses the importance of feedback and reinforcement.

On the basis of the upcoming technologies for learning and education Holmes et al. (2001) have suggested a new educational theory that goes beyond the existing social constructivism. According to their theory learners are not only constructing their own knowledge but they also produce knowledge for other students and learners. They consider that peer tutoring and project-based learning are obvious techniques. Furthermore they advocate the ideas of cognitive apprenticeship, the publishing of information, flexibility in the time table, a radical look at the way in which assessment is done.

Siemens (2005; 2006) coined the term “connectivism” due to the fact that by using the web learning and knowledge management have changed dramatically. He understands learning as creating networks. In order to deal with the increasing plethora of information he suggests the outsourcing of explicit knowledge to the network of the respective community. Having knowledge is not in the center, but rather knowing who can provide the necessary information to generate the knowledge needed

Students should be enabled to invent new things, produce or generate new knowledge. Consequently, learning and teaching at universities in most cases can be assigned to the requirements presented in Learning/Teaching II and III with respect to theories concerning the digital learning

support. In order to achieve this goal, a special learning environment must be provided.

Consequences for IT-Supported Learning and Teaching

Computer software can be used for all three models ranging from programmed instruction (Learning/Teaching I) to problem solving software (Learning/Teaching II) to complex simulations and/or so-called micro worlds (Learning/Teaching III). It is said that the inherent nature of the internet brings the real world into the classrooms and with its hyperlink structure it clearly advocates the model Teaching III (Hsu, 2008; Baumgartner, 2004).

The use of the internet, and especially through its social software, gains in importance because it can contribute to exceed the limits of classical teaching models. By adapting learning and teaching models to the new technical possibilities, the roles of learner and teacher are becoming more indistinct, because the learner can take a central part in the design and arrangement of the learning process (Kerres, 2006).

Systems that support learners with respect to the learning model III are called Personal Learning Environments (PLEs). PLEs are mostly web-based applications and are based on learning management systems (Seufert, 2007).

PLEs are personal and open learning environments and they are suitable for cross-linking contents and people. Learners can use PLEs to manage individual learning progress. They are ideally available for life-long-learning and are supported by the following processes:

Reflexive writing: Besides easy reading access to contributions it is the simple and efficient and rather robust encoding standard usually used in social software that allows the explicit modeling of content flows, feedback loops, and monitoring procedures of various kinds. Thus supporting these systems support an ongoing reiterative process of explication and reflection (Fiedler,

2003). PLEs should support the development of the ability to learn (“learning to learn”): Through the publication of one’s thoughts and reflections, content is made available for assessment as well as for further development, thereby improving self-observation and self-reflection skills. The way the learner can learn and acquire will be improved (Baumgartner, 2005).

As already discussed new learning theories for digital learning support have been developed, for example “social and communal constructivism” that considers learning as a social process or “connectivism” that understands learning as creating networks.

Communication and discussion: The integration supports the exchange of ideas as well as finding like-minded people. Furthermore, social software tools simplify the process of establishing connections between people of the same interests. They also simplify the construction of connections between people with similar interests. Simultaneously its open and expandable philosophy supports going beyond the thinking in groups (of a common interest) by supporting diversity and bringing together different perspectives and backgrounds (Efimova & Fiedler, 2004; Schulmeister, 2004). This supports learning from different perspectives.

Community building: PLE-tools have to provide a personal learning area for their authors. However, this does not force a general learning flow or learning style. Nevertheless, learners are not alone and can profit from the feedback of a community in order to examine and enhance the development of own ideas (Efimova & Fiedler, 2004; Fiedler, 2003; Böttger & Roll, 2004). Achieving synergies of self-organized and joint learning should be enabled by those tools. Through reading in other learning environments, especially beginners are enabled to learn from experts. At the same time they can actively participate in discussions beyond geographic or thematic borders (Efimova & Fiedler, 2004; Fiedler, 2003).

Life-long-learning: Life-long learning is a key issue for knowledge society for today and tomorrow. In order to cope with the fast change of knowledge future knowledge workers have to thus be prepared to react fast and manage their further education and training at the workplace. In addition, they have to take responsibility for their own employability (Klamma, Chatti, Duval, Hummel, Hvannberg & Kravcik et al., 2007). Life-long learning is seen as multi episodic, with individuals spending occasional periods of formal education and training throughout their working life (Attwell, 2007b). Life-long learners need tools that can be used for all learning activities no matter what subject they learn or which educational institution they attend.

Quality of contents: The quality of contents is a key factor that determines the sustainable usage of a knowledge management system. (Maier, 2004, p. 247)

Pleasure: Besides the activities that should be supported by social software tools the usage of the tools must give pleasure to the users. If knowledge management should be fostered, playful behavior needs to be supported rather than strict norms (Schneider, 2004; Landry, 2000).

Unlike a Learning Management System (LMS) that is usually related to one special institution or to one special course, a PLE is focused on the individual learner. A PLE should combine a broad mixture of different resources and sub-systems in a “personally-managed space” (Attwell, 2006).

In the previous decade, Learning Management Systems were developed that moved toward enterprise-level applications. “But the wealth of new, user-friendly, tools in the Web 2.0 environment suggests that the all-in-one monolithic e-learning systems may be entering a phase of obsolescence by the ongoing development of the web” (Craig, 2007).

Social software applications have the potential to cope with these requirements (Brahm, 2007).

DESCRIPTION AND CLASSIFICATION OF SOCIAL SOFTWARE TOOLS

In the following section three social software tools, weblogs, discussion-forums and wikis, are described more in detail and the tools are compared. Students were able to select these tools during the empirical study.

Weblog

A weblog, a compound of “web” and “logbook”, usually just called “blog”, is a website that contains new articles or contributions in a primarily chronological order, listing the latest entry on top.

Primarily, a weblog is a discussion-oriented instrument especially emphasizing two functions, RSS-feed and trackback. RSS-feeds, also called RSS-files can be read and processed for further use by other programs. The most common programs are RSS-readers or RSS-Aggregators that check RSS-enabled websites on behalf of the user to read or display any updated contribution that can be found. The user can subscribe to several RSS-feeds. Thus, information of different websites can be retrieved and combined. Preferably, news or other weblogs are subscribed to.

Trackback is a service function that notifies an entry in a weblog if a reference to this contribution has been made in another weblog. By this mechanism a blogger (person who writes contributions in a weblog) is immediately informed of any reactions to his contribution on other weblogs (Hammond, Hannay & Lund, 2004).

Weblogs are often interrelated with other weblogs, the blogosphere, and discussion forums are rather concentrated on one specific topic. The interrelations between discussion forums are not as intensive as in the blogosphere.

Discussion Forum

A discussion forum or web forum is a service function providing discussion possibilities on the internet. Usually, web forums are designed for the discussion of special topics. The forum is furthermore subdivided into sub-forums or sub-topics. Contributions to the discussion can be made and other people may read and/or respond to them. Several contributions to a single topic are called a thread.

The application areas of the two instruments weblogs and forums are quite similar. The most essential differences between weblogs and discussion forums can be described as follows:

- A forum is usually located on one platform while many bloggers develop their own, individual environment. They connect their weblogs via RSS-feed and trackback functions.
- Through the integration of RSS-files and trackback functions a discussion process can be initiated and continued crossing the boundaries of the bloggers' own weblogs without having to observe other weblogs.
- Weblogs tend to be more people-centered whereas forums are more topic-focused. Through the use of weblogs, learner-specific learning environments can be constructed without interfering with the learning environments of others (Baumgartner, 2004).

Wiki

A WikiWikiWeb, shortly called Wiki, is a hypertext system for storing and processing information. Every single site of this collection of linked web pages can be viewed through a web browser. Furthermore, every site can also be edited by any person. The separation between authors and readers who write their own text, change and delete

them is obsolete as also third parties can carry out these functions (Augar, Raitman & Zhou, 2004).

The most essential differences between weblogs, wikis and discussion forums can be described as follows (Wagner & Bolloju, 2005, p. 5):

Learning Activities Supported by Social Software

The integration of different Social Software Tools offers support in the following learning activities:

- Learning from different perspectives: The integration supports the exchange of ideas

as well as finding like-minded people. Furthermore, social software tools simplify the process of establishing connections between people of the same interests. They also simplify the construction of connections between people with similar interests. Simultaneously its open and expandable philosophy supports going beyond the thinking in groups (of a common interest) by supporting diversity and bringing together different perspectives and backgrounds (Efimova & Fiedler, 2004; Schulmeister, 2004).

Figure 2. Comparison of weblogs, wikis and discussion forums

	BLOG	WIKI	DISCUSSION FORUM
Speed of publication	Single-click publication possible with many implementations. Results reflected instantaneously on the server ("web speed")		
Ease of publication	Single-click publication possible with many implementations, indexing and formatting large handled by software. Users may have access to a simplified mark-up language		
Elementary information unit	Comment-on-topic-at-time	Comment-on-topic	Comment-by-participant-on-topic-at-time
Knowledge representation and organization	Chronological organization less useful than topical organization. Workaround through indices and access to archives.	Topical organization as well as bi-directional indexing, as well as chronology of changes.	Chronological organization less useful than topical organization, workaround "sticky" messages.
Content indexing	Time-indexed (topic-based exist too)	Topic-based	Time-indexed (topic-based exist too)
Team support	Meant for individual publishing; most tools offer team support as well.	Inherently open to public for contributions editing; most tools facilitate restricting wikis to a closed group of users.	Provided in the form of open or closed set of members; some of the members may be designated as moderators.
Mode of conversation	Broadcasting; one-to-many communication tool	Dialog; many-to-many communication tool	Dialog; many-to-many communication tool
Version management	Not provided; although blog posts may be edited by the contributor(s)	Versions and history of changes are provided; facilities are available for rollback	Not provided; messages posted are not expected to be modified (exceptions)
Community of practice fit	Innovation	Best practice	Help
Security	Security measures such as access rights, administrative permissions are normally provided.		

- Synergies of self-organized and joint learning: Social Software tools provide a personal learning area for their authors. However, this does not force a general learning flow or learning style. Nevertheless, learners are not alone and can profit from the feedback of a community in order to examine and enhance the development of own ideas (Efimova & Fiedler, 2004; Fiedler, 2004; Böttger & Röll, 2004).
- Digital apprenticeship: Through reading other wikis, forums or weblogs regularly, beginners are enabled to learn from experts. At the same time they can actively participate in discussions beyond geographic or thematic borders (Efimova & Fiedler, 2004; Fiedler, 2004).
- Weblogs and comparable tools support the development of the ability to learn (“learning to learn”): Through the publication of ones own thoughts and reflections, content is made available for assessment as well as for further development, thereby improving self-observation and self-reflection skills. The knowledge change of the learner will be improved (Baumgartner, 2005).
- Social Software supports reflexive writing: The simple, but efficient and rather robust encoding standard usually used in Social Software allows for the explicit model-

ling of content flows, feedback loops, and monitoring procedures of various kinds, thus supporting an ongoing reiterative process of explication and reflection (Fiedler, 2004).

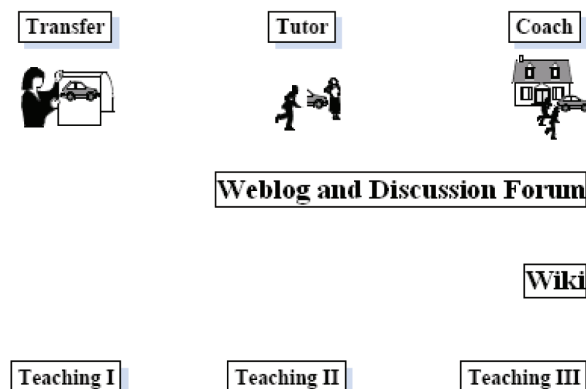
Integration of Social Software Tools and the Learning/Teaching Modes

Baumgartner (2004) has integrated different types of Content Management Systems in relation to the most suitable learning/teaching mode. He clearly states that the boundaries are overlapping and that every tool – in one way or the other – could be used for every teaching model. The following Figure 3 presents the integration of the Social Software tools and the learning/teaching modes:

Weblogs and forums can be defined as “discussion-oriented” tools because the discourse and exchange of ideas related to a certain topic is the pre-eminent aim. Weblogs offer the possibility to support all three phases of the learning process. However, the main focus can be assigned to the modes “Teaching II” and “Teaching III”.

Based on the multitude of interaction possibilities, wikis can be attached to “Teaching III” (Baumgartner, 2004). Additional functions were added to weblog-tools that go beyond the scope of the central use of weblogs, e.g. longer articles can also be stored. Through the creation

Figure 3. Prototypical Modes and Social Software Tool



of directories, a structured collection of links can be implemented.

Through the additional linking of weblogs, wikis and forums, there is the possibility to develop a personal knowledge collection (Kantel, 2003).

EMPIRICAL SURVEY

The purpose of this survey was to determine if the integration of web-based social software tools (wikis, discussion forums and weblogs) are suitable to foster learning from the student's point of view.

Aim of the Survey and Methodology

Scrutinizing the possibilities and constraints of social software tools (wikis, discussion forums and weblogs) as a personal learning environment, students at Austrian universities were asked to use one or more of the offered tools for their research, home work and documentation purposes. In most cases collaboration of students was required to perform the assigned tasks.

The students were asked to use the tools for one course only during Winter Term 2006. Furthermore, there was no obligation for the students to use a tool at all, they were just encouraged to do so. Students were also offered the possibility using two or three tools - their selection was up to the students.

The courses were organized as blended-learning courses, so they included on-campus lessons and off-campus work in which the students could work face-to-face or using the social software tools.

More than 90% of the students attending the courses took part in this survey. In order to give the participants an impression of the functionality and usage of the tools short presentations of the tools were made by an instructor before the students made their choice.

At the end of the testing phase - after four weeks of using the tools - selected student reported their experiences with the tools used. Thereby students who had decided not to use the tools in the first place got an impression about the usage, advantages and disadvantages of the tools by their fellow students. Following these short presentations a questionnaire was completed that provided the basic findings for further inspections and research.

A total of 268 first-semester students of different Austrian universities in five selected courses took part in this survey. The majority of the participants were between 18 and 20 years old. The portion of female students was about 17%.

According to a survey conducted by Seybert (2007) concerning gender differences in computer and internet usages for young people (aged between 16 and 24), there is no gap between men and women in Austria. The proportion of women and men (in the relevant age class) that used a computer (almost) once a day is with 72% the same. A study by Otto et. al. (Otto, Kutscher, Klein & Iske, 2005) indicates that there is a positive correlation between a formal educational background and the usage of the internet in Germany.

"Beside socio-cultural resources like family background, peer structures and social support in general, the formal educational background turns out to be the main factor for explaining differences in internet usage" (Kutscher, Klein & Iske, 2005, p. 219).

As a consequence for the analysis of the results of this survey, no distinction between male and female students was made.

Table 1 presents the distribution of the participants concerning the degree program the students are attending:

For the further analysis of the results no distinction according to the degree programs will be made.

This questionnaire asked each participant questions about her or his subjective impression of the application of the tools. It included five-

Table 1. Distribution of students regarding the degree program

	Distribution
Management & Law	17%
Management & IT	31%
Management & Industrial Engineering	22%
Mechanical Engineering, Electronics	30%

point Likert scales for rating constructs such as eligibility, perceived quality or enjoyment.

The study was conducted to find answers about the

- usage of social software before the study started
- selection of the offered tools
- perceived quality of the contributions and the support for learning
- applicability of the instruments to support communication and community-building
- the correlation of the usage for private and educational purposes of the tools
- fun factor using the instruments
- potential future usage

The results of the study are presented in three parts:

- Part 1: Analysis of the usage of wikis, discussion forums and weblogs of the students before the study was started
- Part 2: Experiences made with the tools during the study
- Part 3: Potential future usage of the tools

Part 1: Tool-Selection and Pre-Study Usage

Due to the fact that the students could select the tools on their own, Table 2 shows the results of this selection process.

Table 2. Tools selected by the students

	Per Cent	Number
Only one tool selected		
Wikis only	23,1%	62
Discussion forums only	22,4%	60
Weblogs only	0,4%	1
More than one tool selected		
Wikis and discussion forums	42,9%	115
Wikis and weblogs	1,9%	5
Discussion forums and weblogs	0,7%	2
Wikis, discussion forums and weblogs	6,7%	18
No tool selected		
No tool selected	1,9%	5

According to the above table the combination of wikis and discussion forums is the most selected combination of tools (42,9%), followed by wikis only (23,1%) and discussion forums only (22,4%). In the end only five students (1,9%) did not take part in the study; they did not select a tool, although they first had had the intention to do so. Only one student used weblogs only. Generally, weblogs were not used very intensively by the participants.

Table 3 shows the usage of the tools by the participants before they took part in the study. It indicates that wikis (76%) and discussion forums (78%) are currently the most widely used tools. Weblogs are only used by 11% of the asked students.

The results clearly show that the weblog hype had not yet reached the surveyed students. Due to the fact that only about 11% of the students are currently using weblogs, the results for this instrument are not published for the first part of the

Table 3. Students already using the tools

	Wiki	Forum	Weblog
Yes	76%	78%	11%
No	24%	22%	89%

analysis. When it comes to the potential future usage of the instruments, weblogs are taken into consideration again.

The following section presents the results for questions analyzing the usage in more detail.

Tables 4 and 5 present the current usage of the tools for private and educational purposes. The question: “I often use (wikis, forums) for private purposes” was asked.

Table 5 shows the results for the corresponding question “I often use (wikis, forums) for educational purposes” are presented.

A huge majority (90%) stated that they use wikis for educational purposes and about two thirds (68%) used wikis for private purposes. Wikis are therefore more intensively used for educational purposes than for private purposes, whereas the usage of forums is exactly the opposite, they are more used for private purposes than for education.

The answers of the students concerning this question were that wikis are foremost considered as a source of serious information, whereas forums are ideal for getting hints or clues to problems related to their privacy. Questions about computer

problems, computer games, leisure activities, etc. were mentioned. A repetition of this image can be identified when the disagreement with the question is analyzed. 29% of the students do not or rarely use forums for private purposes, compared to 36% in their education.

Part 2: Experiences Made During the Study

This section presents the results of the study concerning experiences with the usage of the tools during the study.

Quality and Support for Learning

The next section refers to questions concerning the quality of contributions of wikis and discussion forums and their support for learning.

The results of the question “The quality of contributions in (wikis, forums) is in general good” regarding the quality of contribution are presented in Table 6. The contributions of wikis are evaluated to be much better than those of forums.

The surveyed pupils had the possibility to give reasons for their assessment concerning the quality of contributions via additional qualitative answers. The following summarizes the addressed reasons:

One reason for this excellent grade for the quality of wikis is the “Wikipedian Community”. The term “wiki” is often seen as synonym for the free online encyclopaedia Wikipedia (www.wikipedia.org). Wikipedia is widely used for a great variety

Table 4. Usage for Private Purposes

	Wiki	Forum
I totally agree	33%	33%
I generally agree	35%	29%
neither ... nor (neutral)	9%	9%
I slightly disagree	16%	17%
I disagree	8%	12%

Table 5. Usage for Educational Purposes

	Wiki	Forum
I totally agree	57%	22%
I generally agree	33%	29%
neither ... nor (neutral)	3%	12%
I slightly disagree	8%	24%
I disagree	1%	12%

Table 6. Perceived Quality of Contributions

	Wiki	Forum
I totally agree	38%	10%
I generally agree	52%	31%
neither ... nor (neutral)	10%	41%
I slightly disagree	2%	15%
I disagree	0%	4%

of tasks, so for research on all topics needed for educational and private purposes.

In contrast to the good evaluation of contributions of wikis, the open architecture of wikis was also mentioned. In most cases this open architecture allows everyone to edit entries which results in the uncertainty of whether the knowledge presented is correct or not. The quality of contributions in discussion forums was rated rather mediocre. Forums are primarily used for technical problems, especially computer related problems, and to get in contact with an expert of a certain topic and to get information on online-games.

The next question “The usage of (wikis, forums) leads to misunderstandings and confusion” is about the clarity of the contributions (Table 7).

Only a minority think that the contributions are not clear and may lead to misunderstandings. In this case wikis are also rated better than forums.

The next questions addressed the support of these instruments for learning. Table 8 summarizes the results for the question “When reading contributions in (wikis, forums) it is easier for me to acquire the learning contents”:

More than half of the students express that reading contributions in wikis is helpful for learning, whereas only about 8% think that it is not helpful. Compared to forums, wikis were again much better evaluated especially considering the big difference with the negative evaluations of forums.

Table 9 presents the learning support achieved by writing contributions (“When writing contributions in (wikis, forums) it is easier for me to acquire the learning contents”):

A different picture emerges in the statistics when comparing the evaluation of how writing an article or post supports the learning process. Here forums take the lead when it comes to positive assessment. In both cases there were a large number stating that writing is neither positive nor negative. The majority of the students rather read than wrote, whereas more students wrote in forums than in wikis.

Table 7. Clarity of Contributions

	Wiki	Forum
I totally agree	2%	4%
I generally agree	6%	18%
neither ... nor (neutral)	29%	37%
I slightly disagree	34%	27%
I disagree	29%	14%

Table 8. Reading Contributions helps to acquire Contents

	Wiki	Forum
I totally agree	23%	8%
I generally agree	36%	21%
neither ... nor (neutral)	32%	31%
I slightly disagree	5%	25%
I disagree	3%	15%

Table 9. Writing Contributions helps to acquire Contents

	Wiki	Forum
I totally agree	8%	7%
I generally agree	13%	19%
neither ... nor (neutral)	45%	34%
I slightly disagree	14%	22%
I disagree	19%	17%

Applicability for Communication and Community-Building

The question was formulated as follows: “(wikis, forums) are appropriate to support communication” (Table 10)

The results clearly demonstrate that discussion forums are “made for communication” whereas wikis are rather seen as a kind of reference book or encyclopedia, as already mentioned above.

The results of the next question, “(wikis, forums) support the set up of communities”, can be seen in Table 11.

Table 10. Applicability for Communication

	Wiki	Forum
I totally agree	9%	39%
I generally agree	33%	37%
neither ... nor (neutral)	29%	17%
I slightly disagree	15%	4%
I disagree	15%	3%

Table 11. Support for Community-Building

	Wiki	Forum
I totally agree	10%	28%
I generally agree	25%	32%
neither ... nor (neutral)	39%	23%
I slightly disagree	15%	11%
I disagree	10%	6%

Opinions about the applicability of wikis to establish a community is split. About 35% say that wikis are supportive of building a community, compared to 25% who said that wikis do not support community-building. The support of forums to build a community is rated much better – 50% indicated that forums are well suited to build a community. These results were to be expected because they confirm the nature of the instruments.

Fun Factor when Using the Instruments

In surveying whether students gain pleasure (“I enjoy using (wikis, forums)”), wikis again came back on top (Table 12).

A majority of 62% enjoy using wikis and forums (56%). Considering the answers that there is no (I disagree) or little (I slightly disagree) fun when using these instruments wikis (6%) are much better rated than forums (18%).

Part 3: Potential Future Usage of the Tools

The third section of the empirical study deals with the potential usage by students who had not used one of the instruments before the study. Students gained knowledge and experiences by using the tools during the study by themselves or on the basis of the reported experiences made by their fellow students.

The first question “I will use (wikis, forums, weblogs) for educational purposes in the future” yielded the results shown in Table 13.

According to this study wikis will then have a bright future and will be used often for educational purposes, whereas forums will be used less often. About 54% of the surveyed students had the intention of using wikis more or less often in the future. About 16% did not think that they will use wikis often in the future and 30% are not yet sure if they will use this instrument or not.

The results for forums and weblogs indicate no clear trend, but forums were rated slightly higher than weblogs. 39% of the students stated that they

Table 12. Fun Factor when using the Instruments

	Wiki	Forum
I totally agree	26%	19%
I generally agree	36%	37%
neither ... nor (neutral)	31%	26%
I slightly disagree	5%	14%
I disagree	1%	4%

Table 13. Future Usage in Educational Context (current non-users)

	Wikis	Forums	Weblogs
I totally agree	18%	16%	13%
I generally agree	36%	23%	23%
neither ... nor (neutral)	30%	16%	24%
I slightly disagree	9%	12%	13%
I disagree	7%	33%	27%

can image to use forums (36% for weblogs) in the future for their education. At the other end of the scale, 45% did not have the intention to use forums (40% for weblogs).

The equivalent question “I will use (wikis, forums, weblogs) for private purposes in the future” leads to similar results (Table 14).

From this point of view, wikis are again the leading instrument, followed by forums and weblogs.

It must be said that the answers to this set of questions represented feelings, attitudes and opinions about instruments that had not yet been used by the asked participants. The purpose of posing these questions was to gain insight into the mindset in regard to these instruments.

DISCUSSION

The results clearly show that wikis are currently the most often used instrument and furthermore have the greatest potential as a tool for learning and knowledge management in the field of learning – and these findings are in line with other empirical studies (Bendel, 2007; Chao, J. 2007).

Other studies (Nicol and Macleod, 2004; McGill, Nicol, Littlejohn, Grierson, Juster and Ion, 2005) report that a shared workspace helped to support collaborative learning. Especially the possibility of being able to access and contribute to the development of resources at any time and from any location was appreciated by the students.

Table 14. Future Usage in Private Context (current non-users)

	Wikis	Forums	Weblogs
I totally agree	11%	14%	9%
I generally agree	36%	23%	22%
neither ... nor (neutral)	30%	25%	24%
I slightly disagree	14%	7%	16%
I disagree	9%	32%	28%

In an empirical study conducted by Wheeler, Yeomans and Wheeler (2008) 35 undergraduate students (1st-, 2nd- and 3rd-year) of a teacher training (Bachelor of Education) have been using open-content wiki software for one year as an integral part of their studies. Ages ranged from 18 to 25 years, and there were two mature students. Each participated in this evaluative study voluntarily. Students used the wikis regularly during their classroom sessions as a space to store and edit the work from their research exercises, and as a forum for discussion. During teaching sessions students were invited via the integrated discussion board to post their views on their use of the wiki. They were also invited to complete a post-module questionnaire via email.

The authors conclude that “wikis have the potential to transform the learning experiences of students worldwide. The benefits appear to outweigh the limitations.” (Wheeler, Yeomans & Wheeler, 2008, 994) Collaboration, rather than competition, should be emphasised as a key aim of any wiki-based activity.

A study conducted by Solvie (2008) took place during a three week period of a semester long reading methods course for preservice teachers. Eighteen preservice teachers participated in the study. A combination of quantitative and qualitative methods was used.

One major purpose of this study was to get insights into the usage of a wiki in combination with individual learning styles thereby the cognitive learning style model by Kolb was used. Generally the results show that the used wiki provided a space for effective collaborative work. The furthermore found out that there is a correlation between the individual learning style and the specific usage of the wiki.

Participants who believed the wiki was helpful in constructing knowledge of reading contents in this environment said seeing all the information together was helpful. Learning more about and looking in depth at their particular work was helpful, and researching their approach was

enjoyable. The participants had some problems using the technology but these problems were associated with their own level of confidence in use of technology.

The survey at hand made a distinction between reading and writing contributions with wikis and discussion forums. The results show that reading contributions in wikis is helpful (with the answers “I totally agree” and “I generally agree”) for learning (59%) compared to 21% who stated that writing in wikis is helpful for learning. Reading contributions in forums helped 29% of the participants whereas writing in forums is helpful to 26%. This survey supports the general statement that a shared workspace that supports a constructivist and learner-centered approach is helpful for learning.

An empirical study on an eLearning module on an MSc in Information Technologies and Management was conducted by Gilbert, Morton and Rowley (2007). Nineteen students located across the globe where enrolled on the module. All students were graduates, but most of their prior learning experiences had been in standard face-to-face delivery mode. A discussion forum was integrated in the learning environment that was used by all students more or less frequently. Most of them were very or quite comfortable about posting contributions to the discussion threads, although some students were not confident to make contributions. Compared to email, chat, telephone or face to face the discussion forum was the most widely used communication channel among the students.

Concerning the impact on learning students responded that they learnt from other students. The support from other students with discussion forums were the most frequently cited aspects of the learning process whereas some were reluctant to be the first contributor.

The pedagogical value in the context of learning is described in several publications (Babcock, 2007; Hurst, 2005). Weblogs can foster the estab-

lishment of a learning and teaching environment in which students and teachers can experience a greater degree of equality and engagement. Du & Wagner (2007) published results of a study of an Information Systems undergraduate course (31 participants). This study indicated that the performance of students' weblogs was a significant predictor for learning outcomes, while traditional coursework was not. Moreover, individuals' cognitive construction efforts to build their own mental models and social construction efforts to further enrich and expand knowledge resources appeared to be two key aspects of the constructivist learning with weblogs. According to this study there is a potential benefit of using weblogs as a knowledge construction tool and a social learning medium (Du & Wagner, 2007).

In this survey at hand weblogs were not yet widely used and their potential seems to be limited. It can be assumed that these limited prospects will change, when the penetration of weblogs into the daily routine of the students will increase – for private as well as for educational purposes. These results are confirmed by Reinmann (2008) who states that blogging in an educational context (“edublogs”) is obvious when the possibilities are taken into consideration whereas the usage of these tools is not widely spread in the daily routine. There are already projects and there is a lot of information about using weblogs in educational settings (Scheloske, 2008; Reinmann & Bianco, 2008).

The results about the potential future usage of wikis, weblogs and discussion forums show that these tools have the potential to be used for life-long learning. According to this study, wikis will have a bright future and will be used often for educational and private purposes. The results for discussion forums and weblogs indicate no clear trend, but forums were rated slightly higher than weblogs. Other studies (Klamma, Chatti, Duval, Hummel, Hvannberg & Kravcik et al., 2007; Attwell, 2007a) confirm these results, whereas

weblogs are considered to be more powerful for personal knowledge and learning management (Williams, 2004; Böttger & Roll, 2004; Fiedler, 2003).

The contribution of this thesis to the discussion that can be found in Oblinger and Oblinger (2005), Lenhart and Madden (2005), Aggarwal and Legon (2006) or Prensky (2001) about the already available “digital literacy” of young people indicates that wikis and discussion forums are currently the most widely used tools. More than 75% are already using these tools, whereas weblogs are only used by 11% of the asked participants. From these results it can be concluded that there is some form of digital literacy among young students.

Critics of the net-generation and the derived consequences for learning and teaching state that there is “a sense of impending crisis pervades this debate. However, the actual situation is far from clear. [...] Our analysis of the digital native literature demonstrates a clear mismatch between the confidence with which claims are made and the evidence for such claims” (Kennedy, Judd, Churchward, Gray & Krause, 2008)

Schulmeister (2008) points out that the term “generation” has often been used in the past by attributing some specific characteristics or qualities to people living in a certain period of time. In the USA, for example, earlier generations have been classified by researchers as the “matures” (1900-1946), the “baby boomers” (1946-1964), “Generation X” (1965-1982) or the “net generation” (1983-1991). In many cases these attributes are only valid for a minority of this generation but by establishing a classificatory system this minority is used to represent a whole generation.

In other publications (Media Awareness Network, 2004) it is reported that for young people it is normal to grow up with new technologies. Computers and other new technologies like mobile phones are not new for them, they just exist and they use new technologies to manage and organize their daily life (Tully & Zerle, 2005). A Canadian

study summarizes its results as follows: “The Internet, for young people, is part of the pattern of their day and integrated into their sense of place and time. The Internet just is.” (Media Awareness Network, 2004, p. 8)

With respect to the individual learning styles of young people Bennett et al. (2008) come to the conclusion that “young people’s relationships with technology is much more complex than the digital native characterization suggests. While technology is embedded in their lives, young people’s use and skills are not uniform. There is no evidence of widespread and universal disaffection, or of a distinctly different learning style the like of which has never been seen before. We may live in a highly technologized world, but it is conceivable that it has become so through evolution, rather than revolution.”

Thus it is important to provide systems that offer all possibilities of setting up a personal learning environment in order to enable people to work and learn according to their individual learning style.

To avoid possible pitfalls about the application of these instruments in the context of learning, some social and psychological issues must be taken into consideration (Kreijns, Kirschner & Jochems, 2003). Social interaction is essential for members of a team to get to know each other, commit to social relationships, develop trust and develop a sense of belonging, in developing a learning community. The size and the composition of the learning communities seem to be an important factor how interaction and communication within the learning community will take place (Dooley & Wickersham, 2007). There are also many unresolved issues, like provision of the technology and the services, intellectual property rights and digital rights management, security of data, access restrictions to the contents or questions in the field of information ethics (McGill, Nicol, Littlejohn, Grierson, Juster & Ion, 2005; Attwell, 2006; Sharma & Maleyeff, 2003).

FINAL REMARKS

The aim of this contribution was to investigate the experiences of students using social software tools in the context of learning. Wikis, weblogs and discussion forums are typical social software tools and were used for this survey.

The results clearly show that wikis and discussion forums can support learning and collaboration. The usage of weblogs in this study was limited and hence no statements about their applicability can be made. In order to assure a successful implementation of these tools social and psychological issues must be taken into consideration as well.

The results of this study are the basis for the introduction of social software into education to help students to set up their individual learning environment. These learning environments should support life-long-learning and the structuring of a personal learning environment.

In the “Hype Cycle for Emerging Technologies” report of 2008 describes microblogging and social social computing platforms as technologies and trends that are around the peak of the Hype Cycle in 2008 with the prospect that they will mature in two to five years (Fenn & Raskino, 2008)

Microblogging is a relatively new addition to the world of social networking, in which contributors post a stream of very short messages (normally fewer than 160 characters) providing information via various information channels.

There are likely to be other unplanned consequences of the intensive use of the internet in general and social software especially. Further research is needed to explore possible problems along with hinting at solutions.

The results of the empirical survey indicate that a long-term study in combination with the further development of social software tools may be promising.

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Chapter 3.7

Integrating Blogs in Teacher Education

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ABSTRACT

This chapter demonstrates some of the educational merits of blogs; including how blogs can be integrated in teacher education and proposing a methodology for evaluating blogs to meet the goals of reflection and technology literacy in teacher education. An undergraduate-level course was integrated with blog technology to help readers better understand the inquiry-oriented nature of the blog medium. This exemplar course modeled Web 2.0 technology to teacher educators and pre-service teachers who intend to integrate the technology into their future teaching. Surveys and interviews were used to investigate participant attitude toward blogs. The researcher proposes Zeichner and Liston's (1987) Reflective Index

as a potential framework for evaluating the quality of reflection in blogs. It is expected that this instructional model of blogs will help educators, in particular teacher educators and instructional designers, to design courses to more effectively meet the goals of higher-order thinking required in 21st century teacher education.

INTRODUCTION

Some people do not regard teaching as a profession and think that teaching requires little training. According to this belief, anyone who has the content knowledge would be able to teach. These are misconceptions. As Darling-Hammond (2006) indicated, teachers have a list of things they should know and should be able to do, including knowing how people learn, teaching

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effectively, meeting individual learner's needs, communicating and managing their classrooms well, and the like. One of the competencies, teaching effectively, often contributes to students' learning (Darling-Hammond, 2006). Especially in the digital era, teaching effectively requires more than content knowledge. To teach effectively, one needs knowledge of content, pedagogy, and technology integration, and the interplay of these three bodies of knowledge known as technological pedagogical content knowledge (TPCK) (Mishra & Koehler, 2006).

Mishra and Koehler (2006) defined technological pedagogical content knowledge:

This knowledge is different from knowledge of a disciplinary or technology expert and also from the general pedagogical knowledge shared by teachers across disciplines. TPCK is the basis of good teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (Mishra & Koehler, 2006, p. 1028-1029).

Teacher education programs usually provide pre-service teachers with separate courses in which content, pedagogy, and technology literacy skills are introduced to learners. The interplay between the three components tends to be neglected. This chapter is not about developing technology nor content knowledge, but rather about solidifying technological pedagogical content knowledge by using blogs to meet the tremendous academic needs of teacher education in ways that have never before been available. The final goal of this chapter is to identify the importance of blog technology for pre-service teacher education.

BACKGROUND

The use of Internet technologies has been changing human interaction, communication, and relationships. By including Internet technologies in education, the technology revolution makes the learning environment diverse and complicated, and the role of teachers in students' learning is transformed into facilitating. Can teacher education keep updated with these changes and meet pre-service teachers' needs for their future teaching careers? The answer is far from certain, because the new skill sets required by the new century classrooms differ from skills developed by current teacher educators. The 21st century students are growing up in the time when Internet access has become widespread. Youngsters send/receive e-mails, use instant messaging, search for information online, play online games, and make online friends. Widespread access to information and resources is bringing young people the pros and cons of the digital age. To deal with the complexity of this environment, students need up-to-date skills to compete in the 21st century working environment. According to the report *enGauge 21st Century Skills: Literacy in the Digital Age* (2003) by the North Central Regional Educational Laboratory (NCREL), four groups of skills analyzed through literature reviews, surveys and interviews, represent the 21st century skills needed by students, citizens, and workers in the Digital Age. The skills are 1). Digital-age literacy: including basic, scientific, economic, and technological literacy, visual and information literacy, and multicultural literacy and global awareness, 2). Inventive thinking: including adaptability and managing complexity, self-direction, curiosity, creativity, and risk taking, and higher-order thinking and sound reasoning, 3). Effective communication: teamwork, collaboration, and interpersonal skills, personal, social, and civic responsibility, and interactive communication, and 4). High productivity: prioritizing, planning, and managing for results, effective use of real-world tools, and ability to produce relevant,

high-quality products. In the 21st century, we will need to go beyond textbooks and define literacy to include the ability to exercise thinking skills and to utilize Internet technologies.

While standards for learning and demands on teachers have been increasing, there are changed expectations for teachers and growing concerns about teacher educators. Research studies evidenced that teachers' school experience influenced their belief about teaching and influenced the way they teach (Carter & Doyle, 1996). How teacher educators teach pre-service teachers significantly influences the way pre-service teachers teach. Most of the current teacher educators were educated at the time when Internet access was not available or rarely available, and the information-communication technologies (ICT) were not as user-friendly as they are now. Presently, teacher educators lack sufficient knowledge of the value of the current technologies and hardly think of innovating teaching through the technologies. Teacher educators may continue to educate their students, namely, pre-service teachers, in the way they themselves were educated. Pre-service teachers may either imitate the way their teacher educators taught or adopt their intuition to teach (Gardner & Williamson, 2007). These outdated ways may directly or indirectly result in the inability of pre-service teachers to thrive as teachers. To equip young teachers with 21st century skills, teacher educators have to reshape teaching and learning using technology.

The Blog Technology

Internet technologies and software applications have become more intuitive, and computer technologies and Internet communication tools are being applied to the education field and integrated into classrooms. One of these tools is the weblog (often called blog), which is emerging rapidly in the context of education, providing an uncomplicated but powerful organizational form supporting online expression (Oravec, 2002). Especially

during the last few years, blogging has become a popular online activity across all ages, races, and countries. Many people either blog or read blogs every day. Blogging is a method of journal keeping, except that blogging can share and disseminate information and emotions around the world. In the blog environment, people ask questions, think about thinking (meta-cognition), and write to the public. The environment is culturally rich and educational. Because of its educational value, blogs deserve a high profile in teacher education.

Essentially, blogs are a reflective tool. When people blog, they reflect, and express thoughts through writing. Blog technology provides a premium platform for reflection. Usually bloggers *turn to prior experience, attend to their feelings and emotions, and re-evaluate their experience*; these three components are exactly what Boud, Keogh, and Walker (1985) once defined as reflection. Schon (1987) distinguished between *reflection on action* (reflection after practice has been completed) and *reflection in action* (thinking that takes place during practice). This distinction highlights the fact that there are cycles to thought, and their links, and their impacts on practice. Boud, et al. (1985) pointed out, "Reflection does not have to be a solitary activity" (p. 16). People can keep blogs in the form of groups and/or keep their own blogs. If blogging in groups, pre-service teachers can collaborate with their peers and get familiar with the ethics of working in groups. Through collaboration, pre-service teachers experience the process of knowledge construction in groups and develop collaboration and interpersonal skills. After all, schools often need teachers to work together to accomplish projects. Therefore, it is essential to develop pre-service teachers' effective communication skills during the period of teacher preparation. Another reason why blogs are recommended in teacher education is that blogs can help pre-service teachers become aware. Most learners are not aware of how they construct or attribute meanings to what they see. Learners often do things habitually. Learners can

become prisoners of rigid competencies (Candy, Harri-Augstein, & Thomas, 1985). Blogging can help pre-service teachers get out of the shackle of habit and develop reflective practice in teaching.

In addition to facilitating the skill development of higher-order thinking, keeping blogs can help pre-service teachers cultivate technology literacy. For the last five years, information-communication technology (ICT) has become more and more used as a tool to enhance the delivery of curriculum and instruction. Blogs, a type of Web 2.0 technology, can be regarded as information-communication technology (ICT). When blogging is integrated into teacher education, pre-service teachers can observe teacher educators modeling technology integration in an instructional setting. Pre-service teachers get familiar with the virtual learning environment, and are indirectly enabled, equipped with the pedagogical knowledge, technical skills and interplays required for their future teaching.

Taking advantage of their accessibility and the potential for accountability, blogs can be utilized as e-portfolios. Blogs record both the process and products of learning. Blog portfolios can encourage pre-service teachers to think creatively while considering what content to collect and how to use media to display their content. There have been numerous research studies investigating the significant relationships of individual differences and media modes (eg, Ford, 1985; Ford & Chen, 2001; Jonassen & Grabowski, 1993; Liu & Reed, 1994). Diverse media, including text and non-text, can complement individual differences in learning and can be easily placed in blogs to communicate pre-service teachers' thoughts, display their artifacts, and demonstrate learning outcomes.

Furthermore, the process of blogging helps to develop pre-service teachers' meta-cognitive skills, further generating educational value. To blog well, pre-service teachers monitor their own learning and learn when to ask for help or search for additional information. This type of meta-cognition, thinking about one's own thoughts, can empower pre-service teachers to

learn independently and help them become lifelong learners (Bransford, Brown, & Cocking, 2002). Once developing meta-cognition becomes a reality for pre-service teachers, then expecting K-12 students to be equipped with 21st century skills will be more realistic.

How to Integrate Blogs in Teacher Education

All over the world, we hear cries for the improvement of teacher education. If pre-service teachers get accustomed to recording their own performance through portfolios as early as when they are in teacher education programs, they may be less resistant to evaluation when they start their teaching profession. Thanks to the transparency of blog technology, there is little technical barrier to keeping a blog portfolio. Making blogs is as easy as writing e-mails. Training pre-service teachers to keep their blog portfolios not only prepares them for evaluation but also encourages them to reflect on their own work while promoting their technology literacy. The merits of blogs in education are multi-dimensional.

This section will describe how blogs can be integrated into teacher education programs. The process of teacher preparation is divided into two parts: course-work period and teaching practicum (including a practicum with and without direct supervision). It is crucial that teaching practice is supported by a theoretical foundation (Grossman, 1990). This chapter applies Cognitive Apprenticeship (Collins, Brown, Newman, 1989) to the context of the teacher education programs. Cognitive Apprenticeship is an instructional model in which teachers try to make thinking visible. The model combines elements of apprenticeship and schooling. To transition from a traditional apprenticeship to a cognitive apprenticeship approach, teachers should conduct the following tasks. 1). Identify the task process and make it visible to students. 2). Situate abstract tasks in authentic contexts, so that students understand the

relevance of the task. 3). Adjust the diversity of situations and articulate the commonality of tasks, helping students' transition from what they know to brave the new and unknown (Collins, Brown, Newman, 1991). Cognitive Apprenticeship (Collins, et al., 1989, 1991) identifies five approaches to making the blog-integrated activity an integral aspect of instruction. They are *modeling*, *coaching*, *articulation*, *reflection*, and *exploration*. Details are as follows.

During the first two years of pre-service teacher training, teacher educators should *model* innovative use of technology in their classroom. During that time, teacher educators should create opportunities for pre-service teachers to experience and observe innovative uses of blogs. Teacher educators should make their own teaching journals available in a blog, and demonstrate how to make teaching portfolios. This makes the process of teacher preparation active and develops pre-service teachers' pedagogical literacy. Teaching portfolios should include everything from how to set up a classroom, to how to deal with unexpected behaviors of students. In that way, pre-service teachers can observe and build a conceptual model of the processes that are required to design, develop, and teach a course; they will be better able to solve classroom problems and reflect on their teaching practice. While observing modeling, pre-service teachers can start building their own portfolios by placing their artifacts in their own blogs. Teacher educators will *coach* pre-service teachers by observing pre-service reflection through blogs. During coaching, teacher educators should offer hints, feedback, reminders, and assistance. They should offer these types of scaffolding, while giving the reins to pre-service teachers. Moreover, teacher educators need to clearly convey their expectations as pre-service teachers may want to work hard to meet the requirements of quality work. (Gathercoal, Crowe, Karayan, McCambridge, Maliski, Love, & McKean, 2007).

After pre-service teachers finish their course work and begin their teaching practicum, they can continue to blog, either in groups or individually. When blogging, pre-service teachers are required to *articulate* their thoughts, *reflect* on their reasoning processes, explain or compare their own problem-solving processes with those of an expert or another participant from their practicum. And it is crucial to require pre-service teachers to *explore* how to frame questions and problems (Collins, et al., 1989). Pre-service teachers should be assigned groups, where they can post questions and problems, respond to each other, collaborate and reflect together on their approaches to teaching and learning in their practicum. Pre-service teachers may sometimes get static with their blogging. Teacher educators need to regularly log in to their students' blog sites to provide feedback to group and individual blogs, and initiate discussions. In addition to functioning as a e-portfolio and reflective tool, blogs can be used as another form of class interaction. Through Cognitive Apprenticeship, the course work combined with blog integration, can address the theory-practice divide. And a teaching practicum based on the innovative use of technology will maximize the benefits of the students' in-school field experience. In the process of blogging, pre-service teachers create their own e-portfolios, observe how teacher educators respond and moderate the asynchronous online discussion, learn to reflect on their own practice, and get familiar with the Web 2.0 technology.

Google offers a free blog site "Blogger." Without any technical threshold, users do not need any special skills, teacher educators can go to <http://www.blogger.com> to apply for a free account. Then pre-service teachers can open their own accounts. Teacher educators maintain the class blog site for class discussion. Teacher educators can post diverse types of media (text, graphics, photos, video, MP3 and other media) as course supplementation. In addition, teacher educators should require pre-service teachers to post reflect-

tions on course content, express emotions and ideas that differ from in-class discussions by being more personal. Teacher educators do not need to restrict pre-service teachers about which part of the curriculum content to explore, and should model the way to reflect on the learning experience. The product, a blog, will give pre-service teachers a sense of ownership of their explorations.

When pre-service teachers post reflections on course content and their prior experiences, they are practicing higher-order thinking skills and making deeper connections to the material. For some people, learning is often dull. With blogs, learning becomes reflective and personal. And learning is supposed to be personal, since one has multiple intelligences, as Gardner (1993) advocates. Maintaining blogs in class activities, pre-service teachers actively participate in thinking and knowledge construction. Therefore, teacher educators should encourage pre-service teachers to explore the curriculum content, that way pre-service teachers have abundant choice to decide what to reflect on and how to reflect. By creating blogs, pre-service teachers learn autonomy, and develop into self-directed learners.

Findings

There have been research studies indicating the importance of opportunities for pre-service teachers to share reflection with each other in an environment of trust and respect (Gardner & Williamson, 2007). Creating opportunities for teacher educators to model innovative use of technology and reflection of their pedagogy to pre-service teachers is a necessity in today's teacher education programs. Based on the guidelines for implementation suggested in the previous section, a teacher education course, *Principles of Instruction* was integrated with blogs as a class assignment. The participants were 155 pre-service teachers in a national Taiwan university during the spring of 2006. The course was integrated with

blogs throughout the semester. The course blog was located at <http://spring06p1.blogspot.com/>.

The students were heterogeneous, sophomores to seniors, from a variety of disciplines. The course was a requirement for all pre-service teachers. Surveys and interviews were used for the investigation of the participants' attitudes toward blogs. Overall, the participants' positive attitudes toward blogs were above-average. The descriptive data of a few sample questions on attitude toward blogs are provided in the following paragraphs. More than 70% of participants agreed or strongly agreed that writing blogs helped them reflect on the course, and around 7% of participants disagreed or strongly disagreed with the statement. More details are displayed in Figure 1.

More than 75% of participants agreed or strongly agreed that writing blogs helped participants exchange ideas and thoughts with their fellows, and less than 10% of participants disagreed or strongly disagreed the statement. See Figure 2.

More than 80% of participants agreed or strongly agreed that writing blogs helped participants express emotions, and less than 6% of participants disagreed or strongly disagreed with the statement. More details are in Figure 3.

Figure 1. The distribution of participant agreement on the statement *Writing blogs helped me reflect on the course contents*.

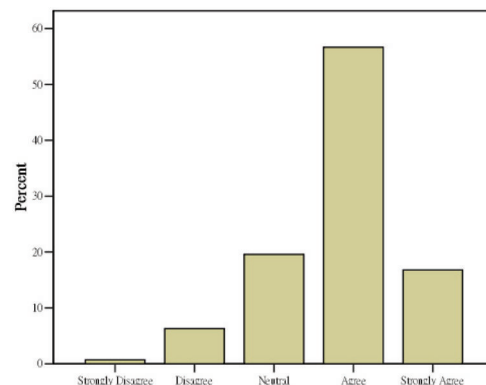
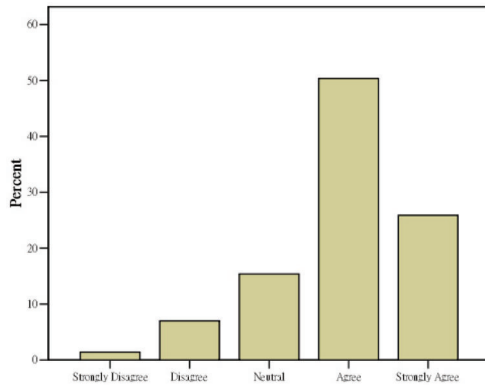
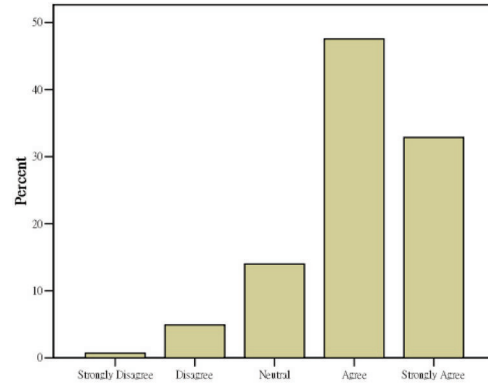


Figure 2. The distribution of participant agreement on the statement Writing blogs helped me exchange ideas and thoughts with fellows.



Regarding the question: *How did writing blogs about the class help you learn the course content*, there are several types of learning that occurred during the course. Details analyzed from interviews are illustrated in Table 1.

Figure 3. The Distribution of participant agreement on the statement Writing blogs helped me express emotions.



The participants reported several types of feelings emerging when they read their fellows' blogs. Details of feelings brought up are in Table 2.

Table 1. How many types of learning took place in the learning context.

Type of learning	Participant Response
Attentive	"Writing blogs after class made me have to review and digest course content, and forced me to pay more attention to what the instructor said in class." "I have no idea what to write in blogs. But if I pay attention to the lectures, I get more inspiration of what to blog about."
Reflective	"Writing blogs helps me be aware of how much I learned in class." "Before going online, I need to make sure if my understanding of the course contents is correct. I usually evaluate it by reading the textbook again or reading others' blogs." "Blogging made me think more logically. Because before I blogged, I needed to think it through and make sure I didn't write something which I would feel ashamed with."
Meta-cognitive	"I often needed to evaluate and think about my own thoughts before writing blogs. Blogging made me do a lot of thinking." "Each week after class, I wrote blogs, and blogs became a tool for me to understand my learning progress. I can more regulate my own learning."
Communicative	"Writing blogs creates opportunity for me to exchange ideas with fellows." "Conversing" with fellows through blogs stimulates my thoughts and makes me feel a member of a learning community."
Connective	"Writing blogs reminds me of the theories I learned in class and connects with my learning experience."
Digital literacy	"The blog activity forced me to learn how to use blogs. At first I felt resistant to learning the tool. After using blogs, I'm glad I got chance exploring the tool. It's cool."
Collective	"Our personal blogs keep our own work" very well. When I had exams, the blogs collected my review notes so well that my life got much easier."
Resourceful	"There was a lot of useful information on other people's blogs. Sometimes I can find a lot of goodies there. For example, web site links to YouTube videos or to podcasts."

Table 2. Feelings brought up when participants read other fellows' blogs.

Feelings	Participant Response
Interest	"I was impressed with some other fellows' opinions. They looked at the things in the way I never thought of." "Reading others' blogs is like listening to people singing the same song; you got different interpretation of the song." "When I read different thoughts expressed in blogs, I feel they broadened my views."
Competition	"I'd like to read other people's blogs and contrast my opinions with theirs." "When I read blogs that are written well, I anticipate some day I could reach the level."
Relaxation	"When I read someone has the same opinions with me, I feel good about that." "I'd like we shared thoughts with each other. Sharing makes me feel relaxed".
Lurking	"Reading other people's blogs let me understand them more. I feel I am peeking their privacy."
Unpleasant feelings	"I feel pressured when I read blogs written with good insights and analyses. It makes me feel uncomfortable." "I'm disgusted with some people who just copied the words from textbook. It wasted my time to read their blogs." "Some blog web sites with messy interface pissed me off!"

The participants disclosed they experienced significant emotional response when they read their own blogs. Details of feelings for reading their own blogs are in Table 2.

Implications

The findings demonstrated the pre-service teachers' attitude towards blogs and the potential educational values of blogs. The evidence showed that pre-service teachers can use blogs to learn course content, to foster reflection, to monitor and assess their learning process. These are the basic elements

of the required 21st century skills (NCREL, 2003; Partnership for 21st Century Skills, 2007).

Reflection in teacher education is not a new concept, but using blogs to facilitate reflection is a new area of inquiry that deserves deep exploration. Based on these research findings of blog integration in a teacher education course, there are a few qualitative implications to address. First, group blogs and individual blogs function in different ways and should exist together in a learning community. Group blogs provide participants with a platform for interaction, communication, and discussion, and individual

Table 3. Feelings when participants read their own blogs.

Emotions	Participant Response
Motivation	"When I read my own blogs, I felt impressed with my work. Those blogs were written week by week and accumulated to such amount. I felt I learned something. I got great sense of achievement!" "Reading my own blogs helped me monitor my own learning progress and motivated me to write more." "I felt proud of myself that I can express myself."
Self-criticism	"Sometimes I felt stupid with my words. I wished I had not written such stupid ideas." "Sometimes when I read blogs, I felt I was making progress, because they were thought-provoking. But sometimes my thoughts were empty and full of ignorance."
Pleasant	"I felt great that I can express my emotions freely." "It's pleasant I can recall what happened in class by reading blogs."
Expectations	"I looked forward to people's responding to my ideas or discussing with me." "I'd like to get more feedback from my teacher."
Critical of the process or of others	"I felt childish with blogs. Blogging is like keeping a diary; a diary is supposed to be private." "People were so superficial in blogs, showing off ideas or stuff. I'm not going to play the stupid game."

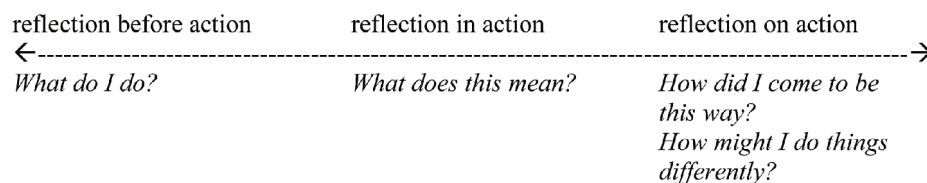
blogs provide participants with personal space to keep learning notes, record learning progress, reflect thoughts and actions, and make personal e-portfolios. Through group blogging, pre-service teachers learned that collaborative interaction can create a positive learning experience, and they took the opportunity to share problems, and to offer suggestions or support each other. In the process of blogging, pre-service teachers addressed each other's concerns, and learned to search for solutions collaboratively, different perspectives were shared and ideas sparkled, resulting in more positive attitudes toward learning and teaching. Through individual blogging, pre-service teachers learned to reflect and construct their knowledge of teaching, become more aware of their thoughts and action, and make their e-portfolios for future career.

Second, participants need scaffolding for reflection. Atkins and Murphy (1993) indicated that the following components are necessary for reflection: self-awareness, description, critical analysis, synthesis, and evaluation. And Pater-son (1995) indicated the following factors affect reflection: 1) developmental levels of reflection; 2) perception of trustworthiness of the teacher; 3) clarity of expectations related to journal writing tasks; 4) quantity and quality of teacher feedback. Teacher educators need to recognize these factors and support pre-service teachers' progres-sion through those different skills of reflection. Starting with personal performance at a practical level, pre-service teachers learn to justify their teaching practice, and finally to reflect on values and thought-provoking issues (Furlong, 2000).

If necessary, teacher educators can post topics or raise questions, to stimulate pre-service teach-ers' thinking. Questions can be used as prompts. This chapter suggests a framework for reflection and prompts. Prompts vary, depending on the time frame of the learning context. Schon (1987) dis-tinguished the time frame of occurrence of reflec-tion, as mentioned earlier. Postholm (2008) added another segment, reflection before action, thinking about prior experiences and theories before tak-ing action. Reflection before action, reflection in action, and reflection on action constitute the complete process of reflection. Regarding what questions to ask during reflection, Smyth (1989) suggested four questions that can stimulate reflec-tion: What do I do? What does this mean? How did I come to be this way? How might I do things differently? With the four stimulating questions, a framework of reflection and questions to guide reflection in learning contexts is recommended in Figure 4. Notice that asking open-ended questions rather than closed ones is a must.

Third, to build a successful blogging com-munity, teacher educators need to participate in the blogs. The participants in this study emphasized that they looked forward to feedback from their instructor and peers. To meet the need, teacher educators should join blog reflection on a regular basis and leave comments on pre-service teachers' blogs. On the other hand, teacher educators can diversify feedback by assigning pre-service teach-ers into groups and requiring them to reply to each other. By doing so, pre-service teachers can acquire feedback from their peers and a learning com-munity is gradually built up. Considering the

Figure 4. Questions to stimulate reflection in the blog context.



limited time teacher educators can commit to a class, it is necessary to make effective use of the learning community and re-direct learners' reliance on the instructor to the learning community. But the instructor must be a part of the community! To encourage active participation in the blog community, teacher educators need to take responsibility for moderating online discussions.

Salmon developed a five-stage framework for moderating groups and suggestions for consideration (Salmon, 2000). Contextualized in the blog environment, the five stages of moderation are: 1) Stage of access and motivation: Teacher educators post welcoming and encouraging blogs to invite pre-service teachers to join the blogging; and construct the atmosphere in which pre-service teachers feel secure and can talk openly and honestly about their feelings. 2). Stage of socialization: Teacher educators introduce themselves to the class, demonstrate respect for differences among class members, and bridge differences of opinion in a non-judgmental manner. 3). Stage of information exchange: Teacher educators encourage pre-service teachers to share information and learning materials by, for example, providing web site links on blogs. 4). Stage of knowledge construction: When blogging, pre-service teachers post reflection on course content or post questions they have. Teacher educators participate in online discussions with pre-service teachers and facilitate the process of knowledge construction. For teacher educators, the priority is to maintain a flexible environment for knowledge construction. 5). Development: It is at this stage that teacher educators respond to questions and monitor the discussion process. As pre-service teachers reflect on their experiences in schools and their learning, it is necessary to interrogate, test, and challenge pre-service teachers' experiences to avoid unconscious assumptions, because assumptions may reduce creativity in trying to understand or resolve a problem. Incidentally, teacher educators should always take pre-service teachers' learning styles

into consideration to handle ideas or thoughts in blogs (Salmon, 2002).

Finally, the quality of the blogs will influence their effect. Some participants complained when they saw fellows not reflecting their thoughts but only copying the words from textbooks, they felt that reading the blogs was wasting their time. In light of the problem, it is essential that teacher educators emphasize and evaluate the quality of blog contents. Blogs provide users with an interactive platform for reflection. Thus, to evaluate blogs, reflection is a key. There are several frameworks for evaluating reflection (Boud, et al., 1985; LaBoskey, 1993; Sparks-Langer, Simmons, Pasch, Colton, & Starko, 1991; Valli, 1990). For example, Boud et al. (1985) categorized critical analysis into four elements: association (connecting new data with what is already known), integration (searching for relationships among data), validation (determining the authenticity of ideas, feelings and emotions that have resulted), and appropriation (making knowledge one's own). Regarding how to evaluate reflection, Zeichner and Liston (1987) designed the Reflective Index to identify student teachers' reflection in meetings with their supervisor. The Reflective Index consists of four categories ranked from lowest to highest in importance. The four levels can be used to measure the reflection that occurs in a blog context. Details are explained with examples as follows.

1. Factual level: When blogging, pre-service teachers recall some students' behavior that occurred in classrooms; the reflection is at the factual level.
2. Prudential level: When blogging, pre-service teachers evaluate the effectiveness of conducting objective assessments or e-portfolios; the reflection is at the prudential level.
3. Justificatory level: When blogging, pre-service teachers focus on the reasons why collaborative learning activities occurred, or

why some individual learning activities are suitable; the reflection is at the justificatory level.

4. Critical level: When blogging, pre-service teachers explore teacher educators' perception that underlies the reasons why teacher educators integrate blogs in the learning process; the reflection is at the critical level.

CONCLUSION

This chapter suggested the implementation how-to and rubrics for assessing reflection in an online blogging environment. To successfully implement blogs in teacher education, the administrative authorities in teacher education programs may have to require that teacher educators implement blogs throughout the period of teacher preparation and provide professional development for teacher educators whenever necessary. Requiring teacher educators to use blogs creates opportunities for pre-service teachers to update their technology literacy, to make personal e-portfolios by collecting artifacts from different courses into blogs, and to prepare for carrying out reflective practice in their future careers teaching in K-12 settings.

Effective technology integration in classrooms does not require expensive hardware and software. People tend to have the misconception that adopting technology integration in schools needs to be expensive. Quite a few web sites provide blog services for free. Teacher educators should learn how to make good use of free online resources and model the practice to pre-service teachers. After all, not all pre-service teachers can teach at schools with sufficient funding. Finally, teacher educators can take Cognitive Apprenticeship as the approach to develop pre-service teachers' pedagogical literacy and reflective practice. This instructional model combines aspects of traditional apprenticeship with formal schooling. Following the principles of Cognitive Apprenticeship, teacher educators will be able to help pre-service teachers

develop higher-level skills, such as decision making and problem solving in classrooms.

During the last decade, while new Internet technologies have been continuously emerging, the popular blog technology has made a significant impact on the dissemination of information and knowledge. Blogs are "transforming publishing and traditional media into more personal and interactive experiences" in which users become active participants, not just passive consumers (Kennedy, 2004, p. 249). Recognizing the potential and popularity of blogs in education, teacher educators in teacher education programs must update their traditional educational practice and connect theory with practice to help would-be teachers gain sufficient competence and confidence to thrive in the 21st century classrooms.

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Chapter 3.8

iPods as Mobile Multimedia Learning Environments: Individual Differences and Instructional Design

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ABSTRACT

In recent years, educators across the globe have begun to employ portable, digital media players, especially iPods, as educational platforms. Unfortunately, while the iPod grows in favor as a mobile multimedia learning environment, relatively little is empirically known about its educational impact. This chapter explores the use of the iPod as an educational platform and reports on a study designed to examine individual differences in iPod

use as a mobile multimedia learning environment. This exploration into applied and basic research involving the iPod reveals that iPods are being used across a variety of content areas, educational levels and geographic locations, involving a variety of pedagogies. However, very little research has been conducted to establish the efficacy of the iPod for fostering learning. To address this need, the authors conducted a study that examined the effects of working memory capacity (WMC) on learning within an iPod-based mobile multimedia learning environment.

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INTRODUCTION

Mobile learning, or m-learning, is typically defined as learning with mobile technologies (see Laouris & Eteokleous, 2005). This type of definition generally emphasizes the ability to move beyond place-bound teaching and learning environments (Goh & Kinshuk, 2006; Seppala & Alamaki, 2003) based on the application of wireless educational technologies (e.g., mobile phones, personal digital assistants, laptop computers, portable digital media players). Educational research into the efficacy of mobile learning and mobile technologies tends to focus on “their use embedded in classroom practice, or as part of a learning experience outside the classroom” (Naismith, Lonsdale, Vavoula, & Sharples, 2006, p. 11). One arena in which this is especially the case is the use of portable digital media players (e.g., iPods, Zunes, MP3 players). In recent years, educators across the globe have begun to employ portable digital media players, especially iPods, as educational platforms (see Belanger, 2005; Cebeci & Tekdal, 2006; Trelease, 2006).

The use of the iPod for educational purposes has included lecture capture at Duke University (USA), podcasting at Auckland University of Technology (New Zealand), foreign language instruction at Astley Community High School (U.K.), math instruction at Apollo Parkways Primary School (Australia), and an entire degree at Sligo Institute of Technology (Ireland), to name only a few. Unfortunately, while the iPod grows in favor as a mobile multimedia learning environment, relatively little is known about its educational impact. How well do students learn from podcasts? How are students using iPods to view or re-view lectures? Does listening to native speakers on the iPod affect learners’ foreign language listening, writing, or speaking skills? This chapter explores the use of the iPod as an educational platform and reports on a study designed to examine individual differences in iPod use as a mobile multimedia learning environment.

IPOD RESEARCH

Over the past several years, research addressing the use of the iPod as a mobile multimedia learning environment has included both applied research, which is designed to solve problems, produce products, or fulfill a specific need; and, basic research, which is designed to expand the current knowledge base regarding learning in iPod-based mobile multimedia learning environments. There is, however, a disparity between the depth of applied and basic research, with there being much more applied research than basic research.

Applied Research: iPods in the Classroom

Mobile multimedia learning environments can take on many forms as technological advancements abound and are being used to supplement and even replace some forms of formal classroom education. The use of iPods and podcasts for educational purposes is a growing trend in the realm of education from primary school through college. Even the military has incorporated these educational tools for learning.

The Navy College Program for Afloat College Education (NCPACE) teamed with Dallas Tele-College to institute educational programs using the iPod for deployed sailors, thereby reducing the number of computers needed on board ships while still allowing the sailors the opportunity to learn (Jay, 2007). In addition, the National Defense University’s Information Resources Management (IRM) College not only uses video iPods to deliver education but also to allow students to create assignments for their courses, such as recording interviews with officers.

New Mexico State University (NMSU) offers educational programs to the airmen on Holloman Air Force Base so that they can continue to pursue their education while on deployment (Venegas, 2007). Their iPod program begins with “sociology in a sack” in which the iPod is loaded with sociol-

ogy lectures and includes support materials such as a syllabus, sample quizzes, and instructions for the program. Upon the end of their offsite operation, the airmen return the iPods to the school and take their exams for course completion. Considering distance education courses often utilize the Internet for most of their materials and lectures, this program can meet the needs of those airmen who are deployed in places where Internet connections are scarce and therefore limit the opportunities to continue their education.

In addition to military use, Apple has reported that there are a plethora of elementary schools, secondary schools, and universities that have reported success with the use of their iPod devices for educational delivery and production. For example, Bob Sprinkle, a teacher at Wells Elementary School in Maine, has been using iPods and podcasts with his third and fourth-grade students to teach research, writing, and presentation skills as well as the embedded technology expertise that inevitably accompanies projects such as these (Apple Education, 2007a).

Vanderbilt University (2007) has partnered with Sheridan School District in rural Arkansas to transform students' use of a lengthy bus ride into educational time. This project, the Aspinaut Initiative, was formed as a way to elevate the mathematics and science achievement of the rural community base and one aspect of this project includes the use of iPod podcasts for the students (Clark, 2007; Vanderbilt University, 2007). This three-year project includes iPods programmed with lessons that focus on science and math and as a bonus the students get to keep the iPods if they complete the full study. The school district's superintendent states that beyond the focus of the current project, the students may actually receive course credit for the time they spend learning while commuting to and from school (Paul, 2007).

High school students preparing for college admissions are also a targeted audience for iPod use. Kaplan, a college-preparation company, recently began to offer customizable iPod programs

to students via Apple's iTunes store (Man, 2007). This innovative SAT preparatory program allows students to purchase materials for viewing and practice with timed and untimed tests and the student can even vary the level of difficulty of the programs they choose. Kristen Campbell, the national director of SAT and ACT programs for Kaplan Test Prep, thinks that students will embrace these types of programs because they allow students to study in a medium in which they are familiar and comfortable. Currently, Kaplan is the only test-prep company offering these types of study programs via the iPod iTunes store.

The University of Minnesota's School of Public Health (SPH) features podcasts for many different uses for students and the general public (University of Minnesota School of Public Health, 2007b). They feature weekly health segments (Public Health Moment) and public lectures sponsored by SPH (Public Lectures). Their "Public Health Matters" section contains student and faculty-created podcasts that cover a wide variety of topics related to current research within the department and other public health issues (University of Minnesota School of Public Health, 2007a).

The University of Utah (UU) uses podcasts for a wide variety of information-sharing endeavors. They present podcasts of lectures, interviews, speeches, performances, and have developed several series of lectures for download (University of Utah, 2007). UU features five major categories for podcast feeds including humanities, politics and society, health and wellness, science and technology, and arts and culture. They also have several other podcast program offerings to include the Genetic Science Learning Center, Hinckley Institute of Politics, Humanities Happy Hour, and Sci-Fi Fridays.

The University of Wisconsin-Madison began their podcasting integration with iPods in 2005 to assist students with language acquisition in a German language class (Apple Education, 2007b). Their goals included incorporating class content (language instruction) into the daily lives of their

students outside of the traditional classroom models and making homework more fun for the student. Instructors report that their project actually helps students learn the German language more easily and increases student motivation because they format some of their podcasts in a fun radio show style with fictional callers; thus decreasing straight lecture format and time for the students.

iPod initiatives at Georgia College and State University (GCSU) began in 2002 and have evolved into more than lectures and music to enhance the classroom education of its students (Georgia College and State University, 2006). By the 2006-2007 academic year, there were nearly 50 iPod-based projects designed to reduce in-class lecture time and increase time for students and faculty members to collaborate on experiences and discuss the most important course content areas. These innovative iPod projects have spawned other technological advancements for the university as well, such as their iColony project, a virtual learning community for students with similar interests; and iDreamers, a group of faculty and staff members interested in further developing plans for iPod usage in the future.

The University of Virginia's (UVA) Web site boasts an enormous amount of iPod-based information available for their students as well as the general public. They list 20 categories of information to choose from ranging from academic lectures to science and research (University of Virginia, 2007). The available podcasts also include recurring series, such as *Engaging the Mind*, *Technology in World History*, and others. In addition, each school at UVA is represented with links for individual podcasts related to topics of interest for that particular area of expertise and interest.

While many higher education institutions are employing iPod technology, there are few who are formally evaluating their iPod and/or podcasting programs. Duke University was one of the first higher education institutions in the United States to implement an iPod program. In August

of 2004, more than 1,600 entering first-year students were given iPods (Duke University, 2005). Approximately 48 courses implemented iPod content during the first year of the program. These courses included music, foreign languages social science, and humanities (Duke University, 2005). Additionally, first-year engineering students used their iPods in the engineering programs' required computational methods course.

As part of the program evaluation conducted by Duke's Center for Instructional Technology, data were gathered via several methods: student and faculty focus groups; a survey of first-year students and faculty; course feedback; and conversations with staff, administrators, and campus stakeholder groups. As part of the evaluation, the Center for Instructional Technology wanted to discover how iPods were instructionally used. They found five categories of academic use for the iPod: disseminating course content, recording classroom activities, recording field notes, supporting study of the content, and storing and transferring files (Duke University, 2005). The evaluation also revealed several benefits in utilizing the iPods. The overall benefits reported after the first year of the program included the convenience of portability, easy digital recording, flexible location, increased student interest and engagement, and enhanced support for individual learning differences.

Despite the benefits of using the iPod in the classroom, Duke students and faculty reported several problems (Duke University, 2005). One problem concerned the challenges of integrating multiple systems for storing, accessing, sharing, and distributing content. Another issue was the limited pre-existing documentation and training resources regarding academic uses. Furthermore, integrating the iPods with Duke's existing technology infrastructure was difficult. PC users were also affected by the limited documentation and training. The inadequacy of documentation and training may have contributed to another problem: a lack of awareness and accurate knowledge among

students and faculty regarding how iPods function and their academic applications. A final set of difficulties with the iPods was bulk purchasing and licensing issues.

At the institutional level, Duke University reported several benefits from incorporating iPods into the classroom. The evaluators found four major institutional impacts (Duke University, 2005). The first was increased collaboration and communication between campus technology groups, which resulted in wider planning and improvement of Duke's infrastructure and technology services. The second impact was the widespread attention resulting from the program. Duke gained new contacts, partnerships, and collaborations with other institutions of higher education, publishers, and technology vendors. Third, the program sparked conversations between faculty, administrators, students, and staff about how to best implement technology in the classroom. Consequently, the 2005-2006 Duke Digital Initiative was created with continued iPod use and further incorporation of other technologies. Finally, the iPod program increased overall awareness of Duke's commitment to technology.

However, there were some problems with the evaluation, especially regarding the survey response rate. Only 28 percent of first-year students involved in the program responded to the survey, while only 13 percent of first-year student faculty responded (Duke University, 2005). The low numbers suggest that perhaps not all benefits or problems were accounted for. The program also began with no formal objectives, a limitation remedied in the 2005-2006 Duke Digital Initiative. Finally, cost was not addressed in the evaluation. While the implementation program cost \$500,000, there were no data included regarding how much money the university would have to spend to continue such a program.

Cost was addressed, however, in the 2005-2006 program evaluation report (Duke University, 2006). One of the main challenges mentioned in the report was the difficulty of acquiring mul-

timedia course content in a cost-effective and timely manner. Additionally, cost was alluded to in other challenges. Ongoing planning, training, and support is an expensive challenge due to how rapidly technology changes. Furthermore, the university lacked the classroom capabilities to meet the demand for video recording of classroom presentations. Upgrading classroom infrastructure to meet this demand would be an expensive endeavor, although as part of the 2007-2008 Initiative infrastructure development is planned.

Cost was not the only challenge. The evaluators again found that faculty and students need more training on how to use the iPod and to transition classroom pedagogy into the multimedia environment (Duke University, 2006). Improvements slated for the 2007-2008 year include more development and utilization of support services and teaching strategies in addition to further research of technology in learning and instruction.

Besides Duke University, many other American colleges and universities have implemented iPod programs and podcasting as a means to advance instruction. The University of Michigan's School of Dentistry started a podcasting program in response to first-year dental students' anxiety regarding the quantity of information presented in their courses (Brittain, Glowacki, Van Ittersum, & Johnson, 2006). Originally, the students asked for video recordings, so the School of Dentistry asked an advisory group to study the situation and recommend solutions. In the first pilot study, the focus was on what type of media format was best for lecture review. The results revealed that students preferred an audio-only format over video or audio-synced PowerPoint. The preference was due largely to the mobility of the audio files.

Two more pilot studies were conducted to fully examine the issue (Brittain et al., 2006). The second pilot study focused on the costs involved with recording lectures. Recording via the computer, although more expensive than recording with the iPod, was deemed more suitable by students and faculty due to its superiority in audio recording

quality. The School of Dentistry decided to use a computer and automated recording, processing, and posting tools to reduce staff time, thus decreasing the overall costs involved with the project.

Finally, the third pilot study looked at the dissemination of recordings, in particular the file format students preferred most (Brittain et al., 2006). MP3 and AAC files were both found to be equally well-liked, so the school decided to post both file types to a centrally located Web site for downloads. Due to convenient access, students' usage of the recordings rose from 28 percent to 57 percent.

In addition to the many American higher education institutions using iPods and podcasting, international institutions are also bringing iPod technology into their classrooms. One such institution is Charles Stuart University in Australia. Researchers investigated and evaluated the use of podcasting in an undergraduate and postgraduate class by studying the listeners, producers, and educators involved in podcasting the course (Chan, Lee, & McLoughlin, 2006). Some of the students were part of the production team, which created podcasts targeted towards other students in the class, who served as the listeners.

To evaluate the "listeners" students, an online survey was employed to gather data concerning students' podcast use, the educational value of the podcasts, and the knowledge and skills gained through listening to the podcasts (Chan et al., 2006). The researchers had a 42 percent response rate to their survey. The majority of students used the available podcasts frequently, felt they were useful, and helped with assignments.

To evaluate the "producers," the researchers used a focus group interview (Chan et al., 2006). The focus group questioned participants about motivation, benefits related to involvement, skills developed, lessons learned, and suggestions for improvement. After coding the transcripts, the researchers found that the main area the producing students elaborated on was the skills they developed from participating in the production of

the podcasts, especially with regard to teamwork, communication, and critiquing others.

A study at another international institution looked at an undergraduate course in communication (Edirisingha, Rizzi, Nie, & Rothwell, 2007). At Kingston University in London, students enrolled in the Introduction to Intercultural Communication course served as participants. Students were surveyed and interviewed as part of the study. The survey revealed that 50 percent of the students had not listened to any of the podcasts available to them via the virtual learning environment (VLE). The main reason given for not listening to the podcasts was a lack of time. Other reasons included; they did not know the podcasts were available, they had technical difficulties accessing the materials, and they did not view the podcasts as relevant for learning. Additionally, of those who did listen to the podcasts, many did not download the podcasts because they could access the material any time they wanted. Furthermore, 31 percent noted that they preferred their MP3 player to be dedicated to music listening only, indicating they did not want the podcasts residing on their portable players.

Students were also surveyed regarding their activities while listening to podcasts (Edirisingha et al., 2007). The majority of respondents (47%) reported they only listened and did not participate in other activities, while 33 percent noted that they took notes while listening. Only seven percent reported doing other activities while listening to the podcasts. These findings suggest that the students, for the most part, engaged with the podcasts.

In addition to the previous findings, the researchers asked students about the key learning objectives related to the podcasts (Edirisingha et al., 2007). Students rated the following statements favorably: (a) Podcasts were useful for me to know more about the assessed work, (b) Podcasts were useful in preparation for workshops/seminars, and (c) Podcasts provided a good supplement to the other learning material for this module. Other statements regarding motivational aspects

were rated highly as well. The students, however, did not believe that the podcasts were helpful in organizing weekly activities or made good use of their time. A study by Edirisingha, Salmon, and Fothergill (2007), looking at learners' attitudes, found similar results.

Although students may remark that the podcasts are useful and aid their learning, there is little empirical evidence to support these claims. While many institutions are now using podcasts and iPod technology, more information about how humans learn from mobile technology is needed before such programs are implemented in the curriculum.

Basic Research: iPods as Mobile Multimedia Instructional Environments

Part of the allure of iPod-based mobile technology is the mobility (being able to use the technology in multiple and mobile environments). Unfortunately, while there is substantial applied research involving the use of iPods in education, there is very little basic research examining how students learn from iPods. Due to the paucity of educationally related basic empirical literature on the use of the iPod, the following studies are taken from a wide array of disciplines.

Salvucci, Markley, Zuber, and Brumby (2007) examined participants' ability to drive under the distraction of iPod usage. Participants were asked to search for and play music, podcasts, and videos while using a driving simulator. Salvucci et al. (2007) found that searching for and the selection of all three media types had a significant detrimental effect on driver performance, measured by lateral deviation (drivers ability to maintain a central lane position) and speed change (drivers ability to maintain a constant speed). Overall, Salvucci et al. (2007) discovered that simply listening to songs or podcasts had no significant effect on driving performance, but that searching for and selecting

media led to an increase in driver distraction and a decrease in driver performance.

O'Hara, Mitchell, and Vorbau (2007) also found distraction during mobile technology use in a study addressing individuals' daily use of mobile technologies, including iPods. O'Hara et al. (2007) studied the behaviors of established users of mobile technologies and found that the technology was being consumed in a variety of places and times such as at home, work, cafes, gyms, and airport lounges, as well as while driving to work, eating lunch, and going to bed. Reasons for using these mobile technologies included avoiding others, blocking out the surrounding environment, sharing videos, using time more effectively, and managing solitude. During the study, O'Hara et al. also found that the use of mobile technologies could lead to divided attention; that is, users often needed to divide their attention between watching a video using the mobile technology and monitoring others around them or being aware of events such as the arrival of a desired bus (2007).

While Salvucci et al. (2007) and O'Hara et al. (2007) found that iPod-based mobile technology is used in a variety of locations, for a variety of reasons, and that iPod use may be distracting, Hürst, Lauer, and Nold (2007) focused on screen size or the presentation modality effect on learning. Hürst et al. (2007) had participants view an animation on algorithm application using either an iPod, with a 2.5" screen, or a laptop computer. In addition Hurst et al. (2007) had participants view either an animation with on-screen text explanations or animation with audio narration. Hürst et al. (2007) deduced that there was no difference in student learning based on screen size (i.e., iPod versus laptop), but that students who viewed the animation with audio narration presentation learned more than students who viewed the animation with on-screen text presentation. Hurst et al.'s (2007) findings that learning was improved through the use of animation with audio narration, as compared to animation with on-screen text, is in agreement with previous research (Ginns, 2005;

Mayer & Moreno, 1998). Also, when asked which of the devices participants preferred for learning, half expressed no preference and the other half preferred the device they had used to engage the material with audio narration presentation. Ultimately, Hürst et al. (2007) concluded, “maybe the most important observation from our experiment is that people actually were able to learn something by using mobile devices” (p. 164).

The findings of Hürst et al. (2007) have demonstrated that iPods may be used effectively to foster learning and the findings of Salvucci et al. (2007) and O’Hara et al. (2007) lead credence to the question of whether or not attention, or distractibility, is a variable of interest in the use of iPods in education. With the issues of learning and attention in iPod-based mobile multimedia instruction environments in mind, a study was conducted.

IPODS AND INDIVIDUAL DIFFERENCES: A STUDY OF WORKING MEMORY

iPods are currently being used in many primary and secondary schools, as well as colleges and universities, as an educational platform. As the previous discussion of basic research into iPod use demonstrates, however, little is known regarding how the iPod-based educational environment interacts with the learner. One aspect of the learner that may bear on the use of the iPod as an educational platform is the learner’s attention. Attention has previously been demonstrated to be an essential component of learning in desktop multimedia instructional environments (Mayer, 2005b; Mayer & Moreno, 1998; Moreno & Mayer, 2000). This previous research has demonstrated that when attention is split between two sets of stimuli, such as an animation with on-screen narrative text (Mayer & Moreno, 1998); or when attention is diverted from instructional content to non-instructional content, such as when an animation is accompanied by

non-essential sounds, music, or videos (Moreno & Mayer, 2000); learning suffers. In addition, Mautone and Mayer (2001) have indicated that when attention is guided *toward* instructional content, learning improves.

Given the iPods’ mobility and its 2.5” screen, it is reasonable to question whether attention plays a special and important role in learning complex mental tasks in an iPod-based multimedia learning environment. In general, learning complex mental tasks has been sensitive to individual differences in attention; specifically, in individual differences in the ability to control attention (Daneman & Carpenter, 1980; Oberauer, Süb, Schulze et al., 2007; Wilhelm, & Wittmann, 2000). The ability to control attention is a central component of *working memory capacity* (WMC; Kane, Bleckley, Conway, & Engle, 2001; Kane & Engle, 2003), where WMC is defined as the ability to (a) maintain the current cognitive task in working memory, (b) maintain task relevant information in working memory, and (c) retrieve task relevant information from long-term memory (Feldman Barrett, Tugade, & Engle, 2004). A study was completed to assess the importance of attentional control, low WMC versus high WMC, in stationary and mobile multimedia learning environments using the iPod.

Working Memory Capacity

Working memory capacity (WMC) represents the ability of an individual to control his or her attentional resources relative to working memory, especially in the presence of distraction (Feldman Barrett et al., 2004; Unsworth & Engle, 2007). That is, WMC moves beyond working memory storage capacity (see Miller, 1956) to include both storage *and* processing capacity (see Daneman & Carpenter, 1980; Kane & Engle, 2003). Thus, ultimately, WMC is a measure of control: the ability to control the maintenance of information in working memory (storage) and the retrieval from long-term memory of information relevant to a

current problem or situation (processing). This control is most evident when there are distractions, internal (e.g., thoughts, drives, feelings) or external (e.g., talking, music, motion), challenging the attentional system (Unsworth & Engle, 2007).

Is this type of attentional control important? Previous research has indicated that individuals with high WMC outperform individuals with low WMC on measures of general fluid intelligence (Conway, Cowan, Bunting et al., 2002; Kane et al., 2004), long-term memory activation (Cantor & Engle, 1993), attentional control (Kane et al., 2001; Rosen & Engle, 1997), resistance to proactive interference (Kane & Engle, 2000; Lustig, May, & Hasher, 2001), primary memory maintenance and secondary memory search (Unsworth & Engle, 2007), and resistance to goal neglect (Kane & Engle, 2003; Roberts, Hager, & Heron, 1994). While these studies have indicated a positive effect for WMC on memory attributes, there is also extensive literature indicating that high WMC positively affects more academic pursuits, such as reading comprehension (Daneman & Carpenter, 1980), language comprehension (Just & Carpenter, 1992), vocabulary learning (Daneman & Green, 1986), reasoning (Conway et al., 2002; Kyllonen & Christal, 1990; cf. Buehner, Krumm, & Pick, 2005), computer language learning (Shute, 1991), lecture note taking (Kiewra & Benton, 1988), Scholastic Aptitude Test performance (Turner & Engle, 1989), mnemonic strategy effectiveness (Gaultney, Kipp, & Kirk, 2005), and story telling (Pratt, Boyes, Robins, & Manchester, 1989). This research has demonstrated a strong, positive relationship between variations in WMC and variations in complex cognitive task performance.

A Study of iPods and Individual Differences

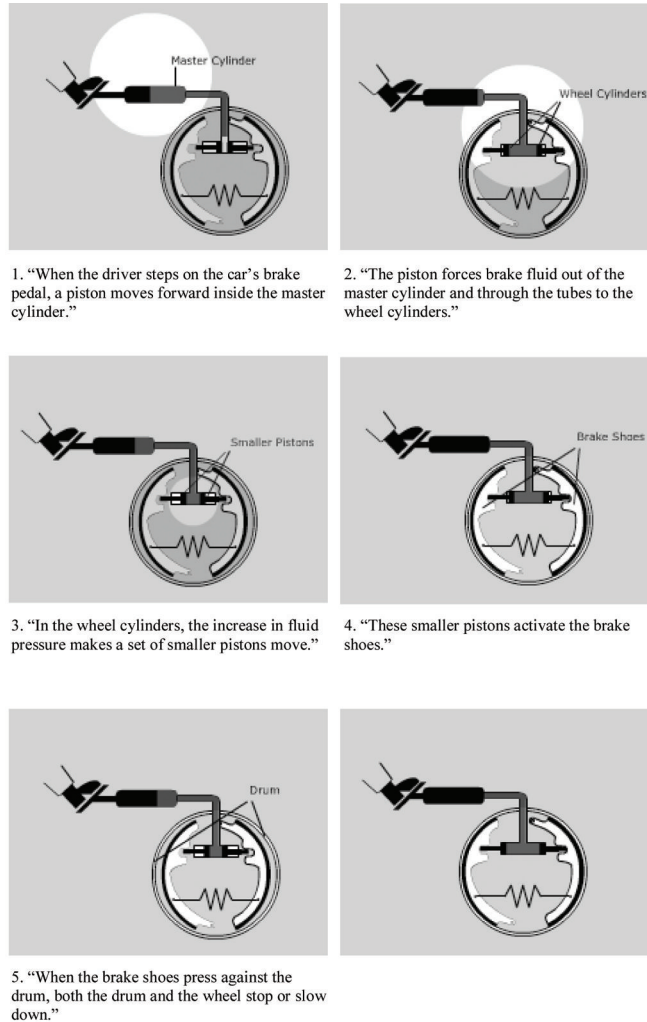
To investigate the effects of high and low WMC students' learning in stationary and mobile iPod-based multimedia learning environments, 76 undergraduate students (52 males and 24 females)

were taken from a larger population of 294 students who were administered the OSPAN working memory span test. The OSPAN test measures working memory capacity and requires students to solve math sentences aloud (e.g., is $(2 + 6) - 2 = 4$?) while also maintaining a list of unrelated words in working memory (La Point & Engle, 1990; Turner & Engle, 1989). Using the OSPAN test scores, the upper and lower quartiles of the original 294 students were designated as high ($n = 38$) and low ($n = 38$) WMC, respectively. These 76 students were then randomly assigned to either the stationary instruction group ($n = 38$) or the mobile instruction group ($n = 38$).

All students, regardless of WMC (high or low) or instructional group (stationary or mobile) engaged in a multimedia tutorial designed to address the workings of a car brake. The multimedia tutorial consisted of a narrated Flash® animation explaining how a car brake works (see Mayer & Anderson, 1992). This explanation included drawings of a foot pressing a brake pedal, a piston moving inside a master cylinder, brake fluid moving out of the master cylinder, brake fluid expanding smaller pistons in the wheel cylinder, and these smaller pistons pushing the brake shoes against the brake drum (see Figure 1). The animation from the foot stepping on the brake pedal to the brake shoes pressing against the brake drum lasted 30 seconds; however, this 30 second animation was played three times in order to accommodate the narration. Thus, each multimedia instructional episode lasted 90 seconds. Finally, this car brake multimedia tutorial was presented on a 5th generation iPod (i.e., video iPod) with a 2.5" screen and Altec Lansing® headphones.

Students in the stationary instruction group viewed the multimedia tutorial on an iPod while sitting in a chair at a desk in a computer lab. Students in the mobile instructional group were first provided with a random number from 1 to 3 and then asked to walk 25 yards down a hallway, and back, repeatedly, until the multimedia tutorial came to an end. Every five yards along this

Figure 1. Sample animation screens and accompanying verbal content from the brake tutorial (animations adapted from and text quoted from Mayer & Anderson, 1992, p. 446)

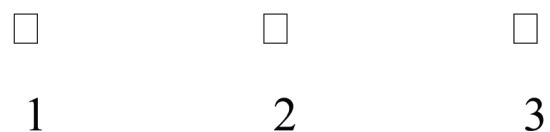


walk was a two-sided sign on the floor that included the numbers 1, 2 and 3, and above each number an arrow pointing left or right (see Figure 2). Participants were instructed to walk to the side of the sign indicated by the arrow above the number to which they were assigned. This walking and navigating, while engaging in the multimedia tutorial, simulated the type of mobile environment one might encounter while trying to walk across a college campus.

After students finished engaging in the multimedia tutorial, whether in the stationary or mobile

instructional group, they were seated and asked to answer both recall questions assessing students' ability to remember the essential knowledge to which they were exposed and their ability to

Figure 2. Directional signs used in the mobile learning environment



express this knowledge, and transfer questions assessing students' ability to apply the knowledge recalled to new, yet similar situations (i.e., near transfer). Students' recall of the car brake tutorial was assessed using a single open-ended question: "Please provide an explanation of how a car brake works." Two trained raters evaluated each student's recall response ($r = .90$) and provided one point for the inclusion of each of the following idea units, regardless of wording: "(a) driver steps on brake pedal, (b) piston moves forward inside master cylinder, (c) piston forces brake fluid out to the wheel cylinders, (d) fluid pressure increase in wheel cylinders, (e) small pistons move, (f) small pistons activate brake shoes, (g) brake shoes press against drum, and (h) drum and wheel stop or slow down" (Mayer & Anderson, 1992, p. 450).

Students' ability to transfer knowledge from the car brake tutorial was assessed using four questions (see Mayer & Anderson, 1992, p. 449): (a) "Why do brakes get hot?"; (b) "What could be done to make brakes more reliable, that is, to make sure they would not fail?"; (c) "What could be done to make brakes more effective, that is, to reduce the distance needed to bring a car to a stop?"; and (d) "Suppose you press on the brake pedal in your car but the brakes do not work. What could have gone wrong?" Two trained raters evaluated each student's responses ($r = .83$) based on acceptable answers established by Mayer and Anderson (1992). Acceptable answers to the first transfer question, "Why do brakes get hot?" included friction causes brakes to get hot; acceptable answers to the second transfer question, "What could be done to make brakes more reliable, that is, to make sure they would not fail?" included maintain a back up system or use a system to cool the brakes; acceptable answers to the third transfer question, "What could be done to make brakes more effective, that is, to reduce the distance needed to bring a car to a stop?" included using a brake shoe that is more sensitive to friction or providing a smaller gap between the brake shoe

and brake drum; and finally, acceptable answers to the fourth transfer question, "Suppose you press on the brake pedal in your car but the brakes do not work. What could have gone wrong?" included that there may be a leak in the brake fluid line or that the brake pads are worn.

Results and Discussion

The results of the study addressed high and low WMC students' cognitive performance in stationary and mobile multimedia learning environments. Overall, there was a significant difference in cognitive performance between participants who learned in a stationary learning environment as compared to participants who learned in a mobile learning environment. Specifically, participants in the stationary learning environment recalled more idea units ($M = 5.74$, $SD = 1.75$) from the car brake multimedia tutorial than participants in the mobile learning environment ($M = 4.92$, $SD = 2.96$), $F(1,72) = 4.72$, $MSE = 25.94$, Cohen's $d = 0.33$, $p = .03$. In addition, participants in the stationary learning environment transferred more car brake knowledge ($M = 5.58$, $SD = 0.59$) than participants in the mobile learning environment ($M = 4.97$, $SD = 1.21$), $F(1,72) = 19.02$, $MSE = 12.36$, Cohen's $d = 0.69$, $p = .00$. These results indicated that participants recalled and transferred more information when learning in a stationary versus a mobile learning environment. Specifically, it was found that students who learned about car brakes using a portable digital media player (i.e., iPod), while navigating a walking course that required attention to the path taken, performed significantly more poorly on measures of recall and transfer than students who learned while simply sitting at a desk.

In addition to the stationary/mobile learning results, an analysis of the WMC data indicated that high WMC students recalled more idea units ($M = 5.92$, $SD = 2.67$) than low WMC students ($M = 4.74$, $SD = 2.07$), $F(1,72) = 7.27$, $MSE = 39.94$, Cohen's $d = 0.49$, $p = .00$. Similarly, for

transfer, high WMC students generated more valid transfer responses ($M = 5.61$, $SD = 0.67$) than low WMC students ($M = 4.95$, $SD = 1.16$), $F(1,72) = 29.96$, $MSE = 13.63$, Cohen's $d = .69$, $p = .00$. These results are consistent with previous findings regarding a general WMC effect (Doolittle, 2007; Unsworth & Engle, 2007), that high WMC students outperform low WMC students on recall and transfer after engaging in a multimedia tutorial.

The preceding results demonstrate that students learn more from a short cause-and-effect multimedia tutorial when stationary, as opposed to when mobile, and that high WMC students learn more than low WMC students. However, a significant question yet to be answered is whether or not there are individual differences in stationary/mobile learning when WMC is taken into account. The answer is mixed. Specifically, there was no interaction between instructional group (stationary, mobile) and WMC (high, low) for recall of the car brake tutorial. There was, however, a significant interaction for transfer (see Table 1), $F(1,72) = 11.98$, $MSE = 7.79$, $p = .00$. An examination of the means indicates that mobile learning environments are less advantageous to low WMC students than high WMC students. This examination was confirmed using a contrast analysis comparing the mobile-low WMC group to the remaining three groups (i.e., mobile-high WMC, stationary-low WMC, stationary-high WMC), $F(1,72) = 27.53$, $MSE = 0.65$, Cohen's $d = 1.33$, $p = .00$. These interaction results indicate

that if deep learning, as measured by transfer, is the goal of instruction, mobile multimedia learning environments significantly disadvantage students with low WMC. Namely, students with the least attentional control and the most susceptibility to distraction (low WMC students) performed the poorest under conditions that required significant attentional control: learning while mobile.

IPODS AS MOBILE MULTIMEDIA LEARNING ENVIRONMENTS

The preceding discussion and research has indicated that (a) iPods are currently being used as educational platforms; (b) podcasting is the typical, although not the only, pedagogy of choice; and (c) students can and do learn from engaging with the iPod. However, previous research also indicates that (d) little basic empirical research is being conducted on the efficacy of the iPod as a learning platform; but (e) recent empirical research has demonstrated that students with low working memory capacity perform less well in mobile learning environments than students with high working memory capacity. These findings begin to bring into focus the landscape of iPod-based instruction, although a crisp and clear picture is still distant.

At the most basic level, it is important to note that Hürst et al. (2007) and the study reported within this chapter both found that students learn

Table 1. Means and standard deviations of recall and transfer from engaging in a car brake multimedia tutorial for instructional groups (stationary, mobile) and WMC groups (low, high)

	Instructional Environment									
	Stationary					Mobile				
	Recall		Transfer			Recall		Transfer		
	M	SD	M	SD		M	SD	M	SD	
Low WMC	5.33	1.68	5.50	0.51		3.71	2.33	4.00	1.35	
High WMC	6.43	1.69	5.71	.072		5.63	3.10	5.54	0.65	

Note: Maximum score for recall was 8. Maximum score for application was 7.

as the result of engaging in an iPod-based instructional episode. In the case of Hürst et al., students learned strategic knowledge, a search algorithm, while students in the current study learned procedural knowledge, how a car brake works. These foundational findings provide support for the use of the iPod as an instructional platform.

The research of Salvucci et al. (2007) and the current study, however, also demonstrate that the iPod must be used with caution and that all students may not benefit equally from the instructional use of the iPod. Salvucci et al. found that, generally, using the iPod can require significant attentional resources in conditions of distraction, for example, using the iPod while driving. Further, the present study revealed that students with considerable attentional resources—high working memory capacity—were unaffected by distractions when using the iPod; however, students with fewer attentional resources—low working memory capacity—were negatively affected by distractions while using the iPod. These findings demonstrate that students' attentional control has a significant impact on the efficacy of the iPod as an instructional platform.

As mobile learning opportunities have become ubiquitous with the advent of portable, lightweight devices (e.g., mp3 players, mobile phones, PDAs) it is imperative that educators, instructional designers and instructional technologists maintain a 360° view of the educational playing field. At this nexus of pedagogy, design and technology “there is a tension... that comes from the fact that most mobile devices in current use are not designed specifically for education or training but rather for personal information management or personal communication” (Kukulska-Hume & Taxler, 2005, p. 3). Kukulska-Hume and Taxler goes on to state that “future projects ought to address learning gains more directly, to gather evidence of what can be learnt using these [mobile] devices” (p. 189). These comments emphasize that for mobile learning to be educationally successful

there is a need to focus on the development of educationally appropriate technology, individually appropriate pedagogy, and the interaction between the technology and the individual.

FUTURE RESEARCH DIRECTIONS

Research and explorations involving mobile multimedia learning environments utilizing portable digital media players is just beginning. While the initial findings are promising, much is still unknown. What specific types of pedagogies work best with specific types of mobile technologies based on specific areas of instructional content? What individual difference variables (e.g., spatial ability, reading ability, prior knowledge, working memory capacity) affect students' success when learning in mobile multimedia learning environments? How can mobile multimedia learning environments be made more accessible to students with special needs? How can, or should, the use of mobile multimedia learning environments be integrated into the daily educational environments of students?

Currently, educators are forced to create mobile multimedia learning environments within mobile devices that were not originally designed to foster learning; cell phones, MP3 players, and PDAs were designed more as communication tools than educational tools. Given that these communication tools are being adapted for educational purposes, it is essential that educators share their adaptations so that others may benefit from and expand these initial efforts. In addition, however, these case studies of adaptation must include rigorous evaluation and assessment so that there is evidence from which to make educated decisions. Without rigorous evaluation and assessment the field of mobile learning runs the risk of devolving into a faddish application of technological flash without substance.

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Chapter 3.9

Telementoring and Project– Based Learning: An Integrated Model for 21st Century Skills

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ABSTRACT

While common models of telementoring (ask-an-expert services, tutoring, and academic and career telementoring) can serve a variety of learning objectives, these models are limited with respect to sustained inquiry learning such as project-based learning (PBL). To reach the full potential of PBL with telementoring, this chapter proposes a telementoring model that integrates inquiry learning, information literacy, and digital media literacy and is implemented by a team of experts – subject matter experts as telementors, classroom teachers, school librarians, and instructional technology specialists. The model provides for multifaceted learning experiences for students that involve disciplinary knowledge and habits of mind, critical thinking, collaborative problem solving,

and information, media, and technology skills. Brief overviews of inquiry learning approaches, information literacy, and digital media literacy are described in relation to telementoring. Design considerations, the benefits and challenges of the model, and broader implications for educational change are also discussed. Using the integrated telementoring model, the PBL team exemplifies the interdisciplinary collaboration and new literacy skills that students need in today's workplaces and communities.

INTRODUCTION

Often associated with apprenticeships in a community of practice, mentoring is the age-old process of wiser, more experienced persons taking younger protégés under their wing. As role models, mentors guide their young initiates into

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the art, craft, ways of thinking, and values of their community, helping to shape not only knowledge and skills but also the identity and personal and professional maturity of their protégés. Mentoring is rewarding for both the mentee and the mentor. The mentee has a deepening relationship with a special person in his/her life - not a parent, teacher, or friend, but a wise guide who listens, cares, encourages, and gives advice. For the mentor, this is a unique opportunity to make a difference in a young person's life and give back to one's profession and community.

Since the rise of the World Wide Web in the 1990s, a variety of online tools has been available to support mentoring beyond the barriers of time and place. Telementoring, also known as online mentoring and e-mentoring, can be defined as:

... using telecommunications technology (including e-mail, conferencing systems, or telephones) to develop and sustain mentoring relationships where face-to-face ones would be impractical. In the field of education, telementoring often involves linking students up with knowledgeable adult volunteers who have an interest in fostering their development. This sort of arrangement allows the participants to take part in intellectual partnerships that would not otherwise take place. (O'Neill, 2000, p. iii)

While communicating online makes telementoring different from traditional face-to-face mentoring, telementoring offers some distinct benefits. Mentors are not limited to the local community and can be drawn from any profession, organization, or geographic location around the world where adults are willing to help a young person develop. And mentors and mentees can communicate at any time, using a wide range of online tools.

Telementoring uses various mentor group configurations to provide different kinds of expert support to students seeking help. MENTOR/ National Mentoring Partnership's "Elements of

Effective Practice" (http://www.mentoring.org/find_resources/elements_of_effective_practice/) identifies these five types of contemporary group mentoring: (1) traditional mentoring (one adult to one young person); (2) group mentoring (one adult to up to four young people); (3) team mentoring (several adults working with small groups of young people, in which the adult to youth ratio is not greater than 1:4); (4) peer mentoring (caring youth mentoring other youth); and (5) e-mentoring (mentoring via e-mail and the internet).

Expert support online comes in many forms – ask-an-expert services for one-time, discipline-based questions; tutoring for supplementary or remedial study; telementoring for career guidance and academic advice; and telementoring for inquiry learning. Examples of each of these types, as well as their strengths and limitations, will be discussed later in the chapter.

This chapter's main focus is on telementoring for sustained inquiry in the classroom through project-based learning (i.e., project-based telementoring). It is written at a time of extraordinary economic and technological changes and associated challenges to the U.S. educational system. The Partnership for 21st Century Skills, a group of leading education, business, community, and government organizations, has identified essential skills beyond reading, mathematics, and science that students need to "increase their marketability, employability and readiness for citizenship" (Partnership, 2008, p. 10):

- Thinking critically and making judgments about the barrage of information that comes their way every day – on the Web, in the media, in homes, workplaces and everywhere else.
- Solving complex, multidisciplinary, open-ended problems that all workers, in every kind of workplace, encounter routinely.
- Creativity and entrepreneurial thinking – a skill set highly associated with job creation (Pink 2005; Robinson 2006; Sternberg,

1996). Many of the fastest-growing jobs and emerging industries rely on workers' creative capacity – the ability to think unconventionally, question the herd, imagine new scenarios and produce astonishing work.

- Communicating and collaborating with teams of people across cultural, geographic and language boundaries – a necessity in diverse and multinational workplaces and communities.
- Making innovative use of knowledge, information and opportunities to create new services, processes and products. The global marketplace rewards organizations that rapidly and routinely find better ways of doing things. Companies want workers who can contribute in this environment.

Project-based telementoring has the potential to address many of these important skills. Due to the widespread use of the internet and the plethora of free or low-cost technologies for online communication and collaboration, the possibilities for innovative telementoring programs are unprecedented.

Providing the environment and structural support for new types of telementoring is a significant challenge. The New Media Consortium (NMC), a community of hundreds of leading universities, colleges, museums, and research centers, sees the following as the most critical challenges schools will face as they integrate new technologies and reshape the educational experience in the next five years: (1) There is a need for formal instruction in key new skills. (2) Educational practice and materials are changing too slowly to support current student needs. (3) Learning that incorporates real life experiences is not occurring enough and is undervalued when it does take place. (4) New technologies must be adopted and used as an everyday part of classroom activities, but effecting this change is difficult. (5) The fundamental structure of the K-12 education establishment

is resistant to any profound change in practice (Johnson, Levine, Smith, & Smythe, 2009, p. 7-8). These trends indicate not only the challenges that schools face, but also the potential of project-based telementoring to contribute to needed changes in structure, teaching practice, and a more relevant educational experience for students.

The next sections of this chapter provide brief overviews of inquiry learning approaches, information literacy (including mastery of information technology), and digital media literacy (particularly with communication and collaboration technologies), as they relate to telementoring. This is followed by an assessment of strengths and weaknesses of common models of telementoring. To reach the full potential of project-based learning, I propose a telementoring model that integrates inquiry learning, information literacy, and digital media literacy and involves a team of specialists – subject matter experts as telementors, classroom teachers, school librarians, and instructional technology specialists. Because of the diverse expertise of this project-based learning (PBL) team, the model provides for multifaceted learning experiences for students that involve disciplinary knowledge and habits of mind, critical thinking, collaborative problem solving, and information, media, and technology skills. Design considerations, the benefits and challenges of the model, and broader implications for educational change are also discussed. Using the integrated telementoring model, the PBL team exemplifies for students the interdisciplinary collaboration and new literacy skills that are increasingly valued in today's workplaces and communities.

INQUIRY LEARNING APPROACHES AND TELEMENTORING

Other chapters in this book explore in depth the use of telementoring in inquiry, problem-based, and project-based learning. The goal of this section is to provide an overview of these approaches

as the foundation for a discussion of how well different models of telementoring can meet the learning challenges and address the new media literacy skills needed today.

Scientific inquiry in the classroom is often simplified to a linear process of asking a question, formulating a hypothesis, performing an experiment, collecting data, and drawing conclusions. The University of California Museum of Paleontology's website, *Understanding Science* (<http://www.understandingscience.org>), aims to accurately communicate "the real process of science" – not only a process of exploration, discovery, and testing ideas, but also of scientific growth based on community analysis and feedback that is shaped by the benefits and outcomes for individuals and society. Science is a process that is dynamic and intensely human:

[S]cientists often begin an investigation by plain old poking around: tinkering, brainstorming, trying to make some new observations, chatting with colleagues about an idea, or doing some reading. Scientific testing is at the heart of the process. In science, all ideas are tested with evidence from the natural world. ... You can't move through the process of science without examining how that evidence reflects on your ideas about how the world works — even if that means giving up a favorite hypothesis. The scientific community helps ensure science's accuracy. Members of the scientific community ... play many roles in the process of science, but are especially important in generating ideas, scrutinizing ideas, and weighing the evidence for and against them. Through the action of this community, science is self-correcting. ... The process of science is intertwined with society. The process of science both influences society ... and is influenced by society. ("A blueprint for scientific investigations," http://undsci.berkeley.edu/article/0_0_0/howscienceworks_03)

Scientific inquiry is clearly a social process as well as a rigorous procedure for testing hypotheses.

Identifying a scientific problem and testing one's ideas through communication, collaboration, and peer review are critical aspects of inquiry often missing from the student's classroom experience. Through the partnerships and collaboration enabled through telementoring, a subject matter expert can be one of the most valuable members of the classroom's community of inquiry.

The Telementor's Guidebook (O'Neill, 2000) describes and analyzes a number of telementoring relationships with project groups from a 9th grade class that illustrate the types of guidance subject matter experts can provide. For example, two students doing a research project on earthquakes were matched with a geology graduate student who provided both intellectual and emotional support to help them reach their project goals. Other examples of telementoring by community experts can be found in the project summaries provided on The Electronic Emissary K-12 Telementoring website (http://emissary.wm.edu/project_public.php).

Inquiry learning approaches such as problem-based learning and project-based learning extend the problem beyond a single lesson or two and bring to the classroom some of the complexity, curiosity, creativity, serendipity, and communal effort that more accurately reflect the nature of scientific inquiry. The Illinois Mathematics and Science Academy's PBLNetwork (<http://pbln.imsa.edu/model/intro/index.html>) provides this definition of problem-based learning:

Problem-based learning (PBL) is focused experiential learning organized around the investigation and resolution of messy, real-world problems. PBL engages students as stakeholders immersed in a messy, ill-structured, problematic situation. PBL organizes curriculum around this holistic problem, enabling student learning in relevant and connected ways. PBL creates a learning environment in which teachers coach student thinking and guide student inquiry, facilitating

learning toward deeper levels of understanding while entering the inquiry as a co-investigator.

A challenging issue in problem-based learning is ascertaining problem difficulty in ill-structured problems, with respect to learners' ability to solve such problems. Jonassen (2000; Jonassen & Hung, 2008) identifies a number of factors that contribute to problem difficulty. Factors related to the learner are level of domain knowledge, experience in solving problems, and reasoning skills. Factors inherent in the problem are level of abstraction, stability of problem attributes over time, complexity, and how well- or ill-structured the problem is. Jonassen and Hung (2008, p. 16) recommend that problems should be open ended, moderately ill structured, and with a degree of complexity that is challenging and motivating to students. Appropriate ill-structured problems should "provide opportunities for students to examine the problem from multiple perspectives or disciplines; [be] adapted to students' prior knowledge; [and be] adapted to students' cognitive development and readiness" (p. 16).

An example of a problem statement for elementary students who role play being entomologists shows how problem-based learning can be approached (Goodnough & Hung, 2008, p. 90):

Every summer, Mrs. Bartlett likes to sit in a chair and enjoy her beautiful garden where she has lots of plants and flowers with butterflies flying from one to another. However, before Mrs. Bartlett can enjoy her peaceful summers, she always has to fight with hungry caterpillars who love to eat the leaves of her plants in the spring. ... You and your teammate are entomologists (bug experts) in training. ... What can your team tell Mrs. Bartlett about caterpillars? What can your team do to help Mrs. Bartlett with her problem without destroying her garden? Mrs. Bartlett will choose the best solution to her problem from all the proposals. In order to produce an effective and trustworthy solution proposal, your team should use scientific

methods, such as continuous, consistent observation and keep a journal of your research plan, how the plan has been carried out, and whether any revisions to your research plan are needed after a period of doing your research.

Similarly, project-based learning attempts to infuse authenticity, complexity, and community into the learning process. The Buck Institute for Education (BIE, n.d., p. 4) defines project-based learning as "a systematic teaching method that engages students in learning knowledge and skills through an extended inquiry process structured around complex, authentic questions and carefully designed products and tasks." BIE (p. 4-5) criteria for exemplary PBL projects include:

- Recognize students' inherent drive to learn, their capability to do important work, and their need to be taken seriously by putting them at the center of the learning process.
- Engage students in the central concepts and principles of a discipline.
- Highlight provocative issues or questions that lead students to in-depth exploration of authentic and important topics.
- Require the use of essential tools and skills, including technology, for learning, self-management, and project management.
- Specify products that solve problems, explain dilemmas, or present information generated through investigation, research, or reasoning.
- Include multiple products that permit frequent feedback and consistent opportunities for students to learn from experience.
- Use performance-based assessments that communicate high expectations, present rigorous challenges, and require a range of skills and knowledge.
- Encourage collaboration in some form, either through small groups, student-led presentations, or whole-class evaluations of project results.

What does project-based learning look like in the classroom? Planning any educational effort begins with the desired outcomes in mind, known as “backward mapping” (Wiggins & McTighe, 1998). A PBL project begins with developing a project idea, deciding the scope of the project, selecting curriculum standards, working from project design criteria, and creating the optimal learning environment (BIE & Boise State University, 2005). Most projects last several weeks but some can last much longer. Information/data collection that involves library research or active research in the field, such as interviews and community inquiry, can extend the length of the projects. Successful projects usually involve adults, either experts or community representatives, as partners or mentors in a project, necessitating more time. Some projects address broad, open-ended questions with many different solutions, resembling problem-based learning. Complex projects need sufficient time for preparation and student research. Student autonomy is one of the characteristics of PBL, and students can be involved in the project design.

Examples of successful PBL projects at the high school level can be found on the website of High Tech High in San Diego, California (<http://www.hightechhigh.org/pbl/index.html>). The descriptions of such projects as how drugs affect your body, how human habitation affects the environment, and how math and science affect artistic expression generally include a project overview, standards addressed, a timeline and narrative of activities, lesson plans, assessment rubrics, and teacher and student reflections. Other examples of PBL projects are found in the additional resources listed in Additional Reading.

PBL projects center on driving questions that are “open-ended, go to the heart of a discipline or topic, are challenging, can arise from real world dilemmas that students find interesting, and are consistent with curricular standards and frameworks” (BIE & Boise State University, 2005). While the subject matter specialist may have deeper and more

extensive content knowledge than the teacher, the teacher has a unique knowledge base needed for PBL: pedagogical knowledge, knowledge of the students, and pedagogical content knowledge – “the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learner, and presented for instruction” (Shulman, 2004, p. 227). PBL projects require teachers to be learning facilitators, drawing on their pedagogical content knowledge. O’Neill (2000, p. 37) provides an example of how the teacher’s unique knowledge helps ensure telementoring success:

While teachers may not participate directly in telementoring relationships, they can do a number of other things indirectly, to help them flourish. To begin with, Mr. Wagner [the teacher] set requirements for the students’ investigation that gave Dan [the telementor] an appropriate role to play. If the students’ assignment had been a more traditional book report, or an investigation of much shorter duration, Dan may have had very little opportunity to become richly involved. Mr. Wagner didn’t simply match his students with their mentor and let them go, either: he was there to make decisions about whether or not the students’ research proposal was solid enough to go forward, so that Dan was not forced to do this on his own. While Dan had ideas about what the students might be capable of doing, and to what level of perfection, only the teacher had intimate enough knowledge of the students to make a confident decision about this. Finally, during Andy, Cori and Bill’s [the students] correspondence with Dan, Mr. Wagner offered the students a substantial amount of behind-the-scenes guidance and support himself. This included helping the students to interpret some of Dan’s messages, which they weren’t always able to understand easily. Even the very best telementor sometimes talks over mentees’ heads unintentionally.

In PBL, teachers are also project managers who structure and guide a project to a successful conclusion while supporting students as they move through an open-ended process of discovery and reflection.

A key consideration is student readiness. Do students have sufficient content knowledge and skills to handle the project successfully? Can they take independent initiative and work collaboratively? Do they have the necessary skills with technology and access to the required tools? Technological resources can be powerful and engaging for students, but they must also be essential tools for learning. Teachers also need fluency with these resources so that the learning can focus on the central content and investigation rather than managing and troubleshooting the technology. While there is no evidence that tools such as virtual learning environments, social software, and other information and communication technologies are being extensively used for project-based learning (Dede, 2007, p. 21), new guides are appearing for how to implement PBL with digital tools, the internet, and Web 2.0 (Boss, Krauss, & Conery, 2008).

Problem-based learning and project-based learning are similar in their emphasis on student autonomy, a shared goal, authentic problems, evidence-based investigations and solutions, collaborative learning, and reflection (Savery, 2006). The primary differences are the goals and the structuring of the activity. Problem-based learning focuses on solving ill-structured problems that require learners to set their own parameters. Project-based learning focuses on an end product. Clear design criteria are essential, with teachers and other adults serving as instructors, coaches, mentors, or project collaborators who provide expert feedback in a timely manner. Ravitz (2009, p. 6) notes that although there are differences among problem-based, project-based, inquiry-based, design-based, and challenge-based learning, “the similarities are more significant, allowing them to be viewed as ‘close cousins’ with many similar characteristics.”

In addition to teachers and subject matter experts, other experts contribute to inquiry learning – helping students think critically and creatively, access and evaluate information, investigate complex problems, and effectively express their ideas. The school librarian and the instructional technology specialist are two of these experts.

INFORMATION LITERACY AND TELEMENTORING

While school librarians are often viewed mainly as the managers of the school library resources, they are much more than that. With credentials and experience in library and information science as well as teaching, school librarians are experts in information literacy and knowing how people seek information. As the complexity of information resources and technologies increases, they are called upon to use their unique skills as learning specialists to help students develop 21st century skills (Zmuda & Harada, 2008). Their roles in PBL are as an instructional partner, a connector with a holistic view of the curriculum who facilitates integration across content areas, and an integrator who links disciplinary concepts with information resources and helps incorporate information literacy skills at various phases of the project (Harada, Kirio, & Yamamoto, 2008b).

The American Association of School Librarians (AASL) has developed new standards that address many of the much-needed skills identified by the Partnership for 21st Century Skills and the New Media Consortium discussed in this chapter’s introduction. The *Standards for the 21st-Century Learner* are based on a set of fundamental beliefs (AASL, 2007):

- Reading is a window to the world.
- Inquiry provides a framework for learning.
- Ethical behavior in the use of information must be taught.

- Technology skills are crucial for future employment needs.
- Equitable access is a key component for education.
- The definition of information literacy has become more complex as resources and technologies have changed.
- The continuing expansion of information demands that all individuals acquire the thinking skills that will enable them to learn on their own.
- Learning has a social context.
- School libraries are essential to the development of learning skills.

Within the inquiry learning framework, school librarians aim to assist students with the following skills, dispositions, responsibilities, and self-assessment strategies (AASL, 2007).

Skills:

- Develop and refine a range of questions to frame the search for new understanding.
- Find, evaluate, and select appropriate sources to answer questions.
- Evaluate information on the basis of accuracy, validity, appropriateness for needs, importance, and social and cultural context.
- Make sense of information gathered from diverse sources (e.g., textual, visual, media, digital) by identifying misconceptions, main and supporting ideas, conflicting information, and point of view or bias.
- Apply critical-thinking skills to information and knowledge in order to construct new understandings, draw conclusions, and create new knowledge.
- Use technology tools to access, analyze, and organize information in the pursuit of inquiry.

Dispositions:

- Display initiative and engagement by posing questions and investigating the answers beyond the collection of superficial facts.

- Demonstrate confidence and self-direction by making independent choices in the selection of resources and information.
- Demonstrate creativity by using multiple resources and formats.
- Maintain a critical stance by questioning the validity and accuracy of all information.
- Demonstrate adaptability by changing the inquiry focus, questions, resources, or strategies when necessary to achieve success.
- Display emotional resilience by persisting in information searching despite challenges.
- Use both divergent and convergent thinking to formulate alternative conclusions and test them against the evidence.

Responsibilities:

- Respect copyright/intellectual property rights of creators and producers.
- Seek divergent perspectives during information gathering and assessment.
- Follow ethical and legal guidelines in gathering and using information.
- Use information technology responsibly.
- Connect understanding to the real world.
- Consider diverse and global perspectives in drawing conclusions.
- Use valid information and reasoned conclusions to make ethical decisions.

Self-Assessment Strategies:

- Monitor own information-seeking processes for effectiveness and progress, and adapt as necessary.
- Monitor gathered information, and assess for gaps or weaknesses.
- Seek appropriate help when it is needed.
- Determine how to act on information (accept, reject, modify).
- Reflect on systematic process, and assess for completeness of investigation.
- Recognize new knowledge and understanding.
- Develop directions for future investigations.

Guided by these standards and the imperative to connect learning to student needs, school librarians are taking a larger role in curriculum planning and instructional design. They are partnering with teachers to support inquiry learning (Harada & Yoshina, 2004) and project-based learning (Harada, Kirio, & Yamamoto, 2008a). In the school context, the need for these collaborations is not always self-evident, and the development of partnerships is a challenge under the heavy constraints on time and budget. Two of the bases for successful librarian-teacher partnerships are professional development support and the creation of communities of practice over time (Yukawa, Harada, & Suthers, 2007). When teachers and school librarians participate jointly in sustained, practice-based professional development, significant improvements can occur in the design of inquiry-focused learning and student performance (Yukawa & Harada, 2009).

School and public librarians are increasingly offering chat reference services to students that generally provide factual answers, information resources, and limited research help, much like ask-an-expert services. Among the few studies of librarians as telementors, Yukawa (2005) examined two library and information science graduate students who telementored two high school students doing yearlong senior projects and found that building rapport and relationships were critical for sustaining telementoring.

In published examples and research, it is rare to find PBL projects that are collaboratively designed and implemented with school librarians, despite the fact that the information and technology resources of the library are often essential for background knowledge, research, and the development of final products. For example, High Tech High's San Diego Field Guide project (<http://www.hightechhigh.org/pbl/sd-field-guide/>) is a 16-week project in which 11th grade students "conduct an environmental assessment of the fauna along the intertidal zone of San Diego Bay. They publish a comprehensive Field Guide including scientific

studies, creative writing, photographs, and histories of human development, industry, environmental measures, mapping and other changes to Bay." The interdisciplinary project (biology, humanities, mathematics) is implemented by a subject matter specialist and two high school teachers, but school librarians do not appear to have a role in guiding the information seeking and research processes.

School librarians have a deep understanding of the guidance and instruction that students need to become information literate, a holistic perspective on the school and curriculum, and extensive knowledge of information resources and information technology. In collaboration with other experts on the PBL team, they can provide students with essential project-based learning experiences and resources.

DIGITAL MEDIA LITERACY AND TELEMENTORING

While there is increased use of new technologies for classroom learning (e.g., Moller, Huett, & Harvey, 2008), distance education (e.g., Huett et al., 2008), and library services (e.g., Burger, 2007; Casey & Savastinuk, 2006), there is little evidence that information and communication technologies are being used for project-based learning or telementoring. Email has been the dominant mode of telementoring communication since the 1990s. The selected K-12 telementoring programs listed in Appendix B indicate that most of these programs use email or discussion lists. Newer forms of online communication such as web-based synchronous communication (instant messaging, text messaging, online chat, and videoconferencing) and asynchronous communication (e.g., using wikis and blogs) have the potential to expand telementoring and help reshape learning to meet 21st century educational challenges (Dede, 2007). The instructional technology specialist is the member of the PBL team with the best understanding of how to use and manage

these technologies for learning, communication, productivity, and creativity.

As noted in the introduction, The Partnership for 21st Century Skills has implicated information, communication, and collaboration technologies in the innovative, entrepreneurial thinking that students will need for future success. Attaining literacy with these technologies is thus essential. The New Media Consortium defines 21st century literacy as “the set of abilities and skills where aural, visual and digital literacy overlap. These include the ability to understand the power of images and sounds, to recognize and use that power, to manipulate and transform digital media, to distribute them pervasively, and to easily adapt them to new forms” (NMC, 2005, p. 2). Technology is implicated in all of the top trends the NMC has identified as likely to affect teaching, learning, and creativity in the next five years: (1) Technology continues to profoundly affect the way we work, collaborate, communicate, and succeed. (2) Technology is increasingly a means for empowering students, a method for communication and socializing, and a ubiquitous, transparent part of their lives. (3) The web is an increasingly personal experience. (4) Learning environments are increasingly virtual rather than physical spaces. (5) The perceived value of innovation and creativity is increasing (Johnson et al., 2009, p. 6).

Among the technologies likely to have a significant impact on schools within the next five years are collaborative environments, online communication tools, mobile devices, and the personal web (Johnson et al., 2009, p. 6). While research on the learning impact of newer technologies is still emerging, a number of guides for classroom use are available (e.g., Pitler, Hubbell, Kuhn, & Malenoski, 2007; Richardson, 2008; Solomon & Schrum, 2007). These technologies have the potential to be powerful tools for inquiry-, problem-, and project-based learning in the hands of technologically fluent telementors and motivated, tech savvy, creative students.

Collaborative environments are virtual workplaces where students, teachers, telementors, and others can communicate, share information, and work together. Collaborative online spaces come in many forms, from online office suites for document sharing (for examples of these and other tools, see Table 1), online document collaboration, personal publishing, social networking tools to connect people and collect resources, flexible learning management systems, personal web portals, to classrooms in virtual environments. As well as enabling collaboration, the online spaces leave persistent conversations that remain for self reflection and peer critique. These spaces can be used synchronously or asynchronously at a distance, or to support and document collaborative work done in class.

Full-featured wikis such as PBworks (<http://pbworks.com>) and WetPaint (<http://www.wetpaint.com>) are powerful tools for telementoring. In addition to supporting the collaborative creation of web pages, these wikis also provide productivity and communication plug-ins such as calendars, spreadsheets, Google gadgets, chat rooms, photo and video integration, and page level discussion threads. Students working on problems or projects can gather resources, post plans, exchange ideas, and write drafts of papers and presentations on wiki pages. Telementors can monitor student progress as it evolves and provide feedback on these wiki pages. Studies have shown that wikis promote collaboration, encourage negotiation, and familiarize students with new technology tools (Elgort, Smith, & Toland, 2008; Hazari, North, & Moreland, 2009). They are also an effective tool for collaborative project planning and documentation (Parker & Chao, 2007), information or data gathering and organization, and organizing a personal or team research library (Walsh & Hollister, 2009).

Online communication tools such as instant messaging and online chats via desktop video conferencing are a popular way for students to interact with family and friends online. These

Table 1. Technologies for telementoring

Examples	Collaborative Environments	Communication Tools	Mobile Devices	Personal Web	Telementoring Software
	Wikis (PBworks, Wetpaint), blogs (WordPress, Blogger, LiveJournal), office suites (Google Docs, Zoho), flexible learning management systems (Moodle, Sakai), personal web portals (NetVibes, Pageflakes, iGoogle), social networking tools (Flickr, SlideShare, YouTube), virtual environments (Second Life)	Instant messaging (AIM, Meebo, Google Talk), online chat (AIM, Google Talk, Skype), desktop video conferencing (Skype), blogging, micro-blogging (Twitter), voice-over-IP (AIM, Google Talk, Skype), combination voice-video-text messaging (YackPack)	iPhone, BlackBerry	Tagging (Delicious, Diigo), RSS feed aggregators (Bloglines, FeedDemon, Google Reader, Netvibes, Pageflakes), simple, all around personal web tools (Tumblr, Posterous)	Telementoring Orchestrator
Uses	Project planning, document sharing, collaborative writing, personal publishing, social networking, resource collections, portfolios, online classrooms, feedback from teachers, experts, and peers.	One-to-one, one-to-many, and many-to-many communication; archiving messages and conversations; multimedia journals; voice, video, and text communication.	Range of communication options: telephone, email, text messaging, internet faxing, web browsing, multimedia. Third-party applications to support learning and research.	Resource collections, keeping updated on student work, enhanced email communication in a telementoring relationship, portfolios.	Building and describing a mentor pool, matching mentors and mentees, providing opportunities for just-in-time learning, limiting administrative overhead, and preventing mentor overload.

familiar tools can also be used to extend learning through telementoring. Desktop videoconferencing, instant messaging services, personal publishing like blogging and micro-blogging, and voice-over-IP enable one-to-one, one-to-many, or many-to-many synchronous communication. As one example, YackPack (<http://www.yackpack.com>) utilizes voice, video, and text messaging that can also be recorded. This enables one-to-one or one-to-many communication that allows students and telementors to see and hear each other in real time or via archived messages. Students can use blogging tools to set up multimedia journals to share their opinions, ideas, and research. Telementors, teachers, and peers can provide feedback using the comments feature.

Mobiles devices such as the iPhone and the BlackBerry are increasingly being used by young people (Johnson et al., 2009, p. 16). These provide a range of communication options: mobile telephone, email, text messaging, internet faxing, and web browsing. They support multimedia, with a camera and the ability to play music and video. They also incorporate productivity tools such as an address book, calendar, and calculator. Mobile devices have strong potential for educational uses because of the ability to run third-party applications such as GPS and collaborative document software. As of early June 2009, there were approximately 50,000 third-party applications of all types available for the iPhone. It is easy to imagine a wide range of applications being developed for fieldwork, data capture, information organization and analysis, visualization, data sharing, and other research and productivity aids that could support inquiry learning and result in products shared with telementors.

The personal web refers to how we manage the way we view and use the internet, based on “a growing set of free and simple tools and applications that let us create customized, personal web-based environments that explicitly support our social, professional, learning, and other activities” (Johnson et al., 2009, p. 25). The internet has

been a major contributor to information overload. Finding, organizing, and evaluating online content are critical for research and learning. Just as researchers and librarians are doing, students can tag and organize web links by subject. Another valuable personal web tool is the feed aggregator, a web application that gathers syndicated web content in one place for easy viewing. News sites, blogs, podcasts, wikis, social networking sites, library websites, and many others provide RSS feeds that automatically appear in personal aggregator content. With the tools of the personal web, teachers, students, and telementors can tag, categorize, annotate, publish, and review work online and build resource collections using web feeds and resources tagged by others. Teachers, students, and mentors can keep track of student work using RSS feeds to import updates of student publishing on the web.

One example of a free, very easy to use personal web tool that can serve a variety of communication and learning functions in telementoring is Posterous (<http://www.posterous.com>). By simply sending email with attachments to Posterous or grabbing content from the web, one can create a blog with text, video, photos, and music. Posterous provides for privacy, group sites, and email subscriptions to inform each group member of new postings. Posterous could be an effortless way to conduct one-to-one or one-to-many telementoring communication via email, with text enhanced by multimedia in a chronological, open record of the exchanges.

Specialized software may be needed for those who wish to launch their own large-scale telementoring projects and services. One of the best developed is the Telementoring Orchestrator (TMO) from Simon Fraser University's On-line Learning Relationships Lab (<http://www.learningrelationships.org/>). TMO streamlines the tasks of building and describing a mentor pool, matching mentors and mentees, and providing opportunities for just-in-time learning, as well as reducing administrative overhead and preventing mentor

overload (O'Neill, Weiler, & Sha, 2005, p. 114-115). TMO supports these roles and functions:

Telementoring Orchestrator assumes three roles: (1) mentors, who volunteer by filling out a recruiting form; (2) coordinators, who solicit the assistance of one or more mentors from the volunteer pool, assign them to mentees, and provide oversight for the relationships until they are closed; and (3) an administrator, who configures the TMO software for a particular program or initiative, and creates accounts for coordinators. ... At a minimum, configuring the installation involves: (1) Setting up an e-mail routing account that can be used by mentors and mentees to exchange messages. (2) Specifying a Knowledge Forum 'database' (workspace) in which mentors and their mentees can work together. (3) Defining the varieties of expertise or interests that volunteers might share with their mentees. (O'Neill et al., 2005, p. 115-117)

Freely available, this software currently works only on Mac OS X.

To make effective use of these technologies, schools and classrooms need a reliable technology infrastructure, as well as high-speed internet access. Instructional technology specialists understand how and why technology can be used effectively for learning, communication, and productivity. In collaboration with other experts on the PBL team, they guide students toward achieving better digital media literacy and provide tools for creative expression and the development of innovative, personally meaningful products.

As discussed in this chapter's introduction, schools also face more fundamental and far-reaching challenges as they integrate new information and communication technologies (ICT) and reshape the educational experience. As Dede (2007, p. 35) notes:

At this point in history, the primary barriers to altering curricular, pedagogical, and assessment

practices toward the transformative vision of ICT in education ... are not conceptual, technical, or economic, but instead psychological, political, and cultural. We now have all the means necessary to implement alternative models of education that truly prepare all students for a future very different from the immediate past. Whether we have the professional commitment and societal will to actualize such a vision remains to be seen.

TELEMENTORING MODELS

This chapter began with a brief mention of the types of expert advice being provided online—ask-an-expert services for one-time, discipline-based questions; tutoring for supplementary or remedial study; and telementoring for career guidance, academic advice, or sustained inquiry learning in the classroom. With the exception of the last, these types of advice address three learning needs: the need for disciplinary knowledge, the need for academic advice, and the need for career guidance. Our exploration of inquiry learning, information literacy, and digital media literacy provides a backdrop for assessing the strengths and limitations of these types of online expert advice.

Disciplinary Knowledge

Ask-an-expert services provide answers to one-time, discipline-based questions such as “What are simple, complex, and compound fractions?” or “What is the Pythagorean theorem?” Examples of these services are Drexel University’s Ask Dr. Math (<http://mathforum.org/dr.math/>), U.S. Geological Survey’s Ask A Geologist (<http://walrus.wr.usgs.gov/ask-a-geologist/>), and NASA’s Ask an Astrophysicist (http://imagine.gsfc.nasa.gov/docs/ask_astro/ask_an_astronomer.html). Students can ask experts questions that they could not ask of others, and receive answers in a timely manner. However, these services can only provide answers to factual questions that are isolated from

the learning context. Factual information does not in itself help students develop critical and creative thinking skills. Moreover, the one-time nature of the process does not help them develop disciplinary knowledge over time.

Online tutoring and homework help services provide supplementary or remedial study that supports well-focused learning needs and guides the student in solving well-structured problems. Often these services are a combination of self-paced tutorials and 24/7 help from live tutors, such as the fee-based services, Tutor.com (<http://www.tutor.com/>) and Homeworkhelp.com (<http://www.homeworkhelp.com/>). Free homework help sites are also available, many of them developed or sponsored by school and public libraries. The Internet Public Library’s Homework Help page (<http://www.ipl.org/kidspace/browse/ref8000>) lists a number of free sites. The disadvantage of online tutoring is that the questions and problems are provided mostly by the service, not driven by student inquiry. Online tutoring does not help students develop critical and creative thinking skills by solving authentic, ill-structured problems relevant to their own lives and interests.

Academic Advice and Career Guidance

Academic advice and career guidance are often combined in programs that are aimed at vulnerable and at-risk students. This type of mentoring resembles the traditional mentor model of wise counselor to a young protégé. For example, icouldbe.org (http://www.icouldbe.org/standard/public/lm_index.asp) targets at-risk students from low-income communities. Connecting to Success (<http://ici.umn.edu/ementoring/default.html>) aims “to promote successful transition of youth with disabilities to adult life.” In these types of telementoring programs, mentors encourage students to stay in school and work toward career goals and further education. They provide care and concern, helping with homework and study skills, plans for

college, and how to seek and keep jobs. They also help youth improve their communication skills, raise their self-esteem, and change negative and damaging behaviors.

Other telementoring programs are aimed at closing the gender gap in science, technology, engineering, and mathematics (STEM) professions. Programs such as Zoey's Room (<http://www.zoeyroom.com/>), an online community for middle school girls that fosters interest in STEM subjects, feature chat rooms where girls can interact with professional women with careers in STEM fields.

These programs provide valuable mentoring to specially targeted sectors of students but are not focused on inquiry learning for the development of critical and creative thinking skills. (For those interested in selected programs of these types, Appendix B provides further information).

Integrated Telementoring Model for Project-Based Learning

While ask-an-expert services and academic and career telementoring address important student needs such as the need for factual knowledge, general study skills, career information, and guidance for at-risk students, they are each limited with respect to sustained inquiry learning focused on authentic problems. To reach the full potential of project-based learning, I propose an integrated telementoring model that involves a team of specialists – teachers, subject matter experts, school librarians, and instructional technology specialists.

- *Classroom teachers* manage PBL projects and facilitate learning on many levels – the process of project-based learning, the team process, community building, individual learning, and the achievement of the learning outcomes.
- *Subject matter experts as telementors* encourage, guide, instruct, and model disciplinary practices and ways of thinking.

- *School librarians* guide students to become information literate and help them navigate the increasingly complex terrain of information resources.
- *Instructional technology specialists* help students achieve better digital media literacy and provide opportunities for creative expression using a wide array of technological tools.

Table 2 summarizes the complementary sets of skills and expertise the team brings to PBL. The model provides a framework for rich learning experiences for students and supports scaffolding of disciplinary knowledge and ways of thinking, project-based learning, information literacy, and digital media literacy. This model is further discussed in the next section.

DESIGN CONSIDERATIONS FOR AN INTEGRATED TELEMENTORING MODEL

For the development of 21st century skills, I have proposed that an integrated model of telementoring implemented by a PBL team has the potential to be more effective than current forms of telementoring. This section discusses how the model could be implemented, based on findings from previous studies of telementoring and/or problem-based learning. The main studies referred to are: (1) an examination of the Portals project, funded by the National Science Foundation to support telementoring relationships in project-based computational sciences classes, involving 40 high school students, five teachers, and 12 mentors (Tsikalas, McMillan-Culp, Friedman, & Honey, 2000); (2) Abbott's (2005) study of eight teachers whose students participated in online learning projects hosted by five established online PBL programs (The Electronic Emissary, iEARN, KidLink, ThinkQuest, and ThinkQuest Jr.); (3) a study by Hmelo-Silver and Barrows (2006) that

Table 2. Integrated telementoring model for project-based learning (PBL)

PBL Team	Teacher	Telementor	School Librarian	Instructional Technology Specialist
Primary Role	Pedagogy, Project Management • Pedagogical content knowledge • Knowledge of learners • PBL coordination & facilitation • Project design • Project planning • Project management • Fostering community building	Disciplinary Inquiry • Exploration & discovery • Testing ideas – Gathering data • Testing ideas – Interpreting data • Community analysis & feedback • Broader perspectives on the benefits of inquiry to society	Information Literacy • Accessing information • Evaluating information • Critical thinking to analyze, organize & use information for decision making • Information ethics • Reflecting on the information seeking process	Digital Media Literacy • Technology tools • Uses of tools for learning • Uses of tools for communication • Uses of tools for productivity • Uses of tools for creative expression

analyzed the facilitation of a student-centered problem-based learning group in higher education; and (4) Project INSITE, a four-year professional development program to prepare teachers to use problem-centered, inquiry-based science (Lehman, George, Buchanan, & Rush, 2006).

As discussed previously, several components of this model – project-based learning, teacher-librarian collaboration, and the use of information and communications technologies for learning – are in themselves challenging to implement. As an integration of these components, this model is even more challenging, as it involves collaboration among all of the PBL team members and the potential use of a variety of online tools. The model requires careful planning, coordination, ongoing collaboration, and negotiation of roles and responsibilities among members of the PBL team.

The planning is done by the school-based members of the team. During the implementation of the project, the teacher's role is both project manager and learning facilitator. Important factors to consider when designing a project using the integrated telementoring model are commitment to the project, learning goals, roles and functions of participants, the online learning environment, and participant readiness for project-based learning.

Commitment

Project-based learning takes much time to plan and sustained effort to complete (Abbott, 2005). The first and most important factor to consider is the desire and willingness of the school-based team members to tackle project-based learning using this model. Another important factor is the school climate and readiness – whether school administrators and peers welcome innovative uses of technology or not. Access to and funding for new technology may also be key considerations.

Learning Goals

These are some of the typical goals teachers set for project-based learning with telementoring (Abbott, 2005; BIE, n.d.; Hmelo-Silver & Barrows, 2006; Lehman et al., 2006; Tsikalas et al., 2000):

- Students engage in the central concepts and principles of a discipline and develop reasoning skills appropriate to the discipline.
- Students do in-depth exploration of authentic and important topics.
- Students solve complex, multidisciplinary, open-ended problems.
- Students create products that solve problems, explain dilemmas, or present infor-

mation generated through investigation, research, or reasoning.

- Students engage in self-directed learning.
- Students acquire, evaluate, and use information effectively.
- Students use essential tools and skills, including technology, for learning, self-management, and project management.
- Students effectively communicate and collaborate with each other in teams, and online with adult experts.
- Students reflect on their own work and provide effective feedback to peers.

During planning, the school-based team members align learning goals with various content standards, technology standards, and life skills standards (e.g., McCREL, 2009), as well as information literacy standards (AASL, 2007). These learning goals are also associated with the 21st century student outcomes outlined by Partnership for 21st Century Skills (2008), namely, knowledge in core subjects; learning and innovation skills; information, media and technology skills; and life and career skills.

Roles and Functions

The complex, interdisciplinary, and open-ended nature of project-based learning requires a clear view of general functions and roles, as these may be taken on flexibly by different members of the team over time. Functions generally fall into four areas: (1) structure, (2) process, (3) facilitation, and (4) community building (Tsikalas et al., 2000). Strategies and functions related to each of these areas may be assumed by any member of the PBL team or by the students themselves, depending on their readiness for PBL.

Structural strategies and functions refer to how activities, communication, and the process of project development are structured. What tasks and activities will be done, when, and by whom? Who will communicate with whom, about what,

and when? In their study of the Portals project, Tsikalas et al. (2000) found that structural strategies and functions are generally set by the teachers and mentors. Teachers specify student roles and also set the activity structure in which the telementoring occurs, tied to a set of project deliverables. Mentors often structure the process of project development, advising students on what steps need to be taken to complete the deliverables by the deadline. In the integrated telementoring model, school-based PBL team members would collaborate on these activities and make decisions about how to integrate information literacy and digital media literacy skills in a timely manner.

Process strategies and functions refer to expectations related to the learning conversations over time. Tsikalas et al. (2000) found that these are often set by students, who decide on what role the mentor will take, set expectations, ask good questions, build personal relationships with the mentor, and manage the communication (such as selecting the type of media to use to communicate about certain topics). Mentors also perform process functions – assessing and anticipating student needs, providing information, stimulating students through questioning, directing action, extending students' vision of their projects, and exercising quality control.

Facilitation strategies and functions refer to the means of guiding, supervising, and supporting the learning and communication processes. Facilitation strategies can be considered a form of modeling done by the PBL team. Such strategies include pushing for explanations; restatement; summarizing; encouraging students to generate hypotheses; mediating content by reviewing, digesting, and re-teaching; and redirecting communication from impasses (Hmelo-Silver & Barrows, 2006; Tsikalas et al., 2000). Teachers are critical facilitators in the mentoring groups (Lehman et al., 2006; Tsikalas et al., 2000). They create structures to facilitate mentoring, mediate students' interactions with others, and build community. Some help students rehearse important conversations

and provide opportunities for students to teach or mentor. When teachers are involved, student communication with mentors is often richer with ideas, opinions, and emotions (Harris & Jones, 1999). In some cases, teachers take on the role of co-mentor (Tsikalas & McMillan-Culp, 2000).

Community building strategies and functions refer to sharing materials, activities, or messages to promote a shared sense of purpose and benefit from participation in the online community. Tsikalas et al. (2000) found that these are undertaken by students, teachers, and mentors alike. For students, this means primarily collaboration within their team. Teachers help build community by fostering a climate of collaboration in their classrooms. Mentors support community building by helping students to socialize into particular cultures; treating students as colleagues; providing acceptance and encouragement; and referring students to other people for assistance.

The work of teachers as facilitators and project managers is often unknown to mentors. Making this work visible to telementors can provide them with valuable insights into students' knowledge, skills, learning styles, and communication styles. When relevant PBL team communication and collaborative work are conducted or documented in the online spaces, these four types of strategies and functions can be better coordinated and duplication of efforts avoided.

Online Learning Environment

The use of online tools should be carefully planned to meet learning goals, ensure ease of use, and accommodate potentially differing levels of technological fluency among the participants. Factors to consider in structuring the online learning environment include whether online communication will be synchronous, asynchronous, or a combination of both (and which tools to use); whether communication between participants will be private or open to other project teams

and mentors; and how to organize resources and individual and group spaces.

Choices about modes of communication and technology tools should be integrated into the regular project planning process – determination of the learning goals, how the learning will be assessed, the skills and understandings expected as outcomes, and the activities that will enable students to achieve those outcomes. For example, if a learning goal is that students understand the structure of a subject, students can organize information in databases (Jonassen, Carr, & Yueh, 1998) or online repositories in wikis and tag each item. Students can then discuss and develop their understanding of conceptual relationships among the tags using a concept map and receive feedback from the PBL team.

In general, the use of separate online tools can be confusing for new users of technology, so the use of a single comprehensive tool (e.g., a full-featured wiki or flexible learning management system) as the main communication center is advisable. The advantage of a wiki over a learning management system is that it can be edited and new pages can be added by any member of a private wiki. At the start of a project, it is important to post goals, project criteria, selected resources, and templates that are accessible to all members of the PBL team, students, and telementors. During the project, wikis are an effective tool for collaborative project planning and documentation (Parker & Chao, 2007). They are also effective for information or data gathering and organization, as well as organizing a personal or team research library that tracks the research process and showcases final products (Walsh & Hollister, 2009). Here, the school librarian plays the major role.

Wiki pages are designed primarily for collaborative writing. Asynchronous discussion and feedback about wiki pages can be done through the page comments or page discussion features available on most wikis. Synchronous discussions may be preferable for brainstorming and other activities that require immediate response. For

these, chat plug-ins are available on most wikis. The recorded communication can be used for further collaborative writing, self-assessment, and critique by peers and the PBL team. At the completion of the project, wiki pages and other online spaces can be used for presentations and portfolios.

Telementor-student communication can be done privately and asynchronously via email or synchronously via instant messaging. For group mentoring, O'Neill (2004, p. 182) argues for the importance of "mentoring in the open," where telementoring conversations are visible to other groups and experiences are shared. This provides an opportunity for students to see exemplary telementoring relationships at work and learn from such vicarious, peripheral participation (Lave & Wenger, 1991). Public mentoring discussions can take place asynchronously via discussion forums and synchronously via chat plug-ins in the wiki. These open conversations allow telementors to use the experiences of other groups to guide and scaffold learning, as well as to initiate peer support. When members of the school-based team also participate online or post summaries of face-to-face work in the online spaces, collaboration is strengthened.

Issues and challenges related to mentoring in an online environment are: (1) miscommunication, due in part to the lack of nonverbal cues; (2) slower development of relationships online than face-to-face; (3) the need for competency in written communication and technical skills; (4) a reliable technology infrastructure; and (5) protection of privacy (McLoughlin, Brady, Lee, & Russell, 2007, p. 4).

Participant Readiness

The importance of student readiness cannot be overemphasized. Do students have sufficient content knowledge and skills to handle the project successfully? Do they have the necessary skills with technology and access to the required technol-

ogy both within school and without? Can they take independent initiative and work collaboratively? Tsikalas et al. (2000) found that students who could communicate and collaborate well with each other tended to do this more effectively with telementors. They also found that mentoring relationships were more successful when students were aware of their needs and proactive about seeking specific assistance. The PBL team can prepare students for the telementoring experience by: (1) encouraging them to be open and honest with their mentors about what they do not understand; (2) providing opportunities to practice describing what they do and do not understand; (3) providing peer and teacher feedback about their communication; and (4) educating them about the various roles and functions mentors may take (Tsikalas et al., 2000, p. 10).

The school-based members of the PBL team need a common understanding of the philosophy, principles, and practice of PBL and preferably some experience either as facilitators or learners. Because implementing PBL online adds complexity, experience with implementing it first face-to-face is beneficial (Savin-Baden, 2007, p. 39). Collaboration requires significant time and effort but also brings rewards in personal learning, professional development, and student achievement. In a study of a yearlong professional development course involving teacher-librarian partners who collaborated on curriculum, Yukawa and Harada (2009, p. 13-14) found that:

Participants characterized the relationship as a partnership of equals, with teachers providing subject expertise and intimate knowledge of their students and librarians providing information literacy expertise, knowledge of resources, technology expertise, and guidance to students through the conceptual and emotional challenges of the research process. Participants appreciated using each other as sounding boards in deepening conversations about unit and lesson planning, standards, essential questions, assessment tools,

and information literacy instruction. A key change in roles was the degree to which librarians were integral to the entire process of planning, implementation, and assessment, with joint responsibility and accountability. A valuable theme was the way the partnerships extended to other faculty at the school.

Telementors who join the PBL team from private and public sector organizations outside of the education sector often find it a challenge to understand how telementoring works in the school culture, which may be quite different from their organizational cultures (O'Neill et al., 2005, p. 111). The role of the telementors can be diverse and encompassing. They encourage, offer advice, coach, help students clarify their values or goals, provide information, act as role models, help students socialize into particular cultures, and stimulate students to acquire new knowledge (Tsikalas et al., 2000, p. 10-11). The most likely mentor group configuration for PBL is one telementor to a small group of students, although a telementor may work with a single student or an entire class. At the start of a project, telementors may need an orientation to inquiry learning, project goals and expectations, student learning needs, their role as consultants, the roles of the other members of the team, the school context, technology and software to be used, and tips on how to communicate with the students online (Bennett, Heinze, Hupert, & Meade, n.d.). Advice to telementors should continue as needed throughout the telementoring relationship.

Using the integrated telementoring model, the PBL team serves as a model for students of the interdisciplinary teamwork that is increasingly valued in today's workplaces and communities. As the PBL team members plan, implement, manage, and facilitate project-based learning for students, they model the skills in collaborative problem solving, information literacy, technological fluency, innovation, and leadership that they

expect students to demonstrate as a result of their PBL experiences.

BENEFITS AND CHALLENGES OF PROJECT-BASED TELEMENTORING

Although PBL with telementoring is time consuming, many teachers feel it is worthwhile because of the benefits to their students. Student benefits include: (1) increased student engagement and motivation, (2) improved writing and speaking skills, (3) improved information gathering skills, (4), improved reasoning and problem-solving skills, (5) learning science and scientific processes, (6) learning about technology, (7) the transfer of learning into student performance, (8) self-directed learning skills, (9) improved collaboration and cooperative learning skills, (10) opportunities to teach their peers, and (11), self-evaluation techniques (Abbott, 2005; Lehman et al., 2006; Ravitz, 2009).

Interviews with volunteer telementors indicate the self-perceived benefits of telementoring: (1) doing outreach for their employers, (2) cultivating interest in their field, (3) increasing the representation of women and minorities in their field, (4) engaging in the pursuit of challenging inquiry, (5) learning more about teaching and about themselves, (6) giving back, and (7) realizing the potential of the internet (O'Neill, 2000, p. 11-15).

PBL with telementoring also brings benefits to teachers, who value: (1) learning new teaching methods and strategies to increase student motivation, (2) learning more about a discipline, (3) learning new technologies and gaining increased technological competence, (4) becoming less directive and more facilitative to promote student-centered learning, (5) seeing students' success, (6) collaboration with others, (7) increased satisfaction from teaching, and (8) improved personal confidence (Abbott, 2005; Friedman, Zibit, & Coote, 2005; Lehman et al., 2006).

The disadvantages of PBL with telementoring include: (1) heavy demands of time and effort, (2) problems with technology and access to technology, (3) disparity in student technology access or skills, (4) classroom management problems, (5) lack of sufficient materials and supplies, (6) difficulties with group dynamics, (7) problems covering content when PBL interferes with the regular curriculum, and (8) poor collaboration and lack of support from team members (Garcia & Rose, 2007; Lehman et al., 2006).

Another significant challenge is effective facilitation. Although facilitation is generally seen as one of the most important dimensions of PBL, Savin-Baden (2007) points out that “there has still been relatively little discussion about what is being facilitated – whether it is students’ understanding and enactment of problem-based learning, the team process, the process of learning, individual learning, or the achievement of the learning outcomes, and to what extent the tutor’s ability to facilitate affects all these” (p. 41).

While the process of planning, implementation, and assessment of a telementoring project is an important type of professional development in itself, more structured educational opportunities for learning about PBL may also be necessary. One of the best ways to understand PBL and telementoring is for educators to experience these processes for themselves (Gareis & Nussbaum-Beach, 2007; Hitchcock & Mylona, 2000; Weizman et al. 2008). Experience with telementoring, project-based and problem-based learning, and technology integration should begin with pre-service teacher education (Garcia & Rose, 2007; McLoughlin et al., 2007; Price & Chen, 2003) and be extended with in-service professional development (Dede, 2006; Yukawa & Harada, 2009; Weizman et al., 2008).

CONCLUSION

The purpose of this chapter has been two-fold: (1) to explore the rich potential of telementoring

for project-based learning in the context of the urgent need to help students develop new skills and literacies, and (2) to provide the framework for an integrated telementoring model to be tested by new telementoring projects. Using this model, an interdisciplinary PBL team of experts – the subject matter expert serving as telementor, the classroom teacher, the school librarian, and the instructional technology specialist – can provide students with new opportunities for holistic, authentic, personally meaningful learning using emerging technology.

Subject matter experts as telementors encourage, guide, instruct, and model disciplinary practices and ways of thinking. Teachers manage PBL projects and facilitate learning on many levels – the process of project-based learning, the team process, community building, individual learning, and the achievement of the learning outcomes. School librarians guide students to become information literate and help them navigate the increasingly complex terrain of information resources. Instructional technology specialists help students achieve better digital media literacy and provide opportunities for creative expression using a wide array of technological tools. As a team, these experts model the skills in collaborative problem solving, information literacy, technological fluency, innovation, and leadership that are needed in the workplaces and communities of today and tomorrow.

This model requires careful planning, coordination, ongoing collaboration, and a clear view of general roles and functions with flexibility in assuming them. Important factors to consider when designing a project using the integrated telementoring model are commitment to the project, learning goals, roles and functions of participants, the online learning environment, and participant readiness for project-based learning. While collaboration requires significant time and effort, the rewards in personal learning, professional development, and student achievement can be great.

Implementation of the model cannot be divorced from broader educational issues and challenges – the need for formal instruction in new literacy skills for students and educators, professional development on learner-centered approaches like PBL, developing and sustaining school-wide and community-based communities of practice, learning environments that incorporate new technologies, and fundamental changes in the structure of the educational environment. These challenges are also opportunities for project-based telementoring to contribute to needed changes in educational structure, transformations of teaching practice, and more relevant learning experiences for students.

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APPENDIX: SELECTED K-12 TELEMENTORING PROGRAMS

Learning Goal	Program	Target Groups	Duration	Mode of communication	Facili-tation	Mentor Training
Project based learning One mentor per class	The Electronic Emissary http://emissary.wm.edu/	K-12 students	6 weeks to school year	Email, forum, chat, teleconferencing	Yes	Yes
Project based learning One-to-one mentoring	International Telementor Program http://www.telementor.org/index.cfm	K-12 students	Flexible	Secure, online messaging system	Yes	
Academic & career mentoring One-to-one mentoring	IBM's MentorPlace http://ibm.mentorplace.epals.org/Whats.htm	Grades 3-12	School year	Face-to-face at beginning and end of school year; online messaging	Yes	Yes
Academic & career mentoring (fee-based) Many-to-many	Zoey's Room http://www.zoeyroom.com/	Girls age 10-14; math, science, technology	Indefinite	Online only via discussion list	Yes	
Career mentoring One-to-one mentoring	Connecting to Success (Minnesota) http://ici.umn.edu/ementoring/default.html	High school students at-risk & with disabilities	School year	Only email and school-sponsored activities	Yes	Yes
Career mentoring 3 mentors for each student	icouldbe http://www.icouldbe.org/standard/public/lm_index.asp	Middle & high school students at-risk, inner city	School year	Email, discussion board (anonymous)	Yes	Yes
Online tutoring (fee-based) One-to-one tutoring	Tutor.com http://www.tutor.com/	Grades 4-12 homework help	24/7 live homework help	Instant messaging		
Online tutoring (fee-based) One-to-one tutoring	Homeworkhelp.com http://www.homeworkhelp.com/	Grades 4-12 homework help	Tutorials, live homework help	Audio dialogue, text messaging		
Ask an expert Career advice in science, engineering, technology	GEM-SET http://www.uic.edu/orgs/gem-set/index.htm	Girls aged 13-18	Short term	Discussion list (students known by first name only)	Yes	
Ask an expert Astrophysics	NASA Ask an Astrophysicist http://imagine.gsfc.nasa.gov/docs/ask_astro/ask_an_astronomer.html	General	One-time question-and-answer	Email		
Ask an expert Math	Drexel University, Math Forum, Ask Dr. Math http://mathforum.org/dr.math/	K-12 students	One-time question-and-answer	Email		

Programs are free unless otherwise indicated

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Chapter 3.10

Developing Educational Screencasts: A Practitioner's Perspective

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ABSTRACT

YouTube to iTunes, company to college websites, there is a seemingly exponential explosion in creating screencasts. A screencast is a digital recording of computer screen activity, often with an audio commentary. Short and engaging, screencasts have the *potential* to enable learning in new and exciting ways. They are becoming easier to create and, as a teacher in higher education, I have gradually increased my use of screencasts, learning with experience and from the generally positive feedback from students.

Drawing on existing research and personal experience, this chapter will introduce screencasts and discuss their potential. The importance of integrating screencasts thoughtfully and carefully into the teaching and learning process will be ex-

amined, including pedagogical and instructional design issues. Next a four-step process for creating a screencast will be presented: prepare, capture, produce and publish. Prior to conclusions and final reflections, future research directions will be examined.

INTRODUCTION

The other day I wanted to embed a YouTube video into a PowerPoint presentation: to link and view directly a video on YouTube, rather than hyperlink out to an internet browser or embed the downloaded video file. I didn't know how to do this, so I searched YouTube and *hey presto* a series of videos appeared. Selecting the first video, I watched a screencast showing how to do the task I wanted to do myself. I was able to watch it, pausing at places and switching to my

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presentation to embed the video I wanted. As well as the basic process, the screencast gave a number of tips. Less than ten minutes later I had completed my task.

A screencast is often used to capture *how-to-do-something*, for example how to use particular software. In the vignette above, I learnt and practiced a new skill: I had an immediate need, I found help in a form that was immediate, understandable and engaging, and I used that help to complete my task.

Increasingly educators are blending more online elements with traditional face-to-face teaching, often by simply using a virtual learning environment (VLE) to provide notes and other documentation as well as to communicate with students. As part of a multimedia approach (combinations of video, animations, images, text and sound) to blended learning, screencasts offer a multimedia-rich option to support student learning in particular contexts (such as learning a new skill as above). Thus a screencast can be a standalone multimedia learning object or can be part of a series that together comprise a fuller learning resource, or indeed be part of a learning object that integrates a screencast(s) with other hypermedia elements. Screencasts are becoming easier to create: a computer, some software and a microphone is enough. At the simplest, it could be adding a voiceover to a presentation, perhaps by using the narration feature within Microsoft PowerPoint. A little more complicated is recording on-screen activity with explanatory labels or a voiceover. With more effort, a screencast can integrate some interactivity, including clickable zones and quizzes. The time, resources and expertise required increases with the complexity of the screencast.

So what exactly is a screencast? How does one go about creating a screencast? What are the pedagogical and instructional design, technical and practical issues involved? And, of course, why do it? What are the benefits for learners? The rest of the chapter will explore these questions, starting

with examining in more detail what a screencast is and sharing some personal experiences of using screencasts with students.

EDUCATIONAL SCREENCASTS

A screencast is a digital recording of computer screen activity, often containing audio narration. It is sometimes referred to as a video podcast or simply a video, and also as a *scrast* (verbally shortening the word screencast to one syllable).¹ A screencast gives a *look over my shoulder effect* similar to one-on-one instruction and can be accessed whenever and wherever it is convenient (Educause, 2006). Students particularly value this, flexibly using screencasts to support their learning and thereby allowing for greater learner independence. A screencast usually has control buttons, enabling it to be paused and particular sections to be replayed: this level of learner control over pace is important (Oud, 2009, p. 169). The combination of video and audio appeals to different learning styles (as an alternative to predominantly text-based learning materials) and, as it is produced locally, it may be more approachable than glitzy packaged instructional videos (Kanter, 2008).

Short, sharply focused screencasts can be very useful in supporting students, working at their own pace, to achieve learning outcomes. Screencasts are particularly useful for teaching software applications and showing how to use online tools such as websites and library catalogues, having the following benefits over reading step-by-step instructions, as identified by Mount and Chambers (2008): ‘improving student cognition through improved information integration, reduced information redundancy and an improved representation of the dynamics of software operation’ (p. 49). They can provide engaging revision materials and, like other learning materials, are particularly valued by students if focused on preparing for assessments. Screencasts can be used to give short presentations (mini-lectures of voiceovers over

images or PowerPoint slides). These short teaching episodes are best used for topic overviews, difficult concepts and guidelines for the module, projects and assessments as well as for just-in-time support for project- or problem-based approaches. Other potential uses include explaining model solutions, correcting and giving feedback, answering frequently asked questions (FAQs) and website testing. Using a tablet and wireless pen together with software for writing on the screen, *mathcasts* (screencasts where the solution to a maths problem is hand-written to an accompanying voiceover explanation (see Budgett, Cumming, & Miller, 2007; Bonnington, Oates, Parnell, Paterson, & Stratton, 2007; Fahlberg, Fahlberg-Stojanovska, & MacNeil, 2007) and other screencasts incorporating writing, drawings and highlighting can be created.

Personal Experiences

A number of years ago, as part of a quantitative techniques module, I introduced first-year students to spreadsheets and then looked at their applications to financial mathematics and statistics. In a computer lab, students first worked through some generic introductory exercises focused on basic skills and then progressed to applying these skills and learning new ones by tackling subject-specific exercises. I would often explain new spreadsheet features using a digital projector, requiring the entire class to stop and watch, irrespective of their progress. The disadvantage of these *helpful* interruptions was that the timing did not suit all the students and thus some would fail to get the full benefit of these explanations.

Changing to an alternative approach, I created a series of short screencasts (using the four-step process explained later in this chapter) that introduced the basic features of spreadsheets as needed by the introductory exercises (each exercise listed the relevant screencasts). Students were now free to work through the exercises, watching the relevant screencast(s) as required. This allowed

a student to watch the screencast exactly when needed, as often as they wanted with full control to pause and replay particular sections. Thus students could spend more time on task, as well as freeing more time for me to assist individual students. Together with a number of screencasts showing how to do a sample assessment, this series of screencasts formed a reference bank that students could draw upon as and when needed, including when revising.

Screencasts showing a suggested approach to completing the tasks of a sample assessment are, like everything explicitly linked to assessment, very popular with students. Useful also are screencasts of solutions to assessments, especially if released prior to results: they provide valuable feedback (and also can be used in future iterations of the module as further sample assessments). Moreover, a reference bank of screencasts introducing a topic, such as the ‘introduction to spreadsheets’ screencasts as described in the vignette above, can subsequently be used in more advanced courses as a quick revision for students to go through prior to classes; this has the benefit of encouraging students to engage prior to the first class as well as establishing a minimum starting level. Groups of screencasts can also be used as a first point of reference for former students who make contact asking for help on using software applications, which usually enables them to resolve their difficulties by themselves.

Initial feedback from students has been very positive (similar to Bush, 2008; Peterson, 2007; Winterbottom, 2007). Consistently for the past five years, in end-of-module evaluations for computer lab-based subjects, most students indicate that the available screencasts have been very useful and, that for future iterations of the module, more should be produced. Accessed through the college’s virtual learning environment, the screencasts provide students with rich, multimedia online content to complement face-to-face classes. The VLE also provides a platform for the integration of scre-

encasts into the module, so that they naturally support other activities and materials.

Recently, one week prior to a test, I uploaded to the VLE a series of four mathcasts (two to three minutes each) showing the handwritten development of the solution to a number of mathematics problems. The screencasts were presented with the questions, so that prior to viewing the screencast the student could read and indeed was encouraged to attempt the question. In the week prior to the test, over half the students in the class accessed the resource and nearly a quarter on two or three different days. A small number of students watched the screencasts over the weekend, with the heaviest use in the day before and the morning of the exam. The screencasts were viewed both during the day and into the late evening. Feedback from students a week after the exam (via a short anonymous in-class survey) showed a positive and enthusiastic attitude, indicating that almost all students would like to see more of this type of support and that using it helps to get a higher grade, with about three quarters of students thinking that this type of online solution is very useful for them personally. Students used the online solutions in a variety of ways, from just quickly watching them, through thinking carefully about the question before watching, to trying the question and then watching the solution (or fast-forwarding to the end to check their answer). Some students study together in groups, only resorting to the mathcasts if the group cannot solve the problem. A reservation that surfaced among a substantial minority, particularly from those who did not use the mathcasts, was the inability to print the solutions.

This vignette illustrates the potential of screencasts: students engaging with revision materials prior to an assessment. They did not all use the online solution, and those that did used the mathcasts in a variety of ways, a way that suited them. It raises the importance of being aware of individual differences and preferences for different ways of engaging with the materials. How screencasts are presented to students is important.

Screencasts need to be integrated into the teaching and learning process, with attention to their design and use so as to avoid passivity and encourage engagement: students doing tasks, thinking and solving problems.

The profusion of screencasts on the internet, on YouTube and on specific websites such as www.teachertrainingvideos.com (a collection of screencasts for teachers to help them to incorporate technology into their teaching) and www.demogirl.com (a blog with short screencasts explaining new internet applications and services), links to a dilemma that faces a teacher considering using screencasts: should you just link to useful screencasts you find on the internet, or create your own? Creating screencasts involves time, pedagogy and technology, with an important trade-off between final screencast quality and sophistication, and the time taken to develop it. Getting the balance right can be difficult, but may be answered by keeping the benefits to students clearly in mind: sometimes it's better to link to a screencast produced elsewhere, other times preferable to create your own. Prior to presenting a four-step process for creating a screencast, the next section will consider some pedagogical and instructional design issues.

Integrating Screencasts into the Teaching and Learning Process

All teaching starts with a learner's need. Screencasts are created by teachers to assist the learning process of students, to help students achieve learning outcomes. As the goal is to support student learning, it should always first be asked whether a screencast approach is the most appropriate and effective way to accomplish this. Only after reflecting on this should screencasts be created. Thus screencasts should be *pedagogically led* rather than *technology led*: in short, when creating a screencast, think about the learner. It is advisable, like with other teaching innovations, to start

small and build on initial successes, learning what works best for your students.

Create bite-sized screencasts: it is better for students to choose from a series of short, clearly focused screencasts than to have to navigate a smaller number of longer ones: two to four minutes, definitely less than ten minutes (see Cann, 2007). Shorter screencasts are more flexible for reusing with other learners and can be updated more easily. Each screencast should have a specific, clear purpose (ideally focused on one learning outcome), such as

- introducing a module
- providing guidelines or giving an overview
- reviewing a difficult concept
- previewing a forthcoming lecture, reviewing or summarising a previous lecture
- illustrating the steps to solve a problem
- explaining a technical diagram or picture
- demonstrating a software or website feature (particularly useful for software that students have limited access to)
- supporting an activity or project
- revising for a test
- answering frequently asked questions
- correcting or giving feedback

Combined together, a series of screencasts can form a reference bank (as discussed earlier) that can be used as a comprehensive resource for independent study and revision, a support for project work and a starting point for more advanced modules. Note that for students viewing on campus, particularly in computer labs, consideration of whether to use audio is required: Will all students have headsets or should an alternative no-audio screencast with captions also be produced? Veronikas and Maushak (2005) concluded, from a small research study, that students learning software applications prefer audio and text, rather than text only despite no statistically significant evidence that audio improves test scores (p. 204).

Careful preparation is crucial to the creation of high quality educational screencasts of high value to students. When creating a screencast, balance the time and effort involved against the potential benefits for learners. Also consider whether the screencast is to be of limited use, by a small number of students for a short period of time? Or should you expend more time and effort to create a screencast of higher quality that can be productively used by a variety of learners over a longer time-span across different modules and contexts? This extra effort may be rewarded if screencasts can be shared, either internally within a college or externally via YouTube or a national repository of learning objects.

A potential and real criticism of screencasts is that they can have a teacher focus rather than student focus and can lack interactivity (Educause, 2006), and thus may encourage passivity in learners, an attitude of *just sit back and watch*. To counteract this, think carefully how students can be encouraged to be active when using screencasts (a criticism and response that was also considered by Franciszkowicz (2008) when using screencasts to teach problem-solving skills and conceptual understanding in a general chemistry module). If possible, add some interactions. These could be some quiz elements, such as answering multiple-choice questions or dragging and dropping. It could be the addition of clickable zones, for example where a student must click on the correct button to get a software demonstration to continue. At the most basic, it could simply be a requirement to click a button to continue, paired with an instruction or exhortation to think or do something before continuing. For example, if illustrating how to solve a question, such as an accounting or engineering problem, the screencast could display the question and then pause, instructing the student to read it carefully and consider how to proceed. The student could then click to view how to approach the question, with an audio explanation linked to underlining or highlighting on screen the key terms and numbers. Then the

student might be requested to attempt the question, only viewing when having completed their solution as best they can. As the learner can forward and rewind, they can focus on specific areas of difficulty, watching these sections a number of times. The solution could be partitioned into stages, with pauses at each transition.

There is an element of ‘watch what I do’ in a screencast: this can be useful, enabling the student to watch an expert at work, thereby offering a scaffold for undertaking the activity herself/himself. Some interactivity giving feedback may be incorporated into the screencast itself, as discussed above. This increases the complexity of the screencast, requiring greater time and expertise to create it; indeed many screen capture softwares may not support this, or it may be easier to create a simple screencast and build the other elements separately. This latter approach is where screencasts may bring audio-visually rich media to an online learning activity, a form of reusable learning object (RLO). Alternatively, it may be better to create simple screencasts and then carefully consider how these can support learning in conjunction with activities designed for students to undertake.

Oud (2009) presents a useful summary of the implications stemming from the limited capacity of short-term or working memory and how this limits learners’ capacities for information processing. When too much information is presented, learners’ ‘working memory is overloaded and they cannot process anything well, which leads to poor understanding, retention and learning’ (p. 166). Thus when creating a screencast, it is important to minimise the cognitive load. This leads to practical recommendations (see below in the Capture section). Of particular importance is chunking, the splitting of longer or more complex content into small sections (p. 167).

Instructional design approaches are valuable for informing the screencast development process. An instructional design approach to the

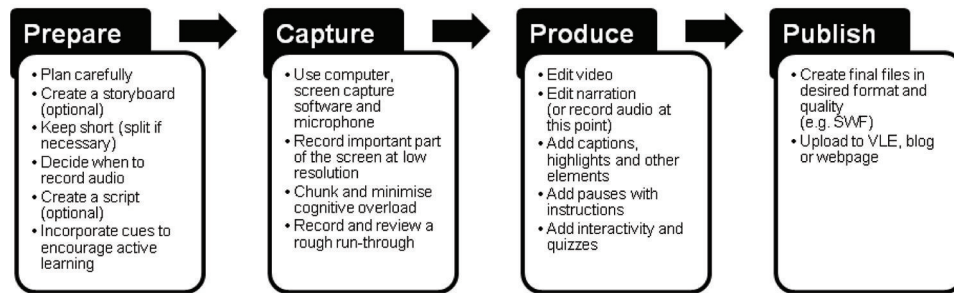
development of educational multimedia, specifically screencasts, is based upon the application of appropriate research, such as the psychology research on cognitive load theory summarised above. Instructional design is the use of systematic design procedures, thereby making, according to Gustafson and Branch (2002), ‘instruction more effective, efficient and relevant than less rigorous approaches to planning instruction’ (p. 18). Fundamental to all systematic design approaches are the following elements: analysis, design, development, implementation and evaluation (often referred to by their acronym ADDIE). (Readers interested in instructional design are directed to the References and Additional Reading sections.) In the next section, the four-step model proposed for creating a screencast broadly corresponds to the middle three elements of the ADDIE model.

Creating a Screencast

The motivation for creating a screencast is to support learning. The process builds naturally on existing teaching expertise, often using low threshold applications (i.e. technology with a relatively short learning curve, Gilbert 2002). As shown in Figure 1 the process to create a screencast can be envisioned in four steps:

The process starts with preparation, careful consideration of a teaching activity and learning opportunity. With a computer, screen capture software and a microphone, educational screencasts can quickly be created that are of immediate use and value. Voiceovers can be captured when recording the screencast or added later during the production process. The production process can be elaborate, including the addition of captions and other visual cues, additional voiceovers and interactive elements such as quiz questions. Alternatively, given usual time pressures, this pre-deployment step can be minimised to simply publishing the screencast in the required technical format (Costello, 2008). Then the screencast can

Figure 1. Four-step screen capture process (with a summary of each step)



be deployed via a virtual learning environment, a blog, an intranet or the Internet. Although Figure 1 presents the four steps as a linear process, the boundaries are fuzzy and, similar to the AD-DIE model, there may be jumps back and forth and reiterations.

For capturing a screencast, there are both hardware and software requirements. The computer needs to be sufficiently powerful to run the capture software plus any target applications that you are recording. The same general issues apply to sound quality as when producing a podcast and an inexpensive microphone headset usually suffices. For capturing handwriting on the screen, such as for mathcasts, a tablet laptop is likely to result in much clearer handwriting than an external USB tablet and it is easier to use for annotations as you are writing on the actual screen. Software that is useful here includes Microsoft OneNote, PDF Annotator and Microsoft PowerPoint, as well as drawing tools such as Microsoft Paint.

There are many capture software options available, from sophisticated packages with powerful capture and editing features such as Adobe Captivate and Camtasia to simple, free options that simply publish what you capture without any editing such as Jing and Screenr.com.² These four software options all include screencasts showing how to use the particular software to create screencasts (see links in Additional Reading). Your choice of software should be dictated by the extent to which you wish to edit your screencasts,

as well as the importance of particular features, such as being able to add quiz elements, modify menu options, accessibility features and publishing format options.

In the following four sections, each of the four steps will be discussed in terms of instructions and tips for creating educational screencasts.

Prepare

Plan your recording carefully. Know what you want to show, to do and what you want to say. Be aware of what your students already know. It may be useful to create a storyboard, a ‘visual representation which illustrates the content, navigation and structure of the learning materials’ (Clarke, 2001, p. 173). Use the storyboard to help the chunking of complex sections into simpler pieces. For short, simple screencasts, the storyboard can be an overview of the major elements. For longer screencasts, the storyboard may be more elaborate, detailing each major element or screen display. If the storyboard indicates a long screencast, consider whether it is possible to break it into a series of two or more shorter screencasts. Remember at this stage to think carefully how students are likely to use the screencast and what cues you can incorporate to encourage them to be active when using the screencast.

Decide when to record the audio. For short simple screencasts you may decide to record narration as you capture the screen activity. For

longer screencasts, it may be easier to record the audio separately after capturing the screen activity. For example, if demonstrating how to use a website, it may be better to first edit out any time waiting for pages to load and any glitches before adding the voiceover. Also recording the audio afterwards allows you when screen capturing to focus on doing clear screen actions. Consider using a script: the trade-off is between spontaneity and naturalness versus a professional, confident narration mostly free of ums and ahs. An added benefit of a script is that it can be used as a transcript or for closed captions.

To summarise, a teacher creates screencasts to help learning happen. Creating good screencasts depends on ‘planning a session with an eye toward its being recorded and on thoughtful editing afterwards’ (Educause, 2006). Careful planning and thoughtful reflection can assist in translating teaching activities into useful screencasts: indeed this preparation is key to the *capture* stage in the creation of educational screencasts.

Capture

After your planning, you should know exactly what you are going to record. If recording audio, use a quiet room with telephones turned off. Ensure that any other applications will not interfere with the recording, for example an email application beeping or otherwise alerting that a new email has arrived. Indeed you should close any unneeded applications. A tip when recording is to record only the application window or a defined area, and to consider recording at low screen resolution (such as 800x600). It is important to be aware of any quirks of your screen capture software that may result in glitches in your recording. For software demonstrations, make clear mouse movements at a pace that is suitable for learners to follow.

Be conscious of instructional design principles. In particular use strategies to minimise cognitive load such as the following guidelines suggested by Oud (2009, pp. 176–177): start with an outline

and end with a summary; split content into small segments/chunks; sequence content logically; use words (text or audio, not both) with graphics; provide clear interface, navigation and instructions; remove unnecessary graphics, text and audio; and, focus attention on important areas with visual or verbal cues.

A pragmatic approach is to record a rough run-through, review it and then record the main version. For a short screencast, if you make a mistake you could just restart recording rather than having to edit. For longer screencasts, errors can be edited out during the *produce* stage.

Produce

The *produce* stage may be extensive, short or omitted entirely (especially in the case of screencasts that are not to be used extensively). Start with editing the video, removing glitches and unneeded elements such as video showing the loading of webpages. Edit the audio, removing ums and ahs (or record the narration at this point). Make the modifications decided upon in the *prepare* stage: add captions as appropriate (or edit captions that have been automatically created by your screen capture software), whilst remembering not to overburden the viewer with too many simultaneous elements; use text animation, highlighting and zoom effects to focus attention and reinforce important points; and, add interactivity such as clickable zones and buttons, quiz elements or simply pauses with exhortations to think.

If your screen software capture allows, modify the default menu (player) options to your desired configuration, ensuring to allow learners substantial control. Now the screencast should be ready to *publish*.

Publish

The *publish* stage of the screencast creation process involves creating the final screencast file(s) in a technical format suitable for use by learners.

Depending on the software used to capture and process the screencast, there may be a variety of options, such as Macromedia Flash (swf), Windows Media Video (wmv), Audio Video Interleave (AVI) or executable (exe). Screencasts can be delivered on a variety of platforms, primarily streamed via the internet for watching via a browser with suitable media player, but also downloadable for later viewing on a computer or portable device capable of playing video (although note that the small display size of some portable devices may be insufficient to display certain screencasts in sufficient detail). For example, Adobe Captivate creates Flash files to be viewed via a browser, also creating the HTML code for launching the screencast.³ It can also create Windows executable files (not requiring any other software) and AVI (which can be further processed for uploading to YouTube).

It is straightforward to upload these files to a VLE, a blog, an intranet or the Internet. Decide whether to only allow the screencasts to be viewed online, or to permit downloading for offline viewing. Some issues may arise regarding file size and server space if uploading a large number of screencasts (particularly within a VLE where each file must be uploaded separately to different courses). A solution is to host separately and to post links to the VLE. For students viewing screencasts from home, large file sizes necessitate having broadband. A separate issue is how students should be notified of new screencasts. Within a VLE, they may be uploaded to the relevant section, possibly accompanied by an announcement or email notification.

FUTURE RESEARCH DIRECTIONS

Screencasts are very popular with students and many teachers in higher education are exploring their use. Although most practitioner-reported experience views screencasts positively, there may

be questions as to the effectiveness of screencasts in improving learning for students; for example Lee, Pradhan, and Dalgarno, (2008) report on a research project in which screencasts were used to support the teaching of programming, finding ‘no significant effect of the provision of screencasts during learning’ (p. 75). The level of complexity of the task or subject matter for the screencast is important, with Bhowmick, Khasawneh, Bowling, Gramopadhyea, and Melloya (2007) finding that for complex procedural tasks ‘a combination of audio, video and synchronized text yields the best results both in terms of learning performance and process efficiency’ (p. 615). Given the development of national repositories for reusable learning objects (RLOs) such as the National Digital Learning Repository Project (NDLR) in Ireland, Jorum in the United Kingdom and MERLOT in the USA, it is appropriate to consider the development of quality screencasts that are reusable by students on a variety of programmes, in different ways and contexts.

A potential criticism of the four-step screen capture process presented above is that, unlike the ADDIE model, it does not explicitly include an evaluation stage. There is a need for the evaluation of the use and effectiveness of screencasts in a variety of intents and contexts. These evaluations and related research should inform the development of evidence-based recommendations for good practice in the creation and use of educational screencasts.

It is incumbent on teachers who develop screencasts to become proficient with the technology. However those who create screencasts also need to become familiar and draw upon research in areas such as instructional design, pedagogy, educational psychology and accessibility. This should be viewed within the context of major change in higher education underpinned by technology and the attending change in the role of the academic (see Davidson-Shivers, 2002).

CONCLUSION AND REFLECTIONS

Simple, short screencasts are quick and easy to produce, popular with students and can help learning happen. The combination of text, audio and video is engaging. Screencasts can be used for many purposes, for instance to introduce a module, give an overview or review a difficult concept, illustrate how to solve a problem, explain a technical diagram or picture, show how to use software or a website, and give feedback. Students can flexibly use short, sharply focused screencasts how, when and where they want.

To create a screencast, you need a computer, some software and a microphone. There are many software choices, with more powerful options having a steeper learning curve. Time is often the major issue, whether to capture a simple screencast and publish with little editing or to expend greater effort in creating a screencast together with interactive elements that is of use by a greater number of students in a wider context.

When introducing screencasts into a module, there are some personal considerations. Screencasts, like full digital recordings of lectures, are a more public form of teaching. This combined with the possibility of the digital recording of mistakes (Do *you* want to appear on YouTube? See Young, 2009) may enable possible misuse by students and criticism of presentation style by colleagues (see Budgett et al., 2007). This openness is broadly positive, but requires a certain level of confidence. Another issue may arise: if recording mini-lectures, software demonstrations and explanations for model solutions of questions, will students stop coming to class? No, I would tentatively suggest; it is likely that screencast use and class attendance are positively correlated, consistent with the findings of Grabe and Christopherson (2007) who found that the use of online lecture resources, lecture attendance and examination performance were positively related. Screencasts do need to be thoughtfully integrated and their introduction may provide an opportunity

to rethink the use of classroom time, to create space for implementing more active learning strategies.

Screencasts indeed have the *potential* to enable learning in new and exciting ways. Screencasts can be used to support greater learner independence and may allow for a change in how lectures, tutorials and lab sessions are used, with less time spent presenting and more time spent on students doing things. It is important to reflect on the strengths and weaknesses of screencasts to be able to harness their potential, as well as to draw upon pedagogical and instructional design principles in their development. In particular, it is essential to carefully integrate screencasts into the teaching and learning process to support students' active engagement with their learning.

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ADDITIONAL READING

a website of a professional screencast creation company, including examples, a blog and a short screencast overview of the company approach to creating screencasts (<http://scraster.com/82/scraster-professional-screencasting-a-3-minute-introduction-2>)<http://scraster.com>

<http://screenr.com>: a website that allows you to create screencasts directly from your browser with no software to install. For free, you can create your screencast, preview it (no editing) and then upload for hosting on screenr.com, download as MP4 or upload to YouTube. It integrates with

<http://www.screencast.com>: a website that allows you to upload and share screencasts, presentations, documents and images. Integrates with Jing and Camtasia.

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<http://www.teachertrainingvideos.com>: Russell Stannard's website is a collection of screencasts to help teachers incorporate technology into their teaching. It demonstrates the usefulness of screencasts, and has a series of screencasts on using Camtasia.

Salmon, G., & Edirisingha, P. (Eds.). (2008). *Podcasting for Learning in Universities*. Berkshire: Open University Press. Comprehensive book on podcasting, including a useful chapter by Mount and Chambers on their research on screencasting for software practicals.

<http://www.mathcasts.org>: Tim Fahlberg's website is a useful starting point for those interested in creating mathcasts (or simply recording writing and drawing on a screen). He also showcases *pencasts*, created using the Pulse SmartPen which digitally records writing and your voice as you write on paper.

Twitter. <http://demogirl.com>: a blog with short screencasts explaining new internet applications and services, useful to see some good screencasts and Molly McDonald explains how she makes a screencast (<http://demogirl.com/2008/01/14/want-to-see-how-i-make-a-screencast>)

<http://www.adobe.com>: website for Adobe Captivate, where you can download a fully functioning trial, get help and tips from the Developer Center, watch example screencasts and visit the blog.

<http://www.techsmith.com>: website for Camtasia, where you can download a fully functioning trial, go on a product tour, watch tutorials and visit a section on using Camtasia in education.

<http://www.jingproject.com>: website for Jing, where you can download Jing or upgrade to Jing Pro, read about Jing's features, watch screencasts demonstrating how to use Jing and visit the Help Center.

<http://www.lynda.com>: website of provider of educational materials on using technology. Many of their courses comprise of a series of screencasts and the site provides an opportunity to review some high quality screencasts.

<http://www.rlo-cetl.ac.uk>: website of the Centre for Excellence in the design, development and use of learning objects. They define an RLO as 'a web-based interactive chunk of e-learning designed to explain a stand-alone learning objective'. RLOs can contain screencasts and this website has many good examples.

ENDNOTES

- ¹ Note Educause's (2006) definition of a screencast as 'a screen capture of the actions on a user's computer screen, typically with accompanying audio, distributed through RSS' (p.1); thus a student will have subscribed to the teacher's RSS feed which will automatically highlight any new screencasts that have been added since the student last logged in (Educause, 2007).
- ² I have used a variety of software, starting with Viewletbuilder (www.qarbon.com), then switching to Adobe Captivate (www.adobe.com) and most recently testing Jing (www.jingproject.com). Another very popular screen capture software, particularly in higher education, is Camtasia (www.tech-smith.com). Note that there are many software options to choose from. The choice of software is a balance between sophistication of features, ease of use and financial cost. If you want to create a professional screencast, usable over time by many students and reusable by others, using a professional tool such as Captivate or Camtasia is advisable. Captivate, which I am more familiar with, has many features enabling full editing of your screencast (editing of recording and

sound, adding captions, clickable zones and buttons, highlighting and much more) as well as the development of e-learning objects with quizzes and branching scenarios. It is part of a suite of e-learning tools. Captivate incorporates a good text-to-speech converter and supports accessibility features like closed captioning. Like Camtasia, it has a presentation feature seamlessly enabling the narration of a PowerPoint presentation. The power of Captivate does come with a learning curve, especially for those less technically literate. Both Captivate and Camtasia have fully functioning trial versions that can be used for 30 days, with integrated screencasts demonstrating how to use the main features. A simpler option that can be used to quickly produce screencasts, especially throwaway (one-use) or limited-use ones, is Jing. Jing makes the capture very straightforward. The free version allows screen captures of up to five minutes to be recorded, with audio if desired. Jing, in conjunction with Screencast.com (www.screencast.com), makes it easy to upload your screencast to the internet, in the process generating a unique URL to link to and the HTML code to embed it within your VLE, blog or other webpages (similar to the options for linking to a YouTube video). Disadvantages however include, as well as the five minute limit, not being able to add captions, indeed not to edit the screencast at all nor to add audio after screen capture, as well as the commercial branding of Jing at the end of screencasts produced. These can be partly overcome by moving to the professional version (which allows removal of commercial branding as well as an easy upload to YouTube) or by bringing the SWF file generated by Jing into Camtasia for editing. At this early stage of my experience of working with Jing, it seems a promising option for colleagues who wish to produce the occasional screencast for use by their

own students and I can see myself increasingly using it for limited-use screencasts (or alternatively Screenr.com, a new web-based option offering similar features). However the editing power of Captivate means it likely that I will continue to use it or similarly powerful screen-capture software for producing screencasts that will be used more widely.

³ It is sometimes useful to create a simple webpage with links to a series of screencasts that students can open as full screen in a separate browser window. These files can be put into one zipped file and uploaded as a package file (for example, when uploading content in Blackboard choose 'Unpackage this file' to allow the online display of the zipped material, pointing to the index page from which the screencasts will be launched).

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Chapter 3.11

Teaching IT Through Learning Communities in a 3D Immersive World: The Evolution of Online Instruction

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ABSTRACT

The development of learning communities has become an acknowledged goal of educators at all levels. As education continues to move into online environments, virtual learning communities develop for several reasons, including social networking, small group task completions, and authentic discussions for topics of mutual professional interest. The sense of presence and copresence with others is also found to be significant in developing Internet-based learning communities. This chapter illustrates the experiences

with current learning communities that form in a 3D immersive world designed for education. Faculty at Appalachian State University (ASU) have developed and taught the graduate instructional technology program in an award-winning 3D world setting for several years. Additional ASU faculty and program areas are currently transitioning into this environment. Further, colleagues from major universities in other countries are using this environment for their students to work and to collaborate across time and distance. Telecommunications technologies in education (exposing the graduate students to the breadth of IT experiences and knowledge required), hypermedia, and advanced Web design are examples

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of IT-related courses offered in the graduate program. The results of these experiences highlight the efficacy of this tool toward the formation of authentic communities within 3D Internet-based worlds as online distance education environments continue to evolve.

INTRODUCTION

New technologies for collaboration have generated increasing interest in the formation of various kinds of online learning communities for distance education. A wide range of distributed learning communities are currently involved in training, education, gaming, social networking, and other emerging online endeavors. These distributed learning communities are available in different forms and demonstrate underlying frameworks that include collaborative text-based environments, Web-based text and graphical multiuser domains, and the more sophisticated CAVEs (projection-based automatic virtual environments). Each of the above presents its own unique technologies and possibilities for online distributed collaboration and learning. Each presents opportunities for group interactions in different ways that bring a sense of community to the task. This chapter will focus on the findings and experiences of various communities of learners formed within a 3D immersive Internet-based virtual world developed for graduate education.

Descriptions of a 3D Internet-based learning environment—called Appalachian Educational Technology Zone (AET Zone)—used by the instructional technology program in the Department of Leadership and Educational Studies at Appalachian State University have been noted in other research (e.g., Bronack, Riedl, & Tashner, in press; Riedl, Bronack, & Tashner, 2005; Tashner, Bronack, & Riedl, 2005). An Active Worlds universe server (<http://www.activeworlds.com/>) serves as the current platform for AET Zone, and provides a means to build virtual worlds for

students, instructors, and other invited guests to meet and to work together in ways not found in other learning environments currently available. AET Zone may be characterized by significant components of space, movement, physical presence and copresence, conversational tools with small and large group shared workspaces, and metaphors and artifacts that assist with collaboration and learning online in unique and powerful ways. Students, faculty, and guests, graphically represented by avatars, move through the 3D world spaces interacting with each other and with artifacts within the worlds. These artifacts may be linked to different resources, Web pages, and tools necessary to provide content and support for various kinds of synchronous and asynchronous interactions. Small and large group shared workspace tools enable interactive conversations in text chats, threaded discussion boards, and audio chats. Group sharing of documents, Web pages, and other types of application software also are available within the virtual world.

Typical students in this graduate program are mid-career K-12 classroom teachers who want to learn more in-depth ways to integrate technology into their curriculum, or who want to become instructional technology specialists in their schools or chief technology officers (CTO) at the district level. Many of the students in the program teach within a 100-mile radius of the institution. However, recent initiatives have expanded opportunities to enroll K-12 teachers in a totally online experience. For example, several Mexican teachers from the D'Amicis School in Puebla, Mexico, and faculty and students in Griffith University in Brisbane, Australia, are working within AET Zone. Without the ability to depend on face-to-face contact, these international collaborations are challenging us to rethink the way we develop and enhance the sense of community in distance educational settings.

The instructional technology program at Appalachian State University uses a cohort model, where students enroll and move through

the program together through a specific sequence of courses. Students and faculty currently meet face-to-face regularly at the beginning of the program, with reduced numbers and frequency of meetings as the members of a cohort become more comfortable working within the virtual world and gain understanding of course structures and expectations. While the virtual world is used for each class, the number of face-to-face meetings rapidly decreases after the first several courses to only an orientation class at the beginning and a final class session for student presentations at the end. A handful of courses during the final phase of the program are conducted completely within the virtual world, with no concurrent face-to-face meetings.

A set of four cohorts, consisting of 80 students who had experienced at least 2 years in the program, were asked several questions concerning ways they would describe their experiences as learners in this immersive 3D world. An informal qualitative analysis was conducted for the common themes expressed through the aggregated responses. These are presented and discussed below.

BASIC TENET

Conceptual Framework

A conceptual framework (Reich College of Education, 2005), based upon social constructivism (Vygotsky, 1978), was developed by the College of Education and provides a clear foundation that guides teaching and learning within AET Zone. These basic concepts are:

- Learning occurs through participation in a community of practice
- Knowledge is socially constructed and learning is social in nature in a community of practice

- Learners proceed through stages of development from novice to expert under the guidance of more experienced and knowledgeable mentors in the community of practice
- An identifiable knowledge base that is both general in nature and also specific to specialties emerges from the community of practice
- All professional educators develop a set of dispositions reflecting attitudes, beliefs, and values common to the community of practice

AET Zone reflects these assumptions about teaching and learning, and provides a powerful space through which effective learning communities are formed and nurtured. Students know and can see when their colleagues are logged into the world. They can approach other students and talk to them about life, work, or the latest news. Through these interactions, both planned and serendipitous, students begin to create knowledge together. They talk about the work they are doing in class, they share ideas, processes, and resources with one another, and they contribute to the base of knowledge that exists in their field. Throughout this process, they move from novice to expert, both in terms of knowledge and skills, but also in terms of their abilities to work collaboratively within a virtual learning environment using tools previously unknown to them. Their beliefs about teaching and learning are challenged, refined, and shaped by the process of learning together in an authentic social world of dialogue and discovery (Sanders & McKeown, 2007).

Differences Between Conventional Classrooms, Traditional Distance Education and Emerging Environments

Table 1 describes the differences between conventional classrooms, traditional forms of distance

education, and emerging educational environments such as AET Zone. These characteristics are based on observations of what occurs in each environment. One key factor is the continuity and persistence of the AET Zone setting in which students and faculty run into each other during all times of the day and night regardless of physical location. While one can argue that similar persistence and continuity can and does occur on traditional campuses, it should be noted that there is a distinct *discontinuity* between the confines of the classroom setting and the rest of the campus setting. In AET Zone, the learning environment and the social environment are one and the same. Thus, the community of practice is more explicit and becomes a more obvious factor in the experiences of students and faculty.

Learning Communities

Learning communities have been characterized in many ways, and some division exists in current literature on the actual meaning of learning communities. “Communities of learners,” according

to some, are groups formed to increase their understandings or knowledge base in specific areas. Jonnasen (1997) cites the following necessary components for a learning community: active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective. Others use the term “community of practice” which seems to indicate communities of similar practitioners who are currently exploring various aspects of their endeavors together. Wenger (1998) states that communities of practice include: “a *joint enterprise* as understood and continually renegotiated by its members..., *mutual engagement* that bind members together into a social entity.... and the *shared repertoire* of communal resources (routines, sensibilities, artifacts, vocabulary, styles, etc.) that members have developed over time.” Others use the terms “learning communities” and “communities of practice” interchangeably.

Developing Online Communities

In either case, the literature suggests several main themes that emerge as useful guides for developing

Table 1. Analysis of the principles of the RCOE conceptual framework

	Conventional Instruction ¹	Current Distance Education ²	AET Zone ³
Knowledge is socially constructed and learning is social in nature	Usually only within the context of each individual class	Rarely and if so within the context of an individual class	Within the entire virtual world community
Learning occurs through participation in a community of practice	Usually only within the context of each individual class	Rarely and if so within the context of an individual class	Regularly throughout the entire virtual world community
The development of educators proceeds through stages from novice to expert under the guidance of more experienced and knowledgeable mentors in the community of practice	Rarely; contact with mentors usually limited to the course instructor	Rarely; contact with mentors usually limited to the course instructor	Exposure to and interaction with a wide range of mentors throughout the virtual world community
An identifiable knowledge base emerges out of the community of practice that is both general for all educators and specific to specialties and content areas	Limited by lack of exposure to the broader community of practice	Limited by lack of exposure to the broader community of practice	Regular contact with the broader community of practice develops a full and shared knowledge base
All professional educators develop a set of dispositions reflecting attitudes, beliefs, and values common to the community of practice	Limited by lack of exposure to the broader community of practice	Limited by lack of exposure to the broader community of practice	Regular contact with the broader community of practice leads to sharing of beliefs and values leading to dispositions that are part of that community of practice

online virtual communities. An overview from a recent conference on building learning communities states that such communities:

Foster peer-to-peer collaboration, communication, interaction, resource sharing, negotiation and social construction of meaning, and expressions of support or encouragement among students. A blended or online learning community must have its own meeting or gathering space, as well as a defined set of members' roles and norms for resolving disputes. ("Academic Impressions," 2006)

A key element in the development of the community in AET Zone is that faculty members who teach in this environment stop thinking of students in one section of a class as "their" students but instead they interact with all students across sections and across classes. The "flattening" of their thinking is trickling down to students as well. Students are meeting each other online, learning what they have in common and how they differ, and then forming effective online partnerships and communities around real-world projects and activities (Sanders, Bronack, Cheney, Tashner, Reidl, & Gilman, 2007). Students just beginning in programs are interacting with students who are nearing graduation. Students in school administration, library science, higher education, and reading programs are interacting with each other and with instructional technology majors. Virtual worlds such as AET Zone are moving distance education efforts toward realizing the full potential of what distance learning might become. The virtual world serves as a catalyst for a learning community that reaches far beyond what normal classroom settings have been able to accomplish. Zhao and Kuh (2004) support this goal, asserting, "Learning communities are associated with enhanced academic performance, integration of academic and social experiences, gains in multiple areas of skill, competence, and knowledge, and overall satisfaction with the college experience" (p. 130).

The communities forming between and among students are beginning to resemble what Wilson and Ryder (2006) describe as "dynamic learning communities." Such communities are defined as "groups of people who form a learning community generally characterized by the following: distributed control; commitment to the generation and sharing of new knowledge; flexible and negotiated learning activities; autonomous community members; high levels of dialogue, interaction, and collaboration; a shared goal, problem, or project that brings a common focus and incentive to work together." These dynamic communities of learners are the ultimate goal in the process of applying social constructivist theory in the design and development of tools and spaces to support effective Internet-based communities for learning.

Common Themes in Learning Communities

Several common themes consistently emerge from these descriptions of learning communities. Communication, collaboration, and support are central to their development and maintenance. Other factors include shared resources and authentic reasons to join together. Recently emerging research and the emergence of 3D Internet-based environments for teaching and learning suggest the importance of the sense of presence and copresence in the development and evolution of online communities (Schroeder, Steed, Axelsson, Heldal, Abelin, Widstrom, et al., 2001). Using such characteristics as both a vision and a guide, the instructional technology graduate program has been studying ways to develop an environment that continues to foster and to support a wide variety of learning communities that may be identified with these characteristics.

Development and support of communities within 3D immersive worlds used for learning require consideration of how students will move through the course environments in collabora-

tive ways, how to provide means to enhance the communication between students, guests, and instructors, and how to ensure participants will interact with the various resources in the environment that contribute to building meaningful communities of learners.

Collaboration

Participants in courses and other activities within AET Zone express a strong sense of collaboration by those engaged in learning within the virtual world. This collaboration exists between students in a specific cohort as well as between students from different cohorts. In fact, students from one section of a course often collaborate on specific tasks with students from other cohorts enrolled in sections of the same course, thereby increasing their collaborative resources exponentially.

Additionally, students cite many instances of working with other students from different program areas who were also taking different courses within the virtual world. It was indicated that students felt a strong collaboration with instructors, who served as knowledge guides rather than sole sources of expertise, as well. Additionally, students

know that the course resources (including fellow students and faculty) will remain available to them through the AET Zone following completion of the course, and for graduates, even after completion of the degree program. They are free to visit other courses, to access various resources, and to engage students in other courses as resources in the learning process.

COMMUNICATION

Learning is a social process which reveals a conflict between what is already known and what is being observed (Brooks & Brooks, 1993). To resolve this conflict, an effective learning process requires interaction between learners and content, between learners and their peers, and between learners and those more expert than they (Levin & Ben-Jacob, 1998). Tools for communication, topics about which to communicate, and an authentic need to communicate are requisite factors for effective communication to be sustained within learning communities or communities of practice.

Figure 1. A community of learners collaborating in AET Zone

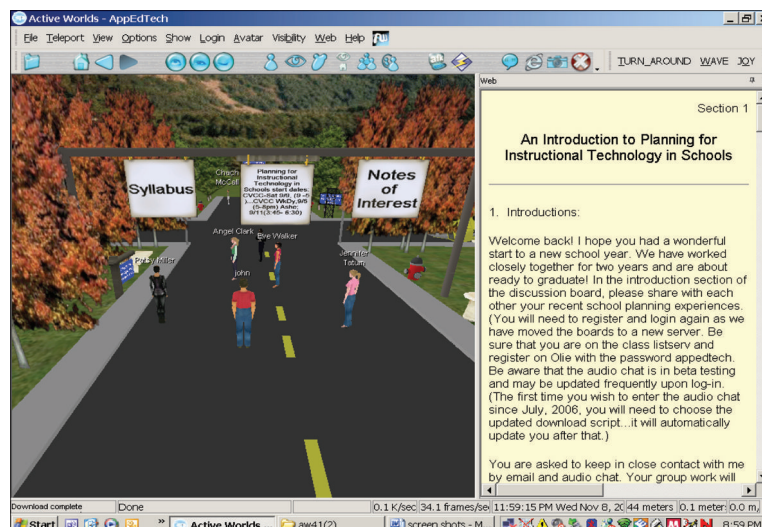


Figure 2.



Synchronous Communication

In 3D immersive worlds, several kinds of communication tools are found to be necessary to support ongoing tasks and community building. Synchronous tools such as text-based and audio chat capabilities are critical parts of the infrastructure necessary for creating learning communities. Such tools provide a means of working together at the same time in ways not otherwise possible. According to a recent analysis (Tashner et al., 2005), participants are able to develop and work together on authentic projects and topics because of the communication tools provided.

Asynchronous Communication

Asynchronous tools, however, also are important to the participants as ways of sharing ideas, research, and practice over time. For instance, a well-defined threaded discussion board provides opportunities for participants to share ideas, opinions, practices, and research. This communication tool also provides for the element of reflection that is not immediately available in synchronous environments. It is noted that the blend of these two communication tools within virtual worlds such as AET Zone enable a greater opportunity for interactions between and among participants.

Both formal and informal communication occurs in AET Zone and throughout the IT courses. Analysis further suggests that the informal communication is a powerful contributor to effective learning within 3D immersive worlds. Informal communication may spring up casually as faculty and students move around together in the world. Just as students on campus are thought to learn a great deal of content outside of structured classroom environments, so too, informal discussions in 3D immersive worlds may provide similar results. For example, students may join an audio chat room while simultaneously walking through the virtual world exploring together the artifacts that are present. Participants also may explore other topics of mutual interest that may or may not be part of their formal curriculum or agenda, but may still be tangentially relevant. This is an essential element of collaboration, communication, and community building.

SENSE OF PRESENCE AND COPRESENCE

Much contemporary Web-based instruction is characterized by “essentialists” view of teaching and learning. That is, certain “essential” things are to be learned as set forth by the instructor.

Information flows in one direction, from the instructor and auxiliary materials to the student. Interactions that occur in such environments generally are limited to those between a single student and the student's instructor or in limited cases, between students enrolled in the same class. The student then shows the instructor by summative assessments that learning has occurred. When done online such environments lack many of the interactions and social aspects of learning that characterize communications within 3D immersive worlds. Emerging constructivist paradigms as noted above can be used as guiding principles in designing environments in which students engage in discussions with others across sections of the same class, different classes, and even different programs to deal with and to solve problems of interest from different perspectives. Such interactions include different forms of student to student, groups of students, instructors, and other experts interacting in various configurations to develop perspectives, to solve tasks, or to explore issues of mutual interest.

As 3D multiplayer games emerged in the late 1990s, researchers became interested in exploring these types of richer participant interactions taking place within gaming environments. Research suggests that social networks are powerful components of online multiplayer games (Jakobsson & Taylor, 2003). Drawing from ethnographical and constructivist approaches, Manninen (2001) offers a taxonomy to conceptualize these forms of interactions based on components such as language-based communications, avatar appearance, body language (subconscious), and physical contact. Research has also focused on roles that presence and copresence may play in enhancing participant interactions within virtual worlds (Schroeder, 2002). While the term "virtual" has recently been applied to many different types of technologies and mediated environments, Schroeder's definition of "virtual reality" focuses on the common elements linking these technologies and environments together, specifically, "a computer-

generated display that allows or compels the user (or users) to have a feeling of being present in an environment other than the one they are actually in and to interact with that environment" (p. 2).

Presence

Schroeder (2002) argues that shared virtual environments "combine a high degree of presence with a high degree of co-presence because the sense of being in another place and of being there with another person reinforces each other" (p. 5). Furthermore, "presence and co-presence will be affected by the extent of experience with the medium" (Schroeder, 2006, p. 439). The more familiar and comfortable users are with the medium and the social norms of the virtual environment, the more their sense of presence and copresence will be heightened. However, regardless of the users' competence and proficiency working in a virtual environment, two users' "connected presence" in that environment will have an impact on the overall experience for both users, simply as a result of being in the environment together (in a similar way to how ethnographers have noted that the act of observing influences that which is being observed).

As an immersive 3D environment, AET Zone allows participants to "see" each other via representative avatars. Each participant moves his or her avatar through the virtual world using a keyboard or a mouse. As one moves, one's perspective changes; thus what the environment looks like changes. This change in perspective as one moves creates a sense of "presence." A participant has the perception of being somewhere else. In addition, as one observes others in the environment, one has a feeling of being somewhere else with someone else or "copresence." These concepts lead one to experience a connected presence or mutual awareness of others. As the mutual awareness increases, so does the desire for and feeling of heightened engagement in the world and in the activities conducted within the

world. Emerging from these feelings is a strong theme of the importance of both presence and copresence in developing learning communities. Students report that the feeling of isolation and working alone diminished as they become accustomed to working in the environment. This was of particular import to both retention and to the individual successes of students toward their educational goals (Tashner et al., 2005).

Interestingly, presence is evidenced in several ways. The foremost is sensing that you are actually somewhere different than your physical location. As you move through the world and you sense the movement, your perspective changes and you become “there” as well as “here.” Some students will desire to change their personas on a frequent basis by changing their avatar. When asked why, they state that they were “feeling different.[sic]” On the other hand, some students do not see “themselves” in the same way.

Copresence

Copresence is characterized as being “there” with “someone else,” though the “someone else” is represented by an avatar. We have noticed that adults take into the 3D world some parts of their personalities and cultural more that they exhibit in the outside world. For instance, if one avatar gets too close to another, the second one will move in order to preserve “personal space.” Novice students must learn to minimize windows so that they can “see” when others are trying to communicate with them. Some become disheartened when they speak to another avatar and the “other” ignores them. Yet, we have also seen a reluctance to meet “others” outside their class, to converse with “strangers” in the 3D world. Such issues are worked through by assignments to meet others, explore courses together with “persons” you do not know, and many other techniques as needed. However, these examples demonstrate the importance of understanding the concepts of presence and copresence in immersive worlds.

Role of Presence and Copresence in Online Communities

The sense of presence and copresence are critical factors in creating and maintaining deeply engaging online communities. As participants gain more of a sense of being somewhere and with somebody else, communication and collaboration are dramatically enhanced. According to Ahuna (2006), when constructs such as communication and collaboration combine to support the formation of community, “a semantic world of sharing knowledge, solving problems, working as a team, playing, building, quarreling, cooperating, planning and forming relationships develop.” The following screen shot illustrates an overview of the Network Basics building. Students move through the building, walking across the various components, clicking on components to access descriptions and resource information. For a slightly different perspective, students may choose to float above the floor. Various tools to enhance the cognitive awareness and understanding of the concepts and constructs are available to the learners. Group interaction is encouraged as an important piece of the learning process, in developing the learning communities, increasing collaboration, and to increase levels of content understanding. The combination of communication and small group shared collaboration tools with a sense of presence and copresence provides opportunities for developing authentic learning environments for Internet-based learning that goes far beyond attempts to replicate traditional classroom instruction using typical Web-based applications.

Our experiences with graduate students in the AET Zone suggest that many forms of communities evolve as needed. Some will develop for specific tasks and time periods and then dissolve. These include task oriented communities, for example, where students will form groups to read and to discuss specific books and to inform other larger groups of what they are learning in

various discussion formats. Hence, a group of four students may find themselves in discussions on ideas with eighty other students. Another example might be a task involving the development and implementation of certain projects that include ideas, knowledge and resources shared among a larger group who have similar interests. Others will remain intact for longer periods of time. For instance, different forms of social groups also have been noted in AET Zone that are more persistent. One group who met online each week to work on assignments decided to meet together at a different time for dinner. They cooked the same dinner, drank the same wine and met, not face-to-face, but connected inside the 3D world in an audio chat room to enjoy each other's company for a while.

Certainly, our experiences in thinking about the roles of presence and copresence in AET Zone help us understand the importance of these sensory inputs in Internet-based instruction. However, we are deeply aware that we are dealing with very complex variables. We are exploring new questions that emerge from our observations. How might we develop a deeper sense of belongingness to these communities? Are there pedagogical ways to provide social networking within a series of courses or is it even desirable?

Instead of information flow in one direction only from a source to a receiver, many other

possibilities emerge. The result is a vibrant, active, participatory, and engaging environment developed for community members to build new knowledge based upon the foundation presented by the group.

METAPHORICAL GRAPHICAL USER INTERFACES

One striking feature of AET Zone is its extensive use of metaphors in the design of the graphical user interface. As students move through the world, they find themselves in plazas, gardens, frontiers, and suburbia. Every space in the 3D world is built upon a metaphor or a series of metaphors to provide students with access to content, context, and tools for navigation. We have been very deliberate in our selection of metaphors in our designs and believe that thoughtful and reflective choices about the metaphors to use are important to the success our students have working within the virtual world.

Cates (1994) cites Lakoff and Johnson in defining a metaphor as "understanding and experiencing one kind of thing in terms of another." One thing, often familiar, is a figurative representation of the other, often abstract or unfamiliar. According to Nicholson and Sarker (2002), Aristotle understood the value of a metaphor when he said, "Ordinary

Figure 3.



words convey only what we know already; it is from metaphor that we can best get hold of something fresh.”

Some suggest that simply a virtual representation of a physical space or artifact is not metaphorical, but rather, the virtual representation must be different in its representation (e.g., Cates, 1996). According to Cates (1996), a graphical user interface (GUI) that is metaphorical must be based on either an explicit or implicit metaphor, but it makes little difference as to whether the metaphor is obvious to the user or not. The important aspect is that the metaphor works to provide some insight into or aid in understanding of that idea, concept, or thing it represents.

According to Black and later expanded upon by Cates (1994), there are two types of metaphors: *underlying* or *primary* and *auxiliary* or *secondary*. An underlying metaphor is the main metaphor used. For example, in one of the courses taught in the instructional technology program, the underlying metaphor of the Wild West was used as the main metaphor throughout the course space within the virtual world. An auxiliary metaphor is one that is consistent with the underlying metaphor and is used to support or enhance this main metaphor. In the case of the aforementioned course, examples of auxiliary metaphors might include a “saloon” for meeting and conversing, a “general store” for finding useful content, and a “haystack” that links to useful search engines.

Complimentary Metaphors

Complimentary metaphors are those that enhance the online teaching and learning environment. These are complementarily aligned with one another to assist learners in developing a “conceptual framework of understanding through which the learner can further enhance prior knowledge and conceptualize a higher level of understanding towards the knowledge being obtained” (Henry & Crawford, 2001, p. 3). Henry and Crawford

further suggest that through the utilization of these metaphorical graphical user interfaces (MGUI), “a sense of community is presented to the learner, and in turn, a collaborative e-learning environment is well on its way towards realization.” (p. 4) This community emerges out of an immersive environment in which students “collaborate on projects, work in teams, and create material and artifacts together... Students assume a variety of roles...and students must negotiate as they will have to negotiate in the adult world” (Marshall, 2000, p. 5). For this to occur, auxiliary metaphors selected must be complementary to the underlying metaphor employed.

The effective use of metaphors in an online learning environment can be valuable in offering students a model to assist in understanding more abstract concepts in more familiar, concrete terms and can help students understand a concept and content more quickly than without the use of the metaphor by helping students learn and understand how things should work (Bishop & Cates, 1996; Cates, 1994). Bishop and Cates (1996) note existing literature that supports the position that content can be better learned through the interaction with metaphorical graphical user interfaces by providing both “superficial and deep similarities between familiar and novel situations.” Ultimately, it is the finding of these and other studies that the use of metaphors helps students build knowledge, develop higher level thinking skills, build community, and gain a more universal understanding of the subject matter being taught (Bishop & Cates, 1996; Henry & Crawford, 2001).

The goal in the use of underlying metaphors is to enhance the students’ learning experience by providing a device that allows each to interact with the instruction and the content in ways more familiar, and, as a result, more accessible, to them. Well-crafted auxiliary metaphors complement the underlying metaphor and the overall learning experience.

Confounding Metaphors

It should be noted, however, that the ineffective use of metaphors can have a deleterious effect on even the most well-designed and well-intended learning environments. Some have suggested that gratuitous or fantastical metaphors can be in conflict with the tenets that ground effective meaning-making (e.g., Nicholson & Sarker, 2002). While this assertion is in stark contrast with the value of metaphor discussed above, it does provide an important reminder that problems can arise in the use of metaphors, especially those that are auxiliary to the underlying metaphor.

Form should follow function, and the selection of underlying and auxiliary metaphors (form) should enhance and complement the teaching and learning tools and activities (function) embedded in a virtual world. One challenge in the inclusion of metaphors is the overdependence on their use within the interface design (Cates, 1996; Nelson, 1990). There are times when the poor choice of metaphors overshadows the instructional design of the content and the virtual world in which the content is presented. When this happens, students must reconstruct what they think they know and understand about the content and virtual world with which they are working. Again, according to Cates (1994, p. 103), “When users are faced with such an auxiliary metaphor [confounding] they are required to reconstruct the environment radically, envisioning a book [for example] that is unlike any that the user has ever seen. Users seem unlikely to make such radical reconstructions.... When users come to this conclusion, the benefits of the underlying metaphor are greatly reduced.” It is even possible that students may reject and disengage from the virtual world completely if the cognitive dissonance created by the confounding metaphor is too great.

Multiple studies warn that metaphors used incorrectly or out of context can make it difficult for learners to engage effectively within environments

such as virtual worlds (e.g., Rosendahl-Kreitman, 1990; Semper, 1990; Vertelney, Arent, & Lieberman, 1990). Misalignment or inappropriate linkage between metaphors and expectations may result in a debilitating tension for learners (Burge & Carter, 1997). Barrie (1996) explains this tension as created out of a “pause in the cadence of the composition...producing a reaction of tension and anticipation” and notes an emotional reaction occurs when this pause or interruption occurs, often resulting in frustration or even feelings of incompetence. Rohrer (1995) offers a different twist, suggesting that there is also a tension taking place between the literal and figurative, or “magical,” qualities of the metaphors being used, and this tension extends to the a tension between the user and the computer itself, which is viewed as an “other—a sentient being with a consciousness of its own (and usually a malevolent consciousness at that).”

When it comes to metaphors, it seems, numbers count. Incorporating too few or too many metaphors can pose problems for users as well. Learners may not have enough to make sense of the interface nor to understand the content to be learned if there are too few metaphors employed. On the other hand, too many metaphors can be overwhelming to a learner and lead to cognitive overload (Cates, 1994). Regardless, any use of metaphor has the potential of requiring learners to translate not only the content and instruction being delivered into more familiar and understandable terms, but also to force them to work through another cognitive layer posed by the use of the metaphor. When the layers overload, the use of metaphors may hinder—rather than help—learners make sense of the information at hand (Lohr & Heng-Yu, 2003). As previously mentioned, the poor use of metaphors can ultimately cause learners to abandon the metaphor altogether (Rohrer, 1995).

What is the lesson for designers of user interfaces for virtual worlds, then? The lesson is clear.

To design an effective virtual world for learning, it is essential to use complementary metaphorical strategies that foster the development of community and to avoid becoming enamored with the metaphors themselves.

SUPPORT

An additional theme that has emerged from our work with virtual worlds for learning is that of “support.” Support is expressed in many forms but in this case, the concept is of peer and instructor support. It is often expressed as assistance that is usually available whenever one requested it. Whether the online library resources, an individual course, or even professional assistance is needed, there is an instructor or peer ready to offer support. In social constructivist learning communities, such as AET Zone, participants move along a developmental continuum from novice to expert. Indeed, in each course and throughout the program, students represent various aspects of this continuum at various points in each individual’s personal development. As each becomes more aware of others through planned and serendipitous interactions, and as each becomes increasingly comfortable with others, their collective working relationships weave a complex support network for and by all participants. Bender (2003) suggests that a feeling of belonging within a chosen community of practice is requisite for effective learning. Both feeling supported and feeling supportive play an integral role in this important construct of belonging.

LEADERSHIP

It is in these same 3D communities that participants find themselves alternately leading and being led and where some participants unexpectedly find

themselves becoming leaders and identifying with leadership roles. The leadership theme emerges as personal as well as organizational leadership.

Working collaboratively and communicating together in learning communities enhances the leadership skills and comfort levels of participants, with self-reported transfer to their own teaching and learning environments. Students who spend time in AET Zone, for example, report a heightened sense of awareness of their own expertise arising from interactions and participation in the various communities in which they work and learn. They express an increase in personal and professional self-confidence, which they indicate is transferred into their professional practices.

In addition to leadership dynamics that emerge naturally from participation in 3D immersive communities of learners, deliberate leadership-focused prompts, such as case studies, provide problem-based learning situations in cross-disciplinary contexts that foster deeper levels of development. In AET Zone, for example, participants are immersed in authentic circumstances requiring the development of leadership “voice” in the “safety” of the virtual community. Participants are given opportunities to “try out” various responses to situations in an effort to solve problems within organizational communities. In the virtual environment mistakes can be made, consequences examined, and corrections tried without fear of real consequence or penalty. This type of natural yet safe learning is necessary for developing better leaders. Thus, experimenting with shared leadership skills can become a natural consequence of learning within the 3D community and, as well, can be a result of responding to deliberately conceived situations requiring leadership thought and decisions (Angel, Sanders, & Tashner, 2005; Sanders & Angel, 2005). In short, the 3D environment is a rich context for learning personal leadership skills and, as well, for applying those skills in real work situations outside this environment.

FUTURE RESEARCH DIRECTIONS

The convergence of sophisticated gaming platforms, communications technologies, social networking trends, and educational needs provide rich opportunities for future research. In this time of global transition, we are changing paradigms of what it means to teach and to learn. Rather than trying to address old problems with new questions, we must begin to ask new questions about new problems.

Online educational environments started by attempting to recreate the four-wall classroom that had been successful in the past. Should online learning continue to try to be the same as its face-to-face counterpart? Can it be unique in its approach, using different methods and tools for teaching and learning? How might a newer generation of online learning platforms containing more immersive and engaging environments add value to learning? Furthermore, should we be asking additional questions about how specific technologies allow us to expand beyond the four walls of a traditional classroom and transcend borders, cultures, and perspectives to create active participatory groups of learners? The development of online pedagogies to create the teaching and learning models needed for a 21st century education is a field ripe for research.

Especially important in future research may be the applications of social constructivism pedagogies to online environments. Social constructivism is fundamentally about the social construction of knowledge through participation in communities of practice. Through interaction and communication, collaboration and mentoring, learners become a part of and contribute to this community of practice. Researchers have just begun to explore the effects of various kinds of online collaboration and communications between students, instructors, and colleagues in developing these communities of practice. Questions subsequently begin to emerge regarding the value that might be added

by the use of tools and processes whose purpose is to enhance synchronous and asynchronous collaborations and communications in the context of social constructivist learning environments.

Specific research questions to be asked include: What constitutes online learning communities and how might they be developed and expanded? To what extent do learning communities enhance online learning? What is the added value of the participants' sense of presence and copresence in online environments? What tools are needed to assist them in high level functioning? Additionally, one might ask: What kinds of skills and attitudes are needed by educational leaders to move and to support students and teachers as their organizations move into 21st century learning environments? How might current educational leaders develop such needed skills and attitudes?

Finally, the need for new assessment methods and tools is critical if we are serious about teaching toward higher levels of "critical thinking" and performance. The current testing movement in the United States is geared toward measuring lower level cognitive skills, thus creating a mismatch between what is measured and what is stated as goals for 21st century success. Teaching and learning in online environments, especially those that are built upon a foundation of social constructivism, will require new assessment tools and measures in order to know and understand the learning that takes place in these 21st century learning communities. Basic research must consider what an educated person looks like in the 21st century. What kinds of educational experiences are needed to develop 21st century individuals? In a world where the same knowledge base is accessible by everyone, what does "knowing," mean? What skills and knowledge are needed by individuals to be deemed "educated"? The answers to these questions will assist researchers in the development of valid and reliable assessment tools that are more consistent with a social constructivist approach to online teaching and learning.

CONCLUSION

Those who have learned and taught within AET Zone report a variety of positive experiences, advantages, and learning outcomes from their work in this environment and through the powerful learning communities that develop within. While participating in this social constructivist, immersive environment, students enrolled in these courses use a variety of tools and metaphors for communication and collaboration, fostering various forms of learning communities. These include the many virtual communities developing within AET Zone for social networking, small group task completions, and authentic discussions on topics of mutual professional interest. Feedback from multiple cohorts across time and distance suggests the strong sense of presence and copresence felt while in AET Zone is a critical factor that fosters the development of useful learning communities which, in turn, facilitate practical, useful learning.

The shared experience of AET Zone participants has a number of other outcomes as well. Students share a variety of resources both during and after their period of formal participation. They also report that the environment provides support for learning, both from instructors and peers. As a result, students' sense of leadership and vision is heightened.

Virtual worlds such as AET Zone are unique environments for teaching and learning. The tools, support, and constructivist pedagogies embedded within AET Zone lend themselves readily to the creation of learning communities. Clearly, there is a need for well-designed research studies to develop a body of literature that will guide educators as they continue to move into emerging online environments for teaching and learning.

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ENDNOTES

- ¹ Typical context is one teacher with many students meeting in a classroom for a finite amount of time and in a class that is not necessarily connected with other classes or other experiences.
- ² Typical context is one teacher with many students who are in many different locations and in a class that is not necessarily connected with other classes or experiences.
- ³ Students and instructors of many classes intermingle at many different times and locations... Alumni and other experts are available throughout the virtual world and at many different times.

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Chapter 3.12

The MOT+Visual Language for Knowledge-Based Instructional Design

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ABSTRACT

This chapter states and explains that a learning design is the result of a knowledge engineering process where knowledge and competencies, learning design, media and delivery models are constructed in an integrated framework. Consequently, we present our MOT+ general graphical language and editor that help construct structured interrelated visual models. The MOT+LD editor is the newly added specialization of this editor for learning designs, producing IMS-LD compliant Units of Learning. The MOT+OWL editor is another specialization of the general visual language for knowledge and competency models based on the OWL specification. We situate both models

within our taxonomy of knowledge models respectively as a multi-actor collaborative process and a domain theory. The association between these “content” models and learning design components is seen as the essential task in an instructional design methodology, to guide the construction of high quality learning environments.

INTRODUCTION

Building high quality learning designs is a very important and demanding task. It is also a difficult task that we started to address already a decade ago by progressively building an instructional engineering method (Paquette et al., 1994, 2005a; Paquette, 2003), a delivery system (Paquette et

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al., 2005b) and a graphical knowledge modeling editor (Paquette, 1996, 2002).

In this on-going work and for the present discussion, the point of view is taken that a learning design is the result of a knowledge engineering process, where knowledge and competencies, learning design, media and delivery models are constructed in an integrated framework. In the first section of this chapter, we present the MISA¹ instructional design method based on these four models and their relationships to each other. The second section presents the MOT (modeling with object types) visual language and the specialized editing tools that have been used in numerous applications. We summarize the theoretical basis of the language, its syntax and semantic. Moreover examples within the MISA instructional design method will be presented.

The third and fourth sections address the standardization issues and how the MOT+ software is adapted to provide visual aid to designers building knowledge and/or pedagogical models. The third section focuses on the learning design models, the IMS-LD specification and the specialized MOT+LD editor that helps designers build IMS-LD compliant and interoperable units of learning. The fourth section presents the ontology web language (OWL) and the specialized MOT+OWL visual editor. We use it to represent domain knowledge models and target competency that can be used to plan, support staff roles and evaluate the quality of learning designs. In the fifth section we discuss the association between LD models and OWL models to support what we believe is the central task for knowledge-based instructional design aiming to support learning environments within the Semantic Web.

Finally, the concluding section will summarize the properties of representation languages that we have found most useful while designing and using the various specializations of the MOT+ software through its evolution from a general knowledge modeling tool to a standardized tool at the heart of the instructional design methodology.

INSTRUCTIONAL DESIGN BASED ON VISUAL MODELING

In this section, we present a synthesis of the MISA 4.0 instructional engineering method main components and concepts. A knowledge modeling approach using the MOT editor was used to define the instructional engineering method itself, its concepts, processes and principles. And thus, this method can also be seen as a visual modeling application.

This R&D initiative, started in 1992, has led to the MISA 4.0 version (Paquette, 2001a, 2002a) and to its support tool, called ADISA² (Paquette et al., 2001). The editor MOT+ is embedded in the ADISA system and accessible through a Web browser from workstations linked to the Internet. It can also be used without ADISA together with forms provided by the MISA documentation. Since 2001, the method has been adapted to the huge standardization work that has occurred in the e-learning sector; we will address this aspect in later sections of this chapter.

Overview of the Method

The MISA learning engineering process produces specifications of learning environment grouped in documents called documentation elements (DE). Table 1 presents these DEs.

Each DE results from tasks distributed into six phases. Within phase 2, 3, 4 and 6, these DE can also be viewed according to four axes or dimensions of an e-learning environment: knowledge, pedagogy, media and delivery. Presently, MISA 4.0 comprises 35 basic sub-tasks, each producing one DE, numbered, as shown in Table 1, from 100 to 640. The first digit denotes the phase, the second, the axis, and the third, the sequence number within the axis. A DE is either a visual model, identified in bold italic in Table 1, or a text-based form describing guidelines for a model or properties of objects in the model.

Table 1. MISA 4.0 documentation elements: Phases and axes

Phase 1: Definition	100 Organization's Training System 102 Training Objectives 104 Learners' properties 106 Present Situation 108 Reference Documents			
	Knowledge Axis	Pedagogy Axis	Media Axis	Delivery Axis
Phase 2: Initial solution	210 Knowledge Model Orientation Principles 212 Knowledge Model 214 Target Competencies	220 Instructional Principles 222 Learning Events Network 224 Learning Unit Properties	230 Media Principles	240 Delivery Principles 242 Cost-Benefit Analysis
Phase 3: LE architecture	310 Learning Unit Content	320 Learning Scenarios 322 Activity Properties	330 Development Infrastructure	340 Delivery Planning
Phase 4: LE detailed Design	410 Learning Resource Content	420 Learning Resource Properties	430 Learning Resource List 432 Learning Resource Models 434 Media Elements 436 Source Doc.	440 Delivery Models 442 Actors and their resources 444 Tools and Telecommunication 446 Delivery Services
Phase 5: Validation	540 Test Planning 542 Revision Decision Log			
Phase 6: Delivery Plan	610 Knowledge/Competency Management	620 Actors and Group Management	630 Learning System/Resource Management	640 Maintenance/Quality Management

MISA proposes a problem solving approach in 6 phases. Each MISA phase is subdivided into a number of steps where parts of a learning environment or system are constructed. These phases are sequential, but spiral, with frequent returns to modify the result or previous tasks:

- **Phase 1:** Designers build a description of the training problem, its context and constraints. The general goal that the solution must fulfill and the main characteristics of the target population are the most important aspects to address at this point.
- **Phase 2:** Designers define a preliminary training solution, centered on a knowledge model for the learning domain. Prerequisite and target competencies are associated to the most important knowledge entities in the model. In this phase, designers also build a first pedagogical visual model called “the learning event network” grouping the main modules or learning units, their sequencing and the resources need-

ed to perform them or to be produced by learners and facilitators.

- **Phase 3:** Designers construct a detailed learning design and specify the infrastructure necessary. Visual learning scenarios are built for each learning unit defined in phase 2, describing the learning and facilitating activities, the actors that perform them and the resources needed or produced by these actors. At the same time, a sub-model of the phase 2 knowledge model is associated with each learning unit thus defining “the learning unit content.” According to the evolution of the design, media and delivery principles are refined to prepare the next phase.
- **Phase 4:** Centered on the learning resources and delivery models and the properties of objects in these models several professionals may work on the initial design of a learning environment (LE). Another important concurrent task is the description of the properties of resources in learning scenarios and the association of a sub-

model of the knowledge model to provide a specification of the “learning resource content.”

- **Phase 5:** The project manager plans the validation of the learning environment and produces a list of possible revisions and decisions about how to improve the specifications created in the previous phases.
- **Phase 6:** Designers and project manager prepare elements necessary to the delivery of the learning environment. They produce a synthetic and global description of the learning environment for its maintenance and quality management by various actors.

A Visual Modeling Approach

In each of phases 2, 3, 4 and 6, MISA also proposes the development of the learning environment along four axes: knowledge and competency (content model), instructional, resources and delivery. The central product of each axis is one or more visual models.

The *knowledge model* centers on a graphical representation of the learning environment content domain. In this model, the domain’s facts, concepts, procedures and principles are displayed and interrelated with precise links. Then, target and prerequisite competencies are linked to knowledge elements in the model, thus identifying prerequisites and learning objectives for the pedagogical model. Subsequently, knowledge units and competencies are also associated to learning units and to the resources present in the learning units’ scenario models.

The *instructional model* is essentially a visual network of learning events and units, to which knowledge and target competencies are associated. Each learning unit is also described by a visual learning scenario specifying learning and support activities linked to resources in the environment. Resources holding content (as opposed to tools and services) are associated with a subset in the knowledge model.

The *learning resource models* are useful to describe materials (or learning objects) to be adapted and produced, their media components, source documents and presentation principles as well as other properties aimed at graphical designers and learning material producers.

Finally, *delivery models* are produced to show how and where actors use or provide learning materials and resources such as tools, communication means, services and locations, used in the learning environment. Each delivery model is a multi-user workflow, where actors use or produce resources, while assuming different roles. These processes address organizational issues, such as group organization, staff assignments, technical help, resource delivery, and so on, which must be prepared to ensure smooth deployment of a network-based or a distance learning environment.

Each and every one of these models is built using the MOT+ knowledge representation technique and tool (Paquette, 1999, 2002b). Graphical visual models are the basic DEs in each axis, the backbone of the MISA method. Most of the other tasks, in MISA, describe properties of objects in these models (e.g., competencies, learning units, resources, roles) as well as their relationships.

MOT+: A GENERIC VISUAL LANGUAGE AND TOOL

When designers start building a learning environment, two basic questions arise: “Which knowledge must be acquired, what are the target competencies or educational objectives for that knowledge?” and “How should the activities and the resources be organized to best achieve knowledge and competency acquisition?” To help designers solve this type of questions, we have developed a graphical knowledge modeling method and tools, which help visualizing activity sequences, actors and tools. In this section, we present the MOT modeling language that serves that purpose and the MOT+ visual modeling editor.

The graphic or visual representation formalism that we present here (Paquette, 1996; Paquette, 2002) has been tested for the past 10 years in a vast array of modeling applications and in many various contexts. It is used by trainers for corporate training, and designers or professors use it to prepare university courses or to propose modeling exercises to their students. It has served to model processes for the implementation of a computer-supported high school, or to model instructional methods or research projects processes.

Basis for a Graphical Knowledge Representation Language

It is often said that a picture is worth a thousand words. That is true of sketches, diagrams, and graphs used in various fields of knowledge. *Conceptual maps* are widely used in education to represent and clarify complex relationships between concepts. *Flowcharts* are graphical representations of procedural knowledge or algorithms. *Decision trees* are another form of representation used in various fields, particularly in decision-making expert systems.

All these representation methods are useful at an informal level, as thinking aids and tools for the communication of ideas, but they also have their limitations. One is the imprecise meaning of the links in a model. Another issue is the ambiguity around the type of entities or symbol system that is used. Objects, actions on objects and statements of properties about them are all mixed-up, which make graph interpretation a fuzzy and risky business. Another difficulty is to combine more than one representation in the same model. For example, concepts used in procedural flowcharts as entry, intermediate or terminal objects could be given a more precise meaning by developing them in conceptual sub-models of the procedure. The same is true of procedures present in conceptual models that could be developed as procedural sub-models described by flowcharts, combined or not with decision trees.

In software engineering, many graphic representation formalisms have been or are used such as entity-relationship models (Chen, 1976), conceptual graphs (Sowa, 1964), the object modeling technique (OMT) (Rumbaugh, Blaha, Premerlani, Eddy, & Lorensen, 1991), KADS (Schreiber, Wielinga, & Breuker, 1993) or the unified modeling language (UML) (Booch, Jacobson, & Rumbaugh, 1999). These representation systems have been built for the analysis and architectural design of complex information systems. The most recent ones require the use of up to eight different kinds of model, which rapidly become hard to follow without considerable expertise.

Our initial goals were different. We needed a graphic representation system that was both simple enough to be used by educational specialists, such as teachers, professors and tutors, who are not, in general, computer scientists, still general and powerful enough to represent the components and their relationships of computer-based educational environments.

There is a consensus in educational science to distinguish four basic types of knowledge entities (facts, concepts, procedure and principles), despite some diversity in terminology and definitions. See for example, the work of Merrill (1994), Romiszowski (1981), Tennyson and Rash (1988), and West, Farmer, and Wolf (1991). This categorization is retained as the basis for the MOT graphic representation language.

All four types of knowledge are also considered in the framework of schema theory. The concept of schema is the essential idea behind the shift from behaviourism to cognitivism, the now dominant theory in psychology and other cognitive sciences, based on the pioneering ideas of Inhelder and Piaget (1958) as well as Bruner (1973). In the early seventies, Newell and Simon (1972) developed, on the same basis, a rule-based representation of the human problem solving procedural activity, while Minski (1975) defined the concept of “frame” as the essential element to

understand perception, and also to reconcile the declarative and procedural views of knowledge.

Schemas play a central role in knowledge construction and learning (Holoyak, 1991; Anderson et al., 1995). They defined perception as an active, constructive and selective process. They support memorization skills seen as processes to search, retrieve or create appropriate schemas to store new knowledge. They describe understanding as a comparison of existing schema with new information. Globally, through all these processes, learning is seen as a schema transformation enacted by higher order processes, aiming at schema construction and reconstruction through interaction with the physical, personal or social world, instead of a simple transfer of information from one individual to another.

The distinction between conceptual and procedural schema has been accepted for a long time in cognitive science. More recently, a third category called “conditional or strategic schema” has been proposed (Paris, Lipson, & Wixson, 1983). These schemas have a component that specifies the context and the conditions to trigger a set of actions or procedures, or to assign values to the attributes of a concept. These categories map very well on the existing consensus in educational science.

The MOT Visual Modeling Language

We will now present briefly the syntax and semantic of the MOT visual modeling language, based on the notion of schema. Here, we could use graphs similar to UML object models to represent the attributes that describe a schema with different formats according to their type. In the MOT graphic language (Paquette, 1996, Paquette, 1999, Paquette, 2003), we have improved the readability and the user-friendliness of graphs by externalizing the internal attributes of a schema into other objects, with proper links to the original schema or object. For example, the link between the schemas “Triangle” and the “Rectangle Triangle” is shown explicitly on Figure 1 using a

specialization (S) link from the later to the former concept. Links between the “Triangle” concept and its sides or angles attributes is externalized using a composition (C) link. The links from an input concept to a procedure and from a procedure to one of its products are both shown by an input/product (IP) link. The sequencing between actions (procedures) and/or conditions (principles) in a procedure is represented by a precedence (P) link. Finally, the relation between a principle and a concept that it constrains, or between a principle and a procedure that it controls, are represented by a regulation link (R).

Using these links, the triangle concepts are arranged in the MOT model of Figure 1 where relations between knowledge entities are transparent, mixing the types of entities and links.

Concepts (or classes of objects), *procedures* (or classes of actions) and *principles* (or classes of statements, properties or rules) are the primitive objects of the MOT graphical language. The type of the objects are represented by geometrical figures as shown on Figure 2, where each class or individual is represented by a name within the Figure.

These objects are different types of schema whose attributes are all explicitly externalized and related to other schemas using six kinds of typed links constrained by the following grammar rules:

1. All abstract knowledge units (concepts, procedures, principles) can be related by an instantiation **I** link to a set of facts representing individuals called respectively examples, traces and statements.
2. All abstract knowledge units can be specialized or generalized to other abstract knowledge using specialization **S** links.
3. All abstract knowledge units can be decomposed, using **C** links into other entities, generally of the same type.
4. Procedures and principles can be sequenced together using **P** links.

Figure 1. A simple MOT model

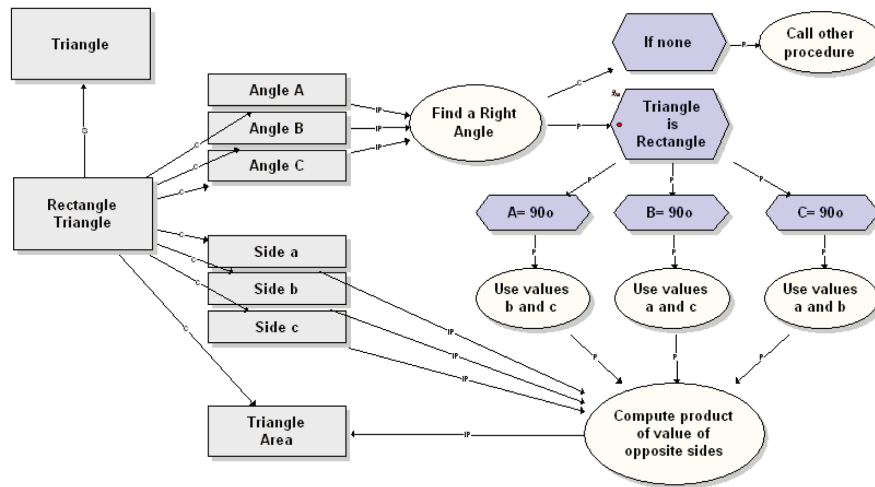
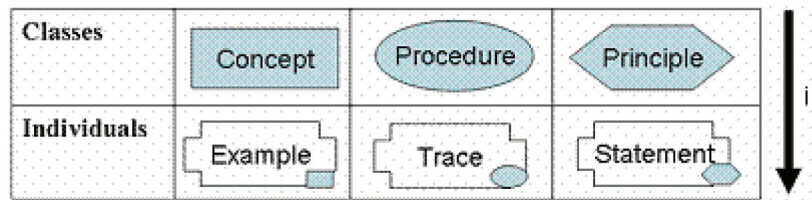


Figure 2. Types of knowledge units in MOT



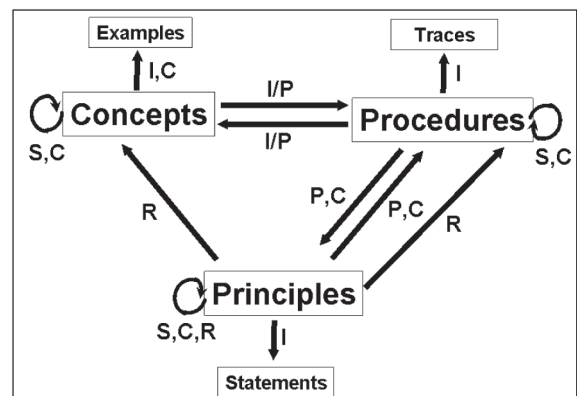
5. Concepts can be inputs to a procedure using an **IP** link to the procedure, or products of a procedure using an **IP** link from the procedure.
6. Principles can regulate, using **R** links, any procedure to provide an “external” control structure, to constrain a concept or a set of concepts by a relation between them, or to regulate a set of other principles, for example to decide on conditions of their application.

- **Concepts** can be object classes (countries, clothes, vehicles, etc.), types of documents (forms, booklets, images, etc.), tool categories: (text editors, televisions, etc.), groups

Figure 3 summarizes these grammar rules of the MOT graphic language in the form of an abstracted graph where the entities represent types of MOT objects.

There are various possible semantic interpretations of these graphic symbols.

Figure 3. The MOT metamodel



of the main MISA visual models constructed with the MOT editor.

Figure 4a presents an example of a knowledge model that describes part of the knowledge in the domain of artificial intelligence (AI) for an introductory Web-based course on that subject designed with MISA. Here ovals represent AI processes, rectangles represent AI concepts and hexagons represent AI principles.

Figure 4b presents an example of a *Pedagogical model* representing a learning scenario model for one of the course modules where learning activities are represented as procedures (ovals) and learning resources as concept/object (rectangles).

Figure 4c presents an example of a *Media model* representing the structure of a Web site for the course. Concepts represent Web pages or page elements, ovals or circles represent hyperlinks, as possible actions or procedures. Templates are represented by principles. Facts represent concrete objects such as page elements with their actual texts, pictures or other resources.

Figure 4d presents an example of a *Delivery model* representing the course delivery process where actors are represented as control principles, acting on tasks represented as procedures, each having input and output resources.

This first version of the MOT editor has been extended to the MOT+ editor, a mature editor with advanced graphic editing capabilities (fonts, color, disposition on a page, etc.). Sub-models can be embedded at any depth and knowledge objects in each one can be displayed in a multilayer mode. Models may be filtered in order to display only some types of knowledge objects or links. Sub-models from one model can be associated to objects in another model called a co-domain, which is very useful for example to assign knowledge to activities in a pedagogical model. Graphic objects can be associated to any type of document (using the OLE standard) such as a text document, slide presentation, Web page, spreadsheet or database file, which can be displayed by clicking on the graphic symbol. MOT+ has extensive export facilities to

XML, HTML, Excel and other commonly used formats. In particular, the “export to XML” command provides the possibility for graphic models to be processed by software agents respecting for example the IMS LD or OWL schemas.

REPRESENTING MULTI-ACTOR WORKFLOWS AND LEARNING DESIGNS

In the two following sections, we address the issues of the standardization of visual modeling languages, to promote the reusability of educational models and the interoperability between systems delivering learning environments. With the advent of an educational modeling standard specification like IMS-LD, we decided to develop a specialization of MOT+ to represent the IMS-LD concepts. During the eduSource and LORNET (www.lornet.org) projects, we found that this specification was closely related to the MISA pedagogical model including some aspects of the MISA delivery model. This R&D and the extension to a Web-based graphical editor are presented in the following sections.

The MOT+LD Special Visual Language

IMS-LD provides a representation of the components of a learning environment in a standardized XML schema that can be executed by any compliant e-Learning platform. IMS-LD does not provide a visual language to build a learning environment specification. Initially, these had to be built using an XML editor or a form-based editor like RELOAD (2005). Also, IMS-LD is not an instructional design method to build such representations. It needs to be accompanied by any instructional design method, and MISA is more closely related than many other methods. Unfortunately, the MOT+ pedagogical models built in MISA are not executable on a variety of

platforms because they are not standardized. In fact, in the projects where we have used MISA, the specification was translated by hand, into the platform's activity editor, with some loss of information.

To address these problems, we first developed a graphic modeling editor for the IMS-LD specification (level A) and made it available as a specialized editor in the MOT+ software. Many examples of learning designs have been produced by different groups using this editor. They can be found at the IDLD portal (www.idld.org). Figure 5 shows part of a unit of learning (UoL) on solar astronomy presented recently at a workshop (Paquette & Léonard, 2006).

It shows an act and its activity structure containing various learning and support activities, all represented as MOT procedures (ovals). Method, plays, and acts are also represented as procedures in other parts of the model. Each procedure type is indicated by a little label at the right lower corner of the ovals representing the procedures.

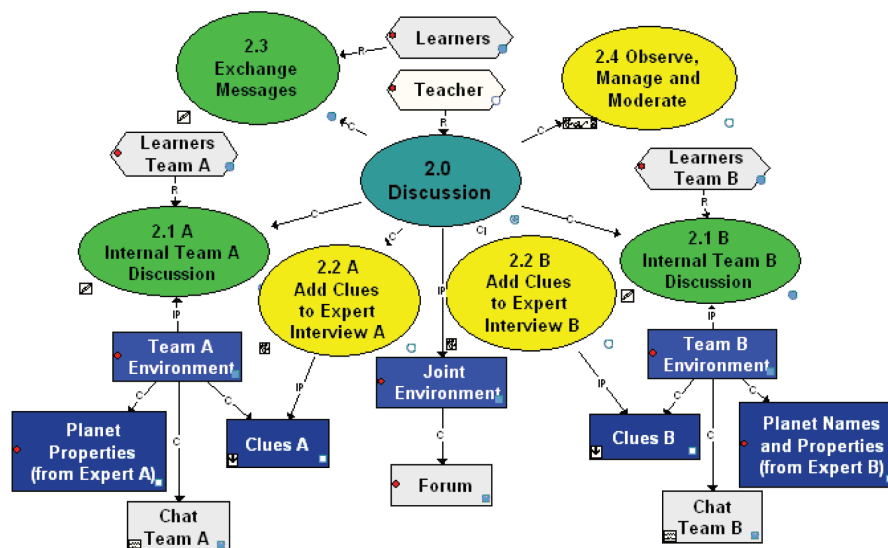
Similarly, roles are represented by different kinds of MOT principles (hexagons). Environments, learning objects, services and outcomes are

represented by different kinds of MOT concepts (rectangles). Standard MOT links are used between these objects. C (is composed of), P (precede), R (regulate or govern) and I/P (input / product) links are sufficient to cover all the components of a standard IMS-LD level A learning design.

The MOT+LD editor is presented with some detail in (Paquette, Léonard, Lundgren-Cayrol, Mihaila & Gareau, 2006). It enables a designer to build graphically a compliant IMS-LD model. Afterwards, the graph is automatically validated and exported as an instance of the IMS-LD XML schema. This XML file can be read in form-based IMS-LD editors such as RELOAD (2005), if level B conditions and/or level C notifications need to be specified. The XML can then be run by IMS-LD compliant players or platforms to deliver online learning sessions to their users.

Paquette and Marino (2005) briefly discuss the strengths and weaknesses of the IMS-LD educational modeling specification. One weakness is the absence of knowledge representation, which is central to learning and knowledge management that we seek to support by the TELOS³ system. We have proposed to improve that by the semantic

Figure 5. An example of a MOT+LD learning design



annotation of the activities, resources and roles included in a learning design. A *semantic annotation* is a mapping from a subject matter ontology to the learning design that associates knowledge elements to the components of the design. This aspect will be developed in the following sections.

Extending the MOT+LD Editor

Another aspect of IMS-LD we need to improve is the control structure of the workflow that is actually covered by level B and C specifications, where properties and conditions can be included in the design to alter the flow of activities, notify an actor or present a resource depending on previous actions or results stored in a user and group file or model. This aspect may not be that important in open learning environments where a total or large degree of liberty is left to the learner and facilitators, but for a business workflow in an organization, or to aggregate software components into larger resources, it is an important dimension.

To address that and provide a basis to build a function editor for the TELOS system, conceptual work on function maps has been defined as a central piece of the TELOS architecture (Rosca, 2005; Paquette, Rosca, Mihaila, & Masmoudi, 2006). Moreover, a comparative analysis has been made between business workflows, IMS-LD learning designs and function maps (Marino et al., 2006), leading to the identification of 21 control situations for workflows encountered in software engineering literature (Correal & Marino, 2006). It was found that IMS-LD covers only some of these control situations, but probably the most useful ones for pedagogical design.

Based on this work and the actual MOT+LD editor, we are in the process of designing a new visual editor. The *scenario Editor* aims both to generalize IMS-LD and to capture the main aspects of business workflows. The graphs produced by this editor will be executable, providing interfaces for concrete actors to enact the activities and use the resources during delivery. It will also serve to

orchestrate actors, activities and other resources, a fundamental principle built in to the TELOS system. A specialization of the scenario editor is being defined to cover all three levels of the IMS-LD specification.

The scenario editor uses four kinds of MOT objects with subtypes taken from the TELOS technical ontology (Magnan & Paquette, 2006). These are shown on Figure 6. *Concept* symbols represent all kinds of resources: documents, tools, semantic resources, environments, resource-actors, resource-activities and datatypes. *Procedure* symbols represent function models composed of activities and commonly used operation templates. Finally, *principles* are used both to represent different types of actors (as control agents) and control conditions. These two kinds of control entities are represented here by different symbols. The actor's symbols are active agents representing users, groups, roles or software agents that enact the activities using and producing resources as planned by the scenario model. Conditions are control element inserted within the basic flow to decide on the following activities that can be activated.

In Figure 7, we see a combination of some of these symbols where a coordinator writes the plan of a document in a first activity, after which the Figure shows a general split condition. After that, these activities are executed in parallel, controlled by the properties of the split condition object. Later on, the flow of activities merges through

Figure 6. Scenario editor symbols

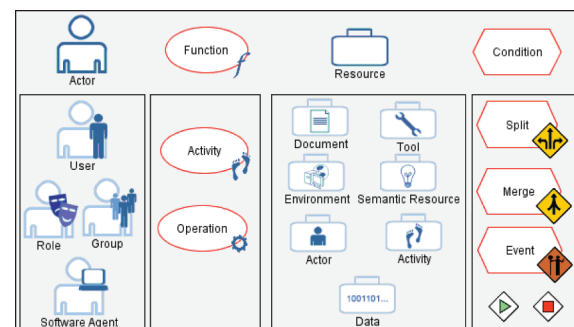
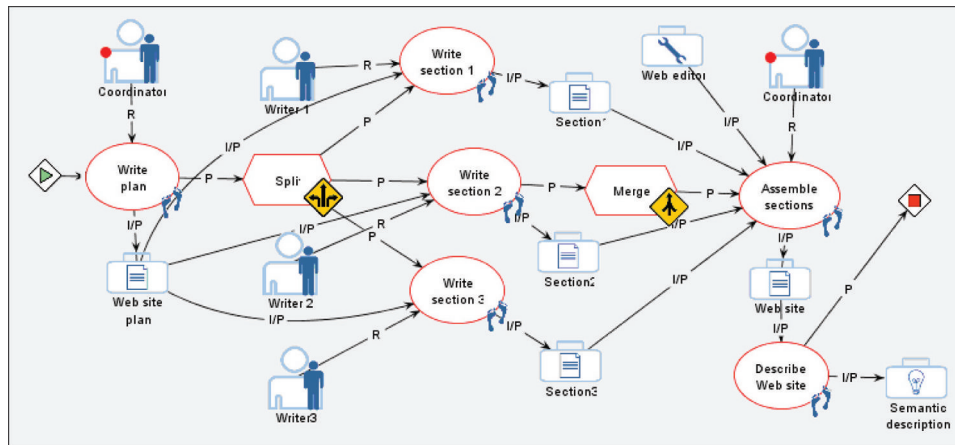


Figure 7. A simple scenario model



the merge condition object the assemble activity takes control. This activity will wait for some or all of the incoming flows to be activated before it is executed, again based on the properties of the merge condition object.

Figure 8 shows another kind of condition that alters the flow of execution. In activity-2, if the time-event condition is met, the flow of control will change. Depending on the type of the condition, the activity-4 will be shown or hidden. Activity-3 is still available. If activity-4 is shown and completed, then activity-5 can be performed.

Properties of the event condition symbol will provide the details on the condition and action parts of the control principle to provide the execution engine with a clear formal definition of the processing to take place.

In the scenario editor, we see a combination of a control flow and a data flow. The control flow is modeled using the MOT basic P and R links. P links indicates the basic sequence or flow of activities. R linked conditions identify which activities an event will trigger, thus altering the basic flow.

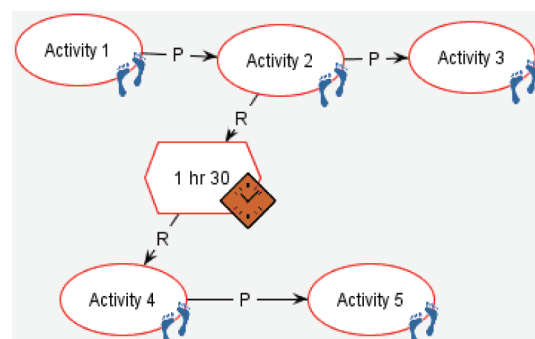
IP links from MOT serve to model the data flow, either from resources to activities where they are consulted, used or processed, or from activities to the resources they help produce. This is why we need to distinguish between actors as active control entities and resource-actors that

will serve as data providers or be products of an activity (e.g. a new person or software agent added in a system). A similar distinction is made for resource-activities that can be seen as resources to be transformed, for example by other activities creating or modifying their description.

C links from MOT may also be used to show the composition of an entity into other entities. A new unification, U link, is also necessary to guide the execution engine, when components are aggregated and outputs from one need to be connected with the inputs of another.

In TELOS, the scenario editor will enable engineers to combine resources into larger aggregates, technologist to built platform workflows for designers of learning or knowledge management

Figure 8. Event-based control



environments, designers to build courses, work flows or learning /teaching scenarios.

MOT+OWL: A STANDARDIZED ONTOLOGY EDITOR

In the first section we identified the pedagogical and the knowledge models as the most important ones. We now proceed with a second standardization task, that of the knowledge model. Any type of knowledge representation, including text-based narratives or informal graphic models, can be used to describe a domain of study. At the initial stage of design, the informal nature of an ontology representation is useful. The user's mind must be free to choose any representation that seems best suited for the educational project to be considered. Still, this very freedom does not facilitate the software processing of the representation.

Semi-formal modeling languages like MOT go part of the way to address this. Unlike informal graphs built with any graphic editor, such as PowerPoint, the MOT graphic syntax is structured and has a general unambiguous semantic. Using the MOT editor, models can be exported in many formats, including a native XML schema. Using this schema, software agents can perform different kinds of processing. Still, some ambiguity remains. In instructional engineering applications, we had to constrain the MOT graphic language even more to enable the delivery of learning scenarios in a digitized platform like Explor@-2 (Paquette, 2001). Even then, part of the transfer of the design to the delivery platform had to be done manually, to prevent enforcing unnatural graphic representations on the designers.

The Ontology Web Language

To deliver computer-based learning environments, after a phase where informal graphic design has cleared up ideas, we need to move from informal or semi-formal graphs to formal computable

graphic representations. Knowledge in a subject domain can be represented in many ways: taxonomies, thesauri, topic maps, conceptual graphs and ontologies.

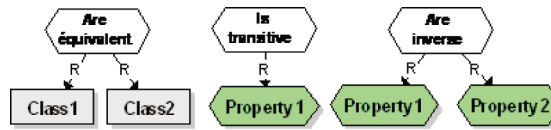
We have selected to use OWL-DL ontologies (see W3C, 2004) for a number of reasons. It is one of the three ontology Web languages that are part of the growing stack of World Wide Web consortium recommendations related to the Semantic Web. Of these three languages, OWL-DL has a wide expressivity and its foundation in descriptive logic guarantees its computational completeness and decidability. *Descriptive Logic* (Baader, Calvanese, Nardi, Patel-Schneider, 2003), is an important knowledge representation formalism unifying and giving a logical basis to the well known traditions of frame-based systems, semantic networks, object-oriented representations, semantic data models, and formal specification systems. It thus provides an interesting framework to represent knowledge for which a growing number of processing agents are built throughout the world.

OWL-DL provides a precise XML schema but no graphic representation per se. Some ontology editors like PROTÉGÉ (2006), provide some graphical views of the ontology, but the construction of an ontology is essentially form-based. Our goal was to provide a complete formal graphic representation of the OWL-DL that could combine the virtues of interactive construction with the computational capabilities of a formal graphic representation.

The MOT+OWL Visual Language

In the context of the MOT representation system, ontologies, in particular OWL-DL constructs, correspond to a category of models called theories. Ontologies can thus theoretically be modeled graphically using the MOT syntax. While doing this, we found out that while the MOT primitive objects and links were sufficient to represent ontologies expressed in OWL-DL, the graphs

Figure 9. OWL-DL equivalents



would become cumbersome unless new symbols were added. We have thus specialized the MOT language and graphic editor by adding sub-types for concepts, principles and facts and by adding new links.

Figure 9 gives a few examples of the MOT+OWL graphic elements with their interpretation in descriptive logic and their correspondence to standard OWL-DL XML schema fragments. See Paquette and Rogozan (2006) for a complete description of the MOT+OWL graphic language.

Three types of MOT entities are sufficient to represent OWL-DL models. Concepts represent classes, principles represent properties and facts represent individuals. On these graphic entities, icons are added corresponding to axioms or principles stating a property of the class. We also added some new special links to express things like equivalent “equi” or disjoint “disj” classes stating properties of two classes or two properties.

In the standard MOT syntax, these icons or special links would be expressed by principles with “R” links to classes or properties. For example, in the second and the two last examples of Figure 9, the following standard graphs (Figure 10) are equivalent, with the same precise OWL-DL interpretation as XML schema components. These would of course make the graphs more difficult to read.

Using a limited set of graphic symbols, we can formally describe any semi-formal MOT model that is amenable to a representation in descriptive logic. This is obviously the case for most conceptual models, laws and theory models. However, this is less evident in the case of procedural models, sometimes called task ontologies. Procedural and process/methods models are im-

portant for our purpose because learning environments are built around multi-actor processes.

Figure 11 presents a MOT+OWL visual graph that translates the conceptual structure of a learning design presented in the IMS-LD information model (2003). In the Figure, “C” properties (green hexagons) are an abbreviation for “is-composed-of” which has the same meaning as the C link in standard MOT models, or the aggregation link in UML models.

This example illustrates the fact that functional relations between components of multi-actor processes such as a learning design can be represented by ontologies. Such ontologies have been used to test, for example, the conformance of particular learning designs to the IMS-LD XML schema (Amorim, Lama, & Sanchez, 2006), and to execute them in the context of an ontology-driven system.

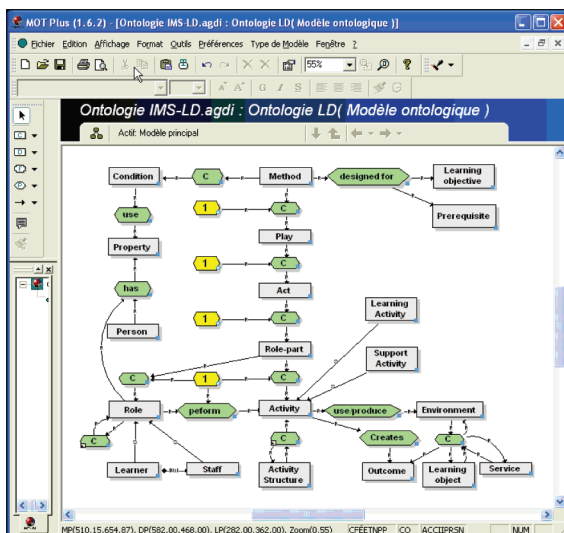
Associating Knowledge and Competencies to Learning Designs

We have pointed out earlier the importance of associating knowledge and competencies to the components of a learning design. This is a key element of the MISA method. Actually, in IMS-LD, the only way to describe the knowledge needed to achieve the activities or that is present in the resources is to assign optional educational objectives and prerequisites, to the unit of learning as a whole and/or to all or some of the learning activities. These can not be added to express the level of competency for a support activity carried out by a teacher or tutor. Objectives and prerequisites correspond to entry and target competencies as used in the

Figure 10. MOT standard equivalents

MOT+OWL graphic symbol	Description logic statements	OWL-DL XML-Schema segment
	Class intersection $\forall x: \text{Class3}(x) \leftrightarrow \text{Class1}(x) \wedge \text{Class2}(x)$	<code><owl:Class></code> <code><owl:intersectionOf rdf:parseType="Collection"></code> <code> List of class descriptions</code> <code></owl:intersectionOf></code> <code></owl:Class></code>
	Equivalent classes $\forall x: \text{Class1}(x) \leftrightarrow \text{Class2}(x)$	<code><owl:Class rdf:about="#name_class1"></code> <code><equivalentClass rdf:resource="#name_class2"/></code> <code></owl:Class></code>
	Disjoint classes $\forall x: \text{Class1}(x) \leftrightarrow \neg \text{Class2}(x)$	<code><owl:Class rdf:about="#name_class1"></code> <code><owl:disjointWith</code> <code> rdf:resource="#name_class2"/></code> <code></owl:Class></code>
	Extension of a class $\forall x: \text{Class}(x) \leftrightarrow (x = \text{Ind 1}) \vee \dots \vee (x = \text{Ind N})$	<code><owl:Class></code> <code><owl:oneOf rdf:parseType="Collection"></code> <code><owl:Thing rdf:about="#name_individual1"/></code> <code><owl:Thing rdf:about="#name_individual2"/></code> <code> ...</code> <code><owl:Thing rdf:about="#nom_individualN"/></code> <code></owl:oneOf></code> <code></owl:Class></code>
	Functional property $\forall x, \forall y, \forall z: \text{Prop}(x, y) \wedge \text{Prop}(x, z) \rightarrow y = z$	<code><owl:FunctionalProperty</code> <code> rdf:about="#name_property" /></code>
	Transitive property $\forall x, \forall y, \forall z: \text{Prop1}(x, y) \wedge \text{Prop1}(y, z) \rightarrow \text{Prop1}(x, z)$	<code><owl:TransitiveProperty</code> <code> rdf:about="#name_property" /></code>
	Inverse properties $\forall x, \forall y: \text{Prop1}(x, y) \leftrightarrow \text{Prop2}(y, x)$	<code><owl:ObjectProperty rdf:ID="name_Property1"></code> <code><owl:inverseOf</code> <code> rdf:resource="#name_property2"/></code> <code></owl:ObjectProperty></code>

Figure 11. A simple task ontology for multi-actor scenarios⁴



MISA method. They are essentially unstructured pieces of text composed according to the IMS RDCEO specification (IMS 2002).

Unstructured texts are difficult to compare. Consistency checking between different levels of the LD structure cannot be supported computationally. Even at the same level of a learning design, for example within an act, no relations exist between the content of learning activities and of the input or outcome resources, and from these to the actors' competencies. In fact, in IMS-LD the knowledge represented in learning resources is not described at all, and the actor's knowledge and competencies are only indirectly defined by their participation in learning units or activities, if, and only if, educational objectives have been associated to the activities.

What we need first is a qualitative structural representation of knowledge and competencies associated to activities, resources and roles. This can be done using domain ontologies. As a first step, the MOT+ editor allows to show side by side a learning design, using the MOT+LD editor, and a domain knowledge ontology using the MOT+OWL editor. An example is shown in Figure 4. The left hand window is the learning design presented earlier in Figure 5. The right hand window presents part of domain ontology of the solar system (that was built before Pluto was declared a quasi-planet).

A *semantic annotation* is simply a mapping from the domain ontology to the learning design that associates knowledge elements (classes, properties and individuals of the ontology) to components of the learning design.

In Figure 12, we see that data on the orbital period of planets in the solar system has been associated to a learning object in the design, which is a PowerPoint presenting this data to team A. This resource is an input to learning activity 2.1.A, but it is not the only input to this activity. There is also another resource (clues A) that gives additional information to team A, plus the chat between team members that will bring other more information to each participant. As a result, the sub-model of the

ontology associated to activity 2.1A would logically correspond to the union of the sub-models of all input resources to the activity.

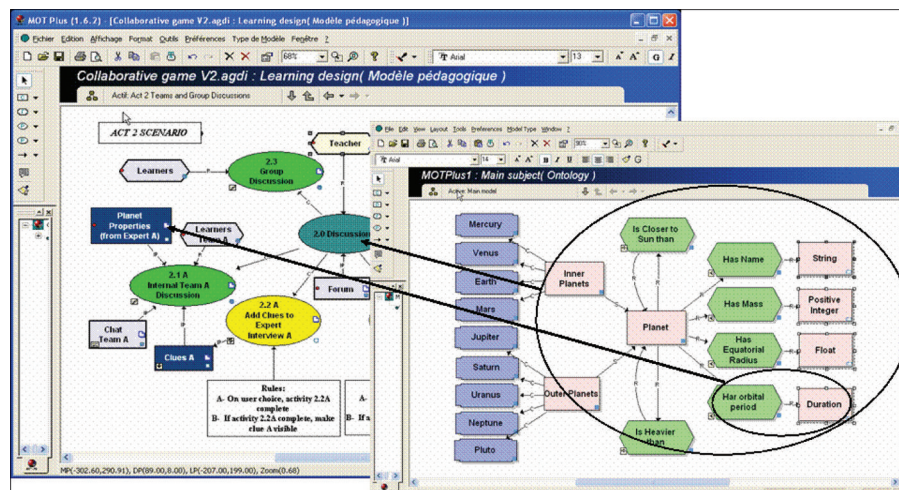
Finally, the Figure shows that most of the ontology model should be the subject of the discussion, since there is another team, team B that has more information to bring to the discussion using also information from input resources and in a team B chat. The larger sub-model is thus associated to the 2.0 activity structure.

This example shows how semantic annotation can help guide the construction of learning designs and to evaluate their coherence. By associating the right amount of knowledge to the different resources and activities, a designer can build a coherent design that will trigger collaboration between learners, or help a trainer decide on its intervention, or guide the actions of an intelligent tutoring system, and, in general support the evolution of the learners' competencies.

Desirable Properties in a Visual Educational Modeling Language

This chapter concludes with a discussion of the most important features and characteristics of a visual educational modeling language, which we think are the most useful and beneficial to the user.

Figure 12. An example of ontology annotation of a learning design



Visual

The benefits of graphical cognitive modeling have been eloquently summarized by Ausubel (1968), Dansereau (1978), Novak (1993) and Jonassen, Beissner and Yacci (1993). Graphs illustrate relationships among components of complex phenomena. They uncover the complexity of actors' interactions and make the most important parts stand out. They facilitate the communication about the reality studied. They favor the global comprehension of the phenomena under study. They help grasp the structure of related ideas by minimizing the use of ambiguous natural language texts. As an example, entity-relation graphs reduce ambiguity compared to a natural language description, but some remain on the interpretation of the terms written on the links or on the nodes. Ambiguity can be reduced further by the use of standardized typed objects and typed links.

User-Friendliness

Not all graphic modeling languages are user-friendly. A good counter-example is UML. The large number of models and symbols require considerable expertise and a steep learning time for the interpretation and for the construction of models. Furthermore, each type of model captures a different viewpoint of the information and it is impossible to mix them in the same graph to provide a global view of a subject domain. The representational system must be easy to use without technical or scientific mastery after a short period of initiation. Dansereau and Holley (1982), have studied experimentally the use of different sets of graphic symbols by learners. Their results show that typed links are preferred by the majority of learners, as long as there are not too few nor too many links and they express sufficiently different meanings.

Generality

Generality means that the representation language should have the capacity to represent, with a relatively small number of object and link categories, all knowledge in very different subject domains, at various levels of granularity and precision. It should enable, to represent simple models such as a multiplication table, up to complex models such as multi-actor workflows, rule-based knowledge systems, methods and theories. It should also embed equivalent representations to commonly used graphs such as conceptual maps, semantic networks, flowcharts, decision trees or cause/effect diagrams.

Formalizable

The graphic language should be upward compatible from informal graphs, up to semi-formal and totally unambiguous formal models. At the informal level, an integrated representation framework facilitates the organization of thought and communication between humans about the knowledge which is exchanged, all along the evolution of the graphic representation model. Here the process is more important than the result. On the other end, the graphic language makes it possible to use more constrained elements to produce totally unambiguous descriptions that can be exported to a set of symbols, such as an XML file, to be processed by computer agents. Here the model is more important than the process.

Declarative

Graphic language can be procedural or declarative. Procedural graphic languages have been built in the past; essentially extending flowcharts to promote graphical programming that would produce code directly. Our proposal is to use, as much as possible, a declarative graphic language, for a number of reasons. Firstly, it is easier for a person to declare the components of his/her

knowledge than to describe the way it should be processed. In expert systems for example, the executive instructions are not wired-in the program, but externalized and made visible in a knowledge base on which a general inference engine proceeds. Secondly, the same model can be used for many different applications, not necessarily the one for which the processing has been planned in a procedural program. This is done by querying the model using an inference engine, in a Prolog-like manner. Thirdly, the processing knowledge itself can be given declaratively, so that higher order meta-knowledge, also can be singled-out. This idea is similar to structural analysis as proposed by Scandura (1973) and it is exactly the way we should see the relation between generic skills and domain knowledge in a competency, as meta-knowledge given declaratively, applied to domain knowledge, for example, rules for diagnosing a component-based system applied to different models describing a car, a software or a learning environment.

Standardized

Standardization is an important property to support knowledge communication and use between persons or software agents. At the informal level, each model constructed by a person must be interpretable by another person. At the formal level, the communication capabilities extend to software agents. The move towards graphic versions of standards like IMS-LD for learning designs and OWL for ontologies adds wider communication capabilities between researchers and educators while at the same time adding formal non-ambiguous interpretation for machine processing.

Computability

Computability is a step beyond standardization. Not only can the graphic model receive a non-ambiguous formal representation that can be processed by computer agents, but this formal

representation is complete (all conclusions are guaranteed to be computable) and decidable (all computations will finish in finite time). These considerations have motivated the construction of the MOT+OWL graphic language that is equivalent to the OWL-DL XML schema based on descriptive logic.

CONCLUSION

This chapter has presented a 10-year effort to provide an educational visual language for applications that can span from informal support to idea generation, up to structured semi-formal graphs based on typed objects and links, and finally to graphic design on the formal conceptual and specification levels (MOT+LD, MOT+OWL).

In Botturi et al. (2006), the reader can find a classification of other visual languages, some of them being presented in other chapters of this handbook. According to this classification, MOT+ has the same properties as those of UML. It qualifies as a visual, layered, formal, conceptual and specification elaboration language, with multiple perspectives.

This corresponds to our initial goal of building a virtual language that is both user-friendly for designers (compared to UML) and still general and powerful enough to enable the design of the main components of a learning system, according to standard specifications. With the development of the new scenario editor based on MOT+ concepts, we can now go a step further and provide a visual scenario programming language that can be executed by an ontology-based engine to deliver usable learning environments to its users.

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ENDNOTES

- ¹ **MISA:** *Méthode d'ingénierie des systèmes d'apprentissage* is a French acronym meaning, “method for instructional systems engineering”
- ² **ADISA:** *Atelier distribué d'ingénierie des systèmes d'apprentissage* is a French acronym meaning “distributed workbench for learning systems engineering”
- ³ **TELOS:** (TELeLearning Operating System) is a new system built within the LORNET project (www.lornet.org) to enable engineer and technologists to assemble eLearning and knowledge management platforms and environments.
- ⁴ On Figure 11, principles with 1 express OWL cardinality axioms here meaning “at least one”.

Chapter 3.13

poEML: A Separation of Concerns Proposal to Instructional Design

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ABSTRACT

This chapter introduces a new visual educational modeling language (EML) based on a separation-of-concerns approach, poEML: perspective-oriented EML. EMLs were proposed to support the modeling of educational units. These languages are related to ID, as they are intended to represent models of educational units. This chapter introduces the poEML separation of concerns and its graphic constructs. The main idea underlying poEML is to break down the modeling of educational units into separate parts that can be specified independently. poEML is mainly focused on supporting the computational execution of educational unit models. In addition, the

separation of concerns allows us to approach the modeling of educational units in an incremental way, offering advantages in expressiveness, formality, adaptability and flexibility.

INTRODUCTION

As a design discipline, ID is devoted to produce effective educational units (e.g., a lesson, a course, a practice, a workshop). Botturi, Derntl, Boot and Figl (2006) show how modeling languages can contribute to ID by supporting the creation of visual models that facilitate the design, communication and execution of educational units. Specifically, some VIDLs are focused on supporting the creation of computational models of educational units that can be executed by customized LMSs. This is the

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main goal of the ID language described in this chapter, while other goals are secondary (e.g., to facilitate the design and the communication).

The achievement of a VIDL that allows us to create computational models of educational units is a complex endeavor. These are some of the problems involved:

- **Expressiveness:** One main problem is how the VIDL will support the creation of models representing the broad variety of static and behavioral issues involved in educational units. Depending on the learning goals, pedagogical approach (e.g., behaviorism, constructivism, social-collaborative) or learning context (e.g., face-to-face, blended, Web-based), teaching and training requires different resources and procedures. Here are some examples: in a traditional face-to-face course a teacher gives lectures and proposes tasks to learners; in a Web-based course a learner accesses a Web site to get documents and to perform tests; in a tennis lesson a player repeats the same movements several times under the supervision of an instructor; in a primary school, children play games to learn numbers and letters. There is a large variety of elements, resources, procedures, and behaviors present in educational units and a VIDL should allow us to express them in models.
- **Formality:** Formality is necessary to support the computational execution of the models in customized LMSs. To be executed, models need to include an appropriate level of detail, and need to be arranged in accordance with clear and unambiguous constructs. Therefore, the intended VIDL should allow us to create models with precision and consistency.
- **Adaptability and flexibility:** Another problem for VIDLs is that educational models are not fixed. Educational units rarely work perfectly in accordance with a

predefined plan. Usually, educational plans have to choose between several alternative paths, or they have to be changed to solve unexpected situations. Therefore, a VIDL should allow us to create adaptable and flexible models of educational units.

The proposed VIDL tries to solve these problems by following a *separation-of-concerns* approach. Separation of concerns is an important principle in other design domains (e.g., architecture and software design). For example, in architecture, building models or plans are divided into several parts. These include plans of the structure of the building, the layouts of floors, electrical installation, and plumbing installation. This separation of concerns facilitates the design task, as the designer's attention can be focused on one concern at a time. Similarly, the modeling of educational units can be approached from a separation-of-concerns approach as well. For example: the activity structure of educational units can be considered as one concern, and the order in which activities have to be performed as another. The proposed VIDL, developed with this separation-of-concerns principle, is called poEML: *perspective-oriented educational modeling language*.

The remainder of the chapter is organized as follows. The following section introduces the context of this proposal and its classification. The next section describes the main ideas of the language, together with the proposed separation of concerns. Then, the fourth section includes the description of the poEML elements and their graphical representations. This section only contains poEML elements that are most relevant to an ID point of view. Next the JPoEML graphical editor is introduced. In the sixth section, a simple course is modeled with poEML as a case study. The chapter ends with some conclusions.

BACKGROUND

The EML Context

poEML is introduced here as a VIDL, but it was developed as an EML: educational modeling language (Koper, 2001). EMLs have been proposed as modeling languages which “describe the content and process within a ‘unit-of-learning’ from a pedagogical perspective in order to support reuse and interoperability” (Rawlings et al., 2002). Several languages have been proposed as EMLs trying to satisfy this definition. IMS-LD (instructional management systems—learning design) (Koper *et al.*, 2003; Koper & Tattersall, 2005), issued by the IMS Global Consortium¹, is the principal attempt and the current *de-facto* EML standard. Since its publication, IMS-LD has become an important e-learning standard, and has promoted the development of active research and practitioner communities (see Chapter XV in this handbook). In any case, IMS-LD does not provide appropriate solutions to solve the problems identified in the introduction of this chapter (also described in Chapters XIII and XIV in this handbook). poEML is an attempt to develop a solution to some of these deficiencies.

Classification

This section introduces poEML in accordance with the classification framework proposed in Botturi, Derntl, Boot and Figl (2006) for ID languages. poEML features and classification is presented in Table 1.

THE SEPARATION OF CONCERNS

Separation-of-concerns is a long-standing idea that simply means that a large problem is easier to manage if it can be broken down into parts. It is an important design approach in other areas, such as software design, where it is used to facilitate the understanding, design and management of complex systems. Accordingly with the separation-of-concerns approach, programs are broken down into distinct parts that overlap in functionality as little as possible (Kazman, 2001). aspect-oriented programming (AOP) has further developed the separation-of-concerns approach to propose the concept of crosscutting concerns as concerns that cut across other concerns (Kiczales et al., 1997).

Table 1. poEML features and classification

Classification of features of poEML	
<i>Stratification</i>	Layered , poEML offers different representations to describe entities of different types, namely: roles, activities, learning materials, etc.
<i>Formalization</i>	Formal , poEML defines a closed set of concepts and rules for composition of concepts.
<i>Elaboration</i>	poEML is mainly an implementation language as it is able to provide a high level of detail of elements and strategies involved in educational units.
<i>Perspective</i>	Multiple , as it provides different views on the same entities. For example, it provides structural, order and temporal diagrams related to different static and behavioral issues about the parts of educational units.
<i>Notation system</i>	poEML has both a textual (XML) and a graphical notation.
Classification of application	
<i>Communication</i>	poEML is reflective and communicative . It is reflective as it is intended to support structuring and conceiving solutions. It is communicative as the graphical representations can be used to share and interchange design solutions.
<i>Creativity</i>	poEML is both generative and finalist . It is generative in the sense that it can be used to create and refine design solutions. It is finalist as its purpose is to formalize the design models that can be processed by computational systems.

poEML follows the separation-of-concerns approach to support the modeling of educational units. Similarly to AOP, poEML identifies two kinds of concerns to break down educational unit models, namely: *perspectives* and *aspects*. These two kinds of concerns can be represented in orthogonal axes (see Figure 1). On the one hand, the horizontal axis separates the elements involved in educational units in different *perspectives*. Static and behavioral elements are both taken into account in the perspectives. For example: the environments are considered in one perspective and the order between activities in another. On the other hand, the vertical axis separates models in accordance with different levels of control or *aspects*. Each *aspect* involves a certain level of control that can be used to determine changes in the structure or behavior of the elements in the perspectives. The basic level of control is *determined*, which does not allow any change in an educational unit model to be specified.

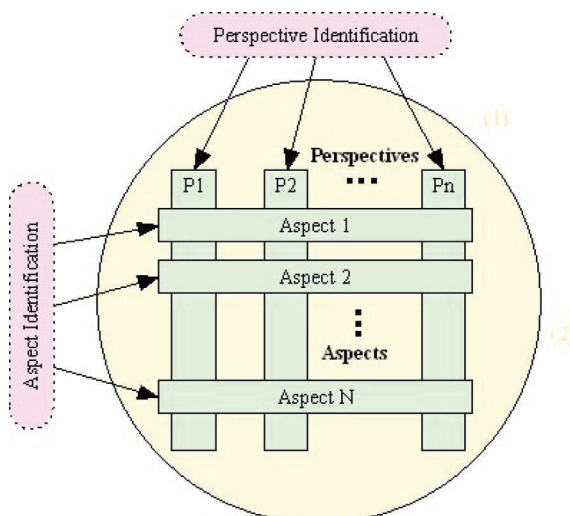
Perspectives

The *activity theory* is a meta-theory about activities and their constituent components (Engeström,

1987). Considering that any educational unit can be conceived as a set of hierarchical aggregated activities, the *expanded mediation model* provided by this theory provides an interesting framework to identify *perspectives* (see Figure 2). The core of this model is that any *activity* involves a *subject* playing a *role* acting on an *object* to achieve a certain *goal*. This connection is influenced by the *environment* and the *community* where the *activity* is performed. In other words, the *activity* depends on the *environment* and the *community*. The *environment* contains the tools and resources that can be used by the *subject* to act on the *object*. The *community* puts the emphasis in the social context where the *subject* operates, involving the influence of two new issues: *rules* and *division of labor*. The *rules* component highlights the fact that within a *community*, *subjects* are bound to rules and regulations that affect the way they interact in the *activity*, including also the interaction with the *environment* and its elements. The *division of labor* refers to the breaking down of the goal into sub-goals and the distribution of responsibilities among the available *subjects*. As a result new subsidiary activities (*sub-activities*) are produced.

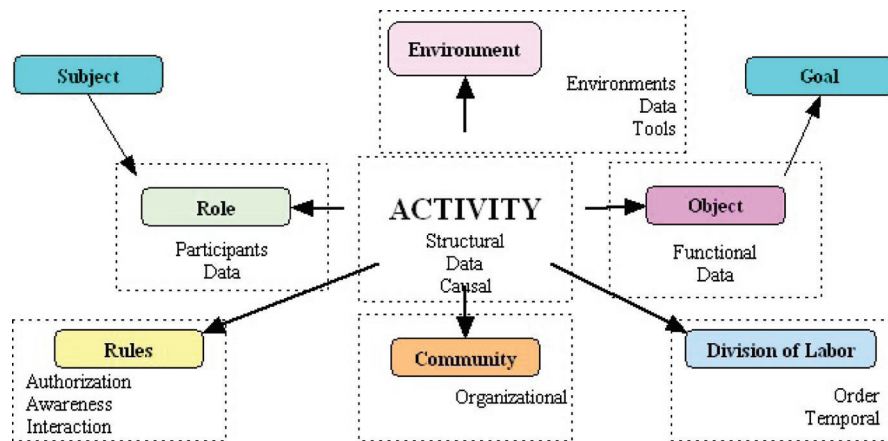
The *expanded mediation model* has guided the identification of 13 *perspectives*:

Figure 1. Separation of concerns in poEML through Perspectives and Aspects



- **Structural:** The structural perspective is about the arrangement of the elements involved in educational units. The proposed structure is based on the activity concept. Educational units are conceived as a set of hierarchical activities grouping all the other elements: functional goals, actors, environments, sub-activities, and specifications. This structural perspective enables these elements to be grouped in an *activity hierarchical structure*. Each of the elements is further described in one of the following perspectives:
- **Functional:** This perspective is about the *functional goals* that have to be attained in an educational unit. Functional goals in-

Figure 2. Proposed perspectives in accordance with the activity theory expanded mediation model



cluded in an activity specify the work that has to be performed by participants on it. For example, a functional goal can be “to produce a basic transistor circuit” or “to evaluate the learners.” These functional goals are different from learning goals that refer to a desired knowledge, skill, or capability. This perspective involves the description of static and behavioral issues of functional goals. The static issues involve features and elements included in functional goals (e.g., input and output parameters). The behavioral issues involve relationships among functional goals (e.g., dependency and completion relationships). They can be used to create *functional flows* in educational units, indicating how goals included in an activity are related with goals included in its sub-activities.

- **Participants:** This perspective is about the participants involved in the educational unit. Participants in the models are not specific persons. Instead, the desired participants are represented by *roles*. This perspective involves the description of the static and behavioral issues of participants. The static issues involve the description of the roles and the structure of groups in-

cluded in each activity. The behavioral issues involve the *participants flow*, namely, how the participants performing a certain role in an activity have to be assigned to another role in a sub-activity.

- **Environments:** An environment is a place where the activity of an educational unit is performed. An environment is also made up of artifacts and tools that can be used by participants. For example, a lab environment is made up of several simulators as well as documentation about the simulators operation. This perspective involves the static description of the environments and the relationships among environments. It does not consider any behavior issues.
- **Data:** This perspective is about the data elements used in educational units. These data elements are included in the other elements: input and output parameters in functional goals; properties in roles; and artifacts in environments. This perspective involves the description of static and behavior issues of data elements. The static issues are about the features of data elements (e.g., type) and their structure. The behavior issues are about the transfer of

data between data elements, namely, the *data flow*.

- **Tools:** The tool concept is used to represent the applications and services that can be used in an educational unit (e.g., simulators, editors, communication, and collaboration services). To facilitate the reuse of the educational unit models, tools are not fixed during design, but are described in an abstract way. During the run-time, tools provided by different vendors that satisfy such description can be used (this differentiation is similar to the distinction between roles and participants).
- **Organizations:** This refers to the organizational structure required to carry out an educational unit. This information may be used to constrain the behavior of other perspectives. For example, the assignment of a teacher to an evaluation activity may depend on his position in the organizational structure.
- **Order:** This perspective is about the sequence in which activities have to be performed. It indicates whether activities have to be performed in sequence or in parallel to set synchronization points among several activities performed in parallel, etc. In other domains this order perspective is also known as *control flow*.
- **Temporal:** Temporal constraints can be used to indicate when an activity must or can be initiated and when it must be finished. An example of temporal constraints would be to indicate that a lab practice must be initiated by 14:00 and that it has to be finished in 2 hours.
- **Authorization:** Authorization involves participants' rights to access the environments' elements, mainly access to the artifacts' and tools' functionalities. For example, a simulator may provide two different permissions: "expert" and "novice." Teachers may be assigned the "expert"

permission while learners are assigned "novice."

- **Awareness:** Awareness refers to the processing of runtime information (events) and the notification of relevant situations. For example, in many educational units it is very important that teachers be aware of learners' actions. Nevertheless, as important as this is, it is not to overload the teacher with excessive information. Therefore, awareness involves giving the right participant the appropriate information and avoiding information overload. To accomplish this, awareness should be focused, customized, and temporally constrained (Baker *et al.*, 2002).
- **Interaction:** This perspective is about the performance of automatic operations in tools. Many of the controls required to support collaboration among a group of participants involve the invocation of operations in collaborative tools at certain time points or as a result of events. This perspective involves the mechanisms required to support the invocation of operations.
- **Causal:** This causal perspective involves the use of competencies (Cooper & Ostyn, 2002), metadata (Duval, 2002), learning objectives, and pre-requisites to inform participants about why they should perform an educational unit.

This chapter is mainly focused on the ID features of this proposal. Some of the perspectives specifically exist to support collaboration in educational practices (e.g., *authorization*, *awareness* and *interaction*). As such, these perspectives may not be very important from an ID point of view and will not be discussed further in this chapter.

Aspects

In addition to the breaking down of static and behavioral issues in *perspectives*, the vertical axis

distinguishes among different levels of control. They are introduced in order to support different kinds of control in educational unit models, from determined to decision-based. The *aspects* proposed in poEML are:

- **Determined:** This is the basic aspect. In accordance with this aspect, the structure and behavior of an educational unit is fixed in the model. During the run-time the educational unit is always carried out in the same way. A “determined” aspect does not introduce any element.
- **Data-based or conditioned:** This involves the use of conditions on data elements to control changes in the structure or behavior of educational unit elements. For example, the functional goals of a course may need to change from optional to mandatory depending on a data element of the learner profile.
- **Event-based:** Event-based aspects involve the use of events to control changes in the behavior of educational units. Events are used to signal situations that appear unexpectedly during the execution. For example, a lab activity has to be finished when a certain event is produced in a simulator.
- **Decision-based:** This involves the use of human decisions to control changes in the structure and behavior of educational units. Often, changes are not dependent on data or events, but on the judgment of responsible persons (one or several). For example, a teacher may decide the goals that should be optional or mandatory. This aspect is used to explicitly describe the human decisions that have to be taken during run-time.

POEML

This section introduces the poEML elements and graphical notations which are most relevant from

an ID point of view. poEML is arranged in several packages reflecting the separation-of-concerns explained in the previous section. The modeling of each perspective and aspect is supported with the elements of a specific package. Therefore, the structural, functional, participants, environment, data, order, and temporal packages are described. For each package, a UML diagram showing its elements and relations is included. (See Chapter IX of this handbook for a good UML primer.) In addition, the graphical representation of such elements and relations is also presented. First, we will explain some general issues about the language.

General Issues

This section describes some general issues about the poEML elements and their features.

Common Features

All poEML elements have two common properties: a name and a description. The name is used as an identifier and a reference. The description is used to inform designers during design-time as well as participants during run-time about the purpose of the element. For example, for a functional goal:

- The *Name* identifies the functional goal in the educational unit model: “To design a microprocessor.”
- A *Textual Description* informs participants about its purpose: “Design a microprocessor of eight bits that enables the performance...”

Abstract Elements

poEML includes several abstract elements. One of the most important is the *Choice Point* that belongs to the *Aspect* package. This element is an abstraction of a *Condition*, *Event*, or *Decision*. Conceptually it represents a point where a choice has to be performed during run-time. Obviously,

this choice can be established using any of the elements considered in these aspects.

Graphical Conventions

poEML elements are represented using different geometric figures. In addition, it includes several kinds of relations (association, aggregation, specialization and dependence) that are represented using arrows. These arrows are depicted in accordance with UML conventions (see Chapter IX in this handbook). As there are many different kinds of dependencies, dependency arrows are annotated with a label that indicates the type of dependency.

Run-time Instances

poEML enables to specify the number of run-time instances that need to be created out of the elements defined. This feature is required in order to support the computational execution of educational unit models. For example, usually *Goals* have to be accomplished only once, but certain *Goals* have to be executed several times (e.g., “a teacher has to assess an examination as many times as individual learners have performed the exam”). In this situation, the functional goal is specified once, but it has to be performed repeatedly for each individual. poEML allows us indicate the number of run-time instances by the specification of a number. This number can be set during design-time or determined during run-time in accordance with the value of a *Choice Point*. In addition, it is also possible that the number of instances take the value zero. In this case the element will not exist during the run-time. This feature enables the adaptation and modification of models.

The Structural Package

The structural package is used to arrange and organize all the elements involved in educational unit models. To support such an arrangement, an

activity-centered approach is followed, but instead of “activity,” the term *Educational Scenario (ES)* is used. From a conceptual point of view, an *ES* represents a complete piece of instruction with a specific educational purpose. It can be used to represent educational unit models at different levels of aggregation, from simple lessons to complete curricula. From a practical point of view, any educational unit model involves a hierarchical structure of aggregated *ESs*. In other words, an educational unit is represented by an *ES* (named as *root-ES*) that is composed by other *ESs* (named as *sub-ESs* or children *ESs*). These *sub-ESs* can also be made up of other *ESs*.

In addition, each *ES* involves a closed system of elements. The elements included in one *ES* can operate with elements included in the same *ES*, exclusively. The interactions with elements in other *ESs* have to be explicitly specified at certain perspectives as *functional flows*, *participant flows*, *data flows*, and *control flows*.

Elements Involved

Figure 3 illustrates the *ES* and its constituent elements. It represents an *ES* element involving an aggregated structure relating the elements considered in the 13 perspectives: (i) its own break down in *sub-ESs*; (ii) a *Goal* (or set of *Goals*) that need to be satisfied; (iii) a participant or set of participants (specified as *Roles*) that will work towards the goals achievement; (iv) one or several *Environments* where participants will work, composed by (v) *Data Elements* and (vi) *Tools* that represent applications and services; and optionally (vii) a particular *Organizational Structure* that situates participants in an organization scheme; (viii) *Order Specifications* to indicate the order in which the *sub-ESs* are intended to be performed; (ix) *Temporal Specifications* to indicate or constrain the moment at which each *sub-ES* has to be initiated and finished; (x) *Authorization Specifications* giving permissions to participants for the use of resources; (xi) *Awareness Specifica-*

tions indicating how events should be processed and notification submitted to participants; (xii) *Interaction Specifications* with constructs that permit the performance of automatic operations; and, (xiii) several *Records* containing descriptions of competencies, learning objectives and pre-requisites. Each one of these elements is modeled in a different package.

In addition to its constituent elements, an *ES* can involve the specification of multiple *instances*. Sometimes during execution several instances of the same *ES* must be created. For example, an *ES* involving a pair of learners performing a lab practice has to be created for as many pairs of learners there are in the class, because the same lab practice has to be performed by each pair.

Graphical Representation

The elements of this package can be graphically represented as a set of hierarchical aggregated elements. At this time this representation is a hierarchical tree (see Figure 4). The root and the branches of the tree are *ESs*. The leaves of the tree are the other poEML elements that are represented by appropriate symbols. The root *ES* is represented with an icon different from the icon used for the other *ESs* to show that it is the root *ES* that represents the educational unit.

The Functional Package

The *Functional* package involves the modeling of *Goals* (functional goals). Every *ES* needs to include a *Goal* or set of *Goals* indicating what to do. It involves the modeling of the static and behavioral issues of functional goals.

Figure 3. Main elements and relationships involved in the Educational Scenario element

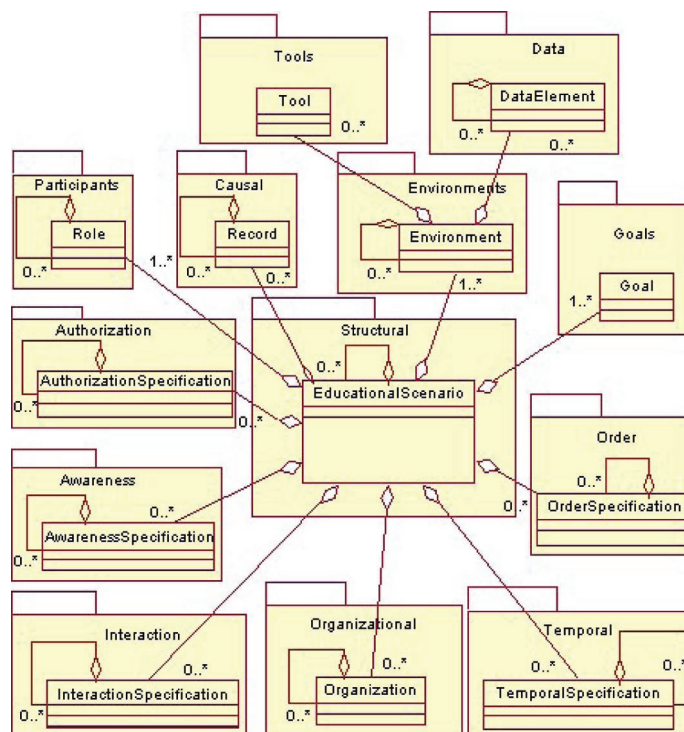
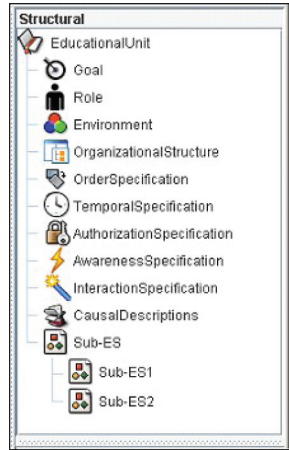


Figure 4. Graphical representation of the elements of the Structural package



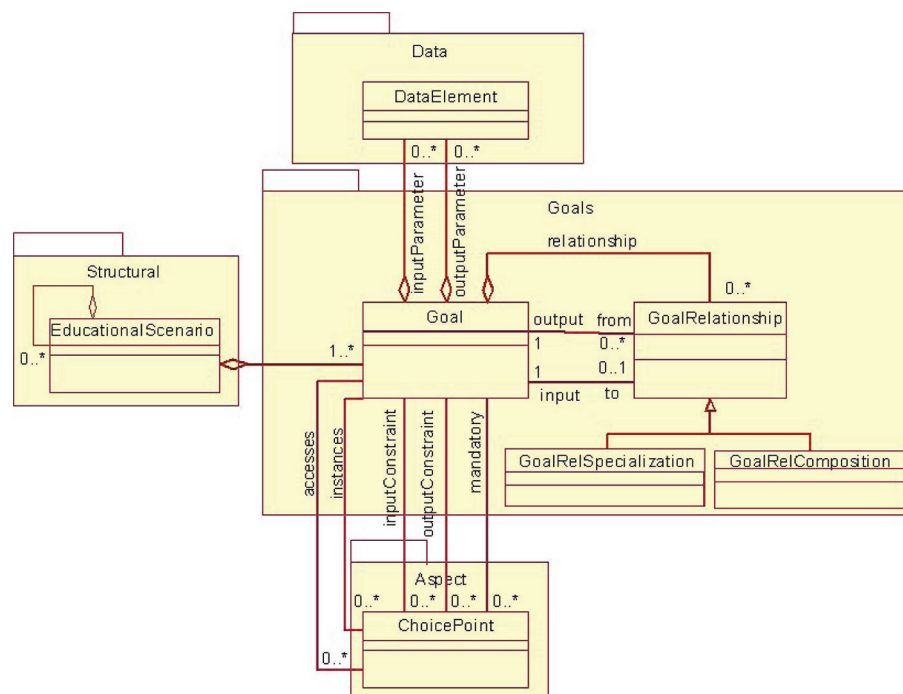
Elements Involved

Figure 5 represents in an UML diagram the elements and relationships of this package.

The next items describe the elements of this package:

- *Input Parameters* and *Output Parameters* indicating the data elements that have to be provided to perform the *Goal*, and the data elements that must be produced as a result of the performance of the goal, respectively. For example: “Specifications of the problem,” “The qualification obtained in an evaluation.” These parameters are characterized in accordance with the *Data Element* of the *Data* package (see Figure 5).
- *Input Constraints* and *Output Constraints*. The *Input Constraints* enable control of when a functional goal can be attempted. For example: “The software tool that supports the design of microprocessors must be available,” “The learner assigned to the corresponding *ES* has obtained a qualification greater than five in a previous ques-

Figure 5. Main elements and relationships of the Goals package



tionnaire.” Meanwhile, *Output Constraints* enable control of when a goal has been satisfied. For example: “The document containing the microprocessor design has been delivered.” These constraints are specified using a *Choice Point* of the aspect package or they can reference to other functional goals.

- The *Mandatory or Optional* character of a *Goal*. Many times, educational units include certain parts that are not required. They are included as a complement to satisfy learners’ curiosity or to get a better understanding. poEML recognizes this possibility and distinguishes between mandatory and optional goals. This aspect can be fixed during design-time or determined during run-time using a *Choice Point* of the aspect package.
- The *Instances* that have to be created of a *Goal*. In poEML, a *Goal* has to be performed as many times as instances are created from it. This construct permits us to indicate how many times a *Goal* has to be performed. The number of *Instances* of a *Goal* can be fixed to a value during design-time, be determined during run-time, or constrained in accordance with a *Choice Point*.
- The *Accesses* indication allows us to specify how many times a *Goal* can be accessed for performance. Some times *Goals* cannot be satisfied by an unlimited number of attempts, but have limits. For example: “A student airplane pilot has to learn to take off and land in less than a certain number of attempts.” Similarly to the *Instances* indication, this value can be fixed during design, determined during run-time or constrained.
- Relationships between *Goals*. Finally, poEML allows two different kinds of relationships to be indicated:

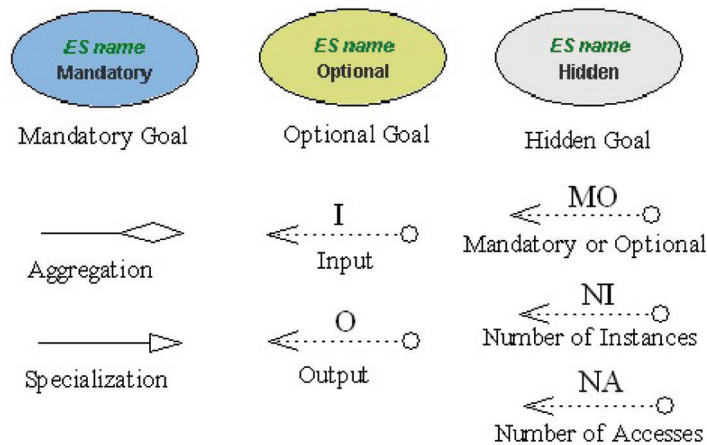
- *Aggregation Relationships* are used to indicate that a *Goal* (G1) can be decomposed into several *sub-Goals* (G1, G2, ... GN). To satisfy G1 it is necessary to satisfy the N *sub-Goals*. This allows complex goals to be broken down into more simple ones. For example, a practice has as a goal “to develop a software application.” This goal is broken down into the following sub-goals: “perform the analysis”; “design a solution”; “program the design”; and “perform tests.”
- *Specialization Relationships* are used to indicate that a *Goal* (G1) is detailed by several *sub-goals* (G2, G3, ... GN). To satisfy G1, some number of the N specialized *sub-goals* must be satisfied. This allows different paths to achieve the same purpose. For example, the goal “examine the learners” has the following possible specializations: “make a written examination;” “make an oral examination;” “make a portfolio examination;” etc.

Graphical Representation

Figure 6 shows the graphical representation of the elements of this package. Please note the following issues:

- *Goals* are represented with different colors depending on whether they are mandatory, optional or hidden. They include the name of the *ES* and the name of the *Goal*.
- The *Aggregation* and *Specialization* relationships connect *Goals* with other *Goals*.
- The *Mandatory or Optional* (MO), *Input* (I) and *Output* (O) dependencies connect *Goals* with *Choice Points*.

Figure 6. Graphical representation of the elements of the Goals package



- The *Number of Instances* (NI) and *Number of Accesses* (NA) connect *Goals* with *Data Elements*.

Dependencies with the Structural

Perspective

The *Goals* specification has strong implications for the execution of the educational unit models. The *structural* package permits us to compose the structure of the educational unit through the aggregation of *ESs*. Meanwhile, the *Goals* package let us indicate what has to be done in the educational unit. This enables the design of “goal maps” where different paths through the structural model can be conceived.

The Participants Package

The *Participants* package involves the modeling of *Roles*. Every *ES* may include a *Role* or set of *Roles* representing the expected participants.

Notice that each *ES* has to define its own *Roles*. They can be the same or different from the *Roles* in its *Parent ES*. During the execution, participants will be transferred from the *Roles* in the *Parent ES* to the *Roles* in the *Sub-ESs* ac-

cordingly to a *participant flow* specification. This kind of specification facilitates the reuse of *ESs*.

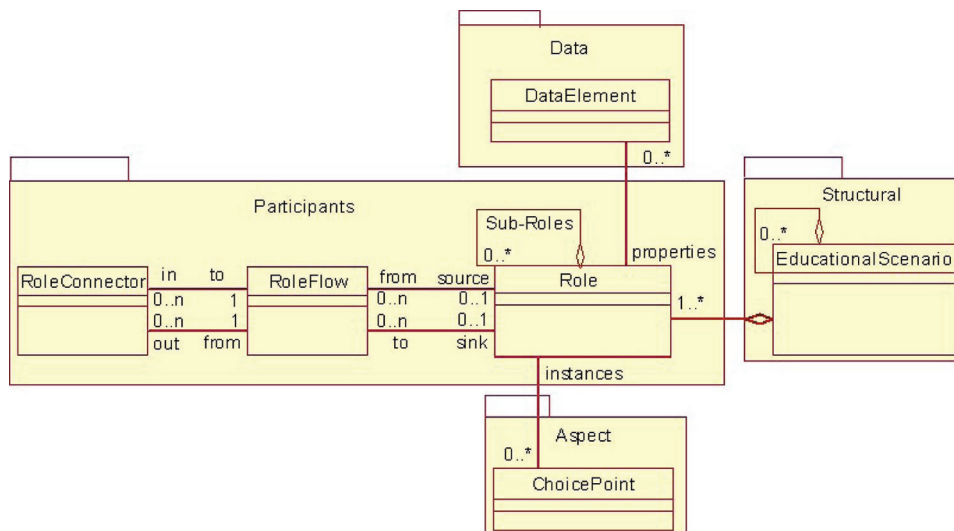
Elements Involved

Figure 7 represents in a UML diagram the main elements and relationships of this package.

The next items describe the main elements of this package include the following:

- *Properties* involving *Data Elements* about the *Role*. The value of the *Properties* during the execution will correspond with the particular participant assigned to the *Role*. Some examples of properties associated with a *Role*: personal data as name, surname, address; previous knowledge, etc.
- *Role Aggregations* enabling the specification of *Composed Roles* made up by other *Roles* (*sub-Roles*). This feature allows the modeling of groups. For example a project group is made up by the following roles: one leader, three developers, one tester and one supervisor.
- The *Instances* that have to be created of each *Role*. During the execution each instance of a *Role* has to be performed by a different participant. In this way it is pos-

Figure 7. Main elements and relationships of the Participants package



sible to indicate that a certain *ES* requires the participation of several persons in the same *Role*. For example: “A discussion *ES* needs to involve five learners.”

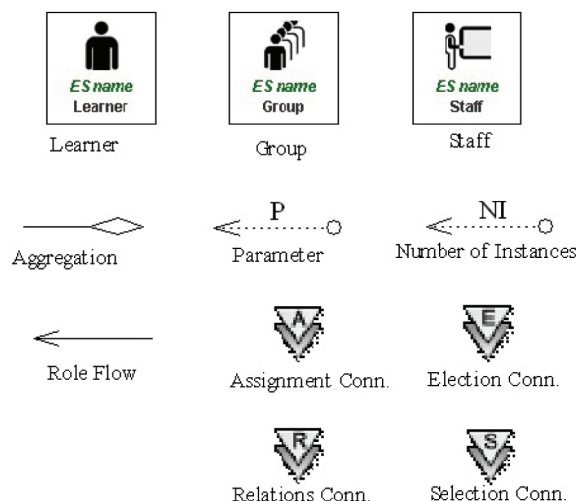
- The *participant flow* recognizes that participants can change their *Role* between activities during the run-time. For example: “A participant performs as learner in a theoretical *ES* and as project leader in a practical *ES*.” The *participant flow* can be modeled using two elements:
 - *Role Connectors*. These are operators that indicate how participants will be processed. Four types of connectors are supported: (i) *selection* connectors that permit us to take several participants from a larger set; (ii) *election* connectors that let us to take exactly one participant from a larger set; (iii) *relation* connectors that enable to constraint possible elections; and (iv) *assignment type* connectors distinguish between *forced assignment* and *voluntary assignment*.

- *Role Flow* elements. These are simple arrows connecting *Roles* and *Role Connectors*.

Graphical Representation

Figure 8 shows the graphical representation of the elements of this package. Note the following issues:

Figure 8. Graphical representation of the elements of the Participants package



- Three different kinds of *Roles* icons are provided: *Learner*, *Staff* and *Group*. They include the name of the *ES* where they are included and the name of the *Role*.
- The *Aggregation* association is used to model *Groups*.
- The *Parameter* (P) and *Number of Instances* (NI) dependencies are used to connect *Roles* with *Data Elements*.
- Each kind of *Role Connector* is represented with a different icon.
- The *Role Flow* dependency is used to connect *Roles* with *Role Connectors*.

The Environments Package

The *Environments* package involves the modeling of *Environments*. Every *ES* may include an *Environment* or set of *Environments* containing the resources that can be used. *Environments* contain *Tools* and *Artifacts* specified with *Data Elements*. Two different kinds of *Environments* are considered: virtual and physical.

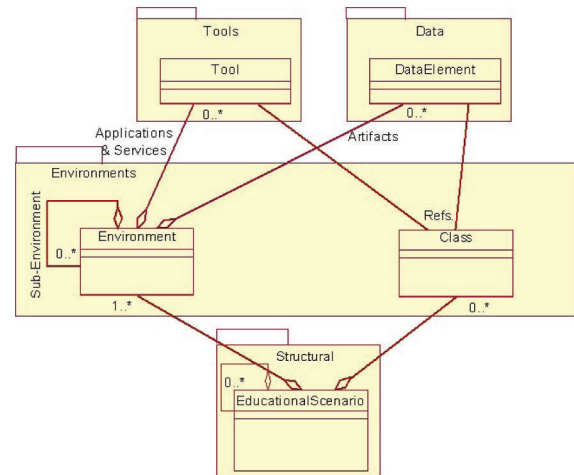
Elements Involved

Figure 9 represents in a UML diagram the elements of this package.

The next items describe the elements of this package:

- *Artifacts* contained in the *Environment*. These *Artifacts* are characterized using *Data Elements*. Some examples: “A document explaining a concept,” “A variable indicating the grade obtained in a questionnaire.”
- *Tools* contained in the *Environment*. These *Tools* are characterized in accordance with the *Tool* element of the *Tools* perspective. Some examples: “A simulator,” “A text-editor,” “A chat service.”
- *Environment Aggregations* enabling the specification of *Composed Environments*

Figure 9. Main elements and relationships of the *Environments* package



made up by other *Environments* (*sub-Environments*). For example: “A laboratory room is made up by a working environment and a test environment.”

- The *Class* element is used to support the classification of the resources included in the *Environments* of an *ES*. Many times, the resources of an environment need to be classified. For example: “Resources for expert learners and resources for novice learners.” They are used in the specification of the *awareness*, *authorization*, and *interaction* perspectives.
- Finally, poEML considers that *Environments* will be characterized in an abstract way during design-time. Then, during run-time, a concrete environment containing the specified *Artifacts* and *Tools* will be provided. This is similar to the distinction between *Roles* and participants. Nevertheless, it is possible to specify the use of a concrete *Environment*. To do so, a *Reference* indication has to be specified to establish the concrete environment. In addition, this *Reference* can also be used to indicate that an *Environment* in an *ES* has

to be the same that other *Environment* in other *ES*.

Graphical Representation

Figure 10 shows the graphical representation of the elements of this package. Please note the following issues:

- Special icons are used to represent *Physical*, *Virtual*, and *Class* elements. They include the name of the *ES* where they are included and the name of the element.
- A *Contains* (C) dependency is used to indicate which *Artifacts* and *Tools* are included in each *Environment*.
- A *Belongs* (B) dependency is used to relate resources with *Classes*.
- A *Reference* (R) dependency is used to indicate the reference from an *Environment* to other *Environment*.

The Data Package

The *Data* package supports the modeling of *Data Elements* and the transfer of data values between *Data Elements*. *Data Elements* may be included in *Goals*, *Roles* and *Environments* to feature parameters, properties and artifacts respectively.

Elements Involved

poEML proposes the elements depicted in Figure 11 to support the representation of data needs in educational unit models:

- The *Data Element* is the main component. For each *Data Element*, the following properties can be specified: name, description, type, and default value.
- The *External File* element allows one to specify data elements contained in a file external to the educational unit model. This element can be used to transfer information to or from the external context.
- The *Data Flow* element enables the indication of how data values flow between *Data Elements*, *External Files*, and *Data Connectors*.
- The *Data Connector* involves several alternatives to transfer values between data elements. Three different connectors are available:
 - The *Reference* connector shows that a *Data Element* has the same value as other one
 - The *Copy* connector shows that a *Data Element* takes the value of other *Data Element*. The *Copy* can be synchronous (if it is produced when the sink *Data Element* is created) or

Figure 10. Graphical representation of the elements of the *Environments* package

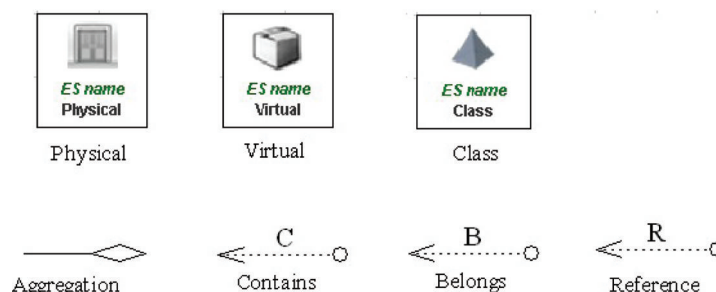
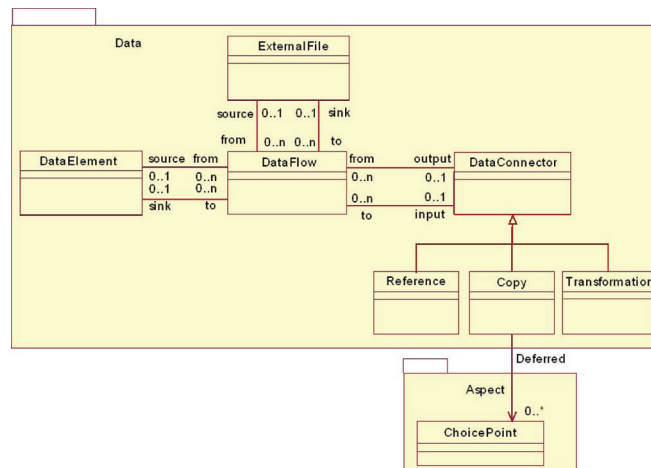


Figure 11. Main elements and relationships of the Data package



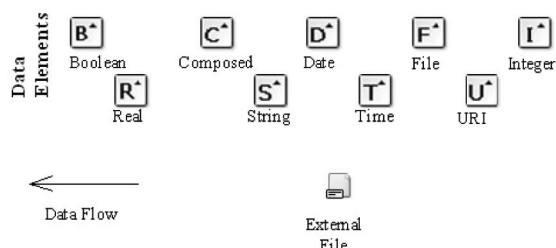
asynchronous (if it is produced when a *Choice Point* is satisfied).

- The *Transformation* involves the performance of operations using the data contained in *Data Elements*. Some operation types are: Boolean (e.g., AND, OR), mathematical (e.g., +, -, *), string processing (e.g., sub-string, delete).

Graphical Representation

Figure 12 shows the graphical representation of the basic elements in the *Data* package. The different *Data* types have particular graphical representations.

Figure 12. Graphical representation for the elements of the Data package



The Order Package

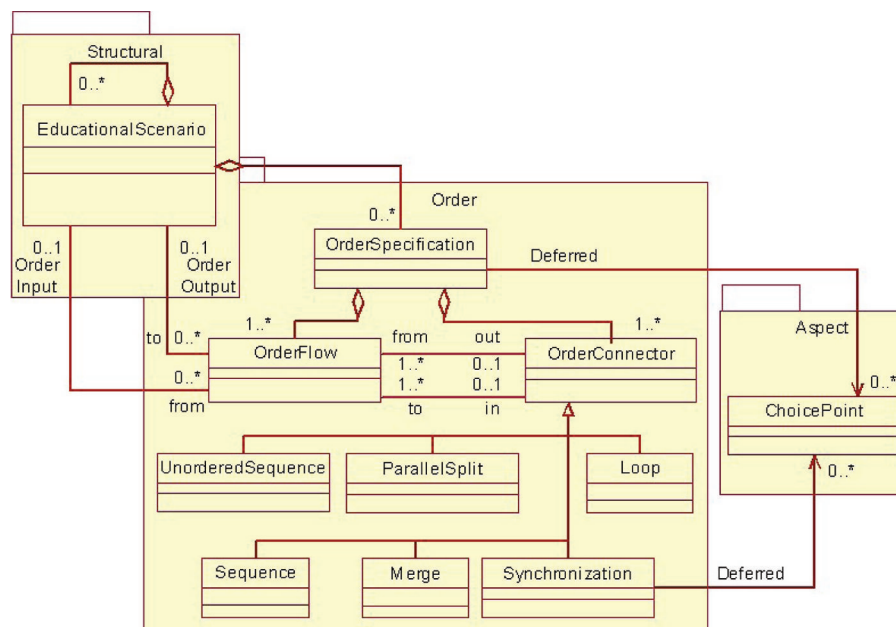
The *Order* package allows us to indicate the order in which the *sub-ESs* of an *ES* will be performed. It is not possible to establish order specifications among *sub-ESs* that belong to different parent *ESs*. This constraint is introduced to help facilitate the reusability of *ESs*.

Elements Involved

The indication of the *Order* among *sub-ESs* is maintained in *Order Specifications*. For an *ES*, several *Order Specifications* can be included in the same model. During the execution one or zero in the *Order Specifications* may be activated in accordance with a *Choice Point*. Each *Order Specification* is composed by the elements depicted in Figure 13:

- The *Order Flow* element enables the specification of links between *ESs* and *Order Connectors*.
- The *Order Connector* element is used to indicate different order operations. The provided connectors are:
 - **Sequence:** The Sequence specification describes a point where an *ES*

Figure 13. Main elements and relationships of the Order package



can be initiated when the previous *ES* has finished.

- **Unordered Sequence:** The Unordered Sequence specification describes a situation where several *ESs* can be initiated in sequence, but with no predefined order in which they must be performed. The order is decided during the execution.
- **Parallel Split:** Parallel split specifies a point where several *ESs* can be initiated and performed in parallel.
- **Loop:** Loop specifies a point where a return to an already finished or completed *ES* may be required.
- **Merge:** Merge specifies a point where several *ESs* that were being performed in parallel converge. Each time one of the *ESs* finishes, a new instance of the next *ES* is created and initiated.
- **Synchronization:** To specify a point where several *ESs* that were being performed in parallel converge, the

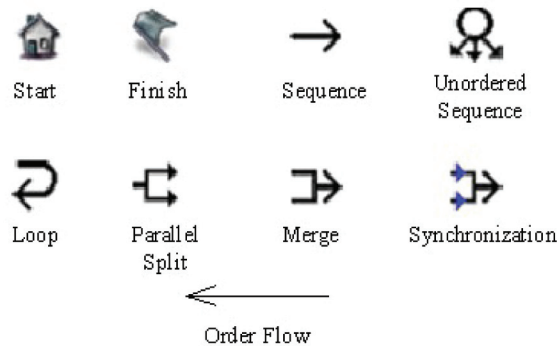
synchronization specification is used. To initiate the next *ES*, all parallel *ESs* must finish. Using an association with a *Choice Point* it is possible to indicate that the synchronization has to be produced in a *Deferred* way, namely, when a condition, decision or event is satisfied.

Graphical Representation

Figure 14 shows the graphic representation of the elements of this package. Note the following issues:

- Two special figures are used to indicate the start and the finish of the order execution.
- Each *Order Connector* is represented by a different figure in accordance with its behavior.
- The *Order Flow* arrow is used to connect *ESs* with *Order Connectors*. Each *ES* and *Order Connector* has exactly one input *Order Flow* and one output *Order Flow*.

Figure 14. Graphical representation of the elements of the Process package



The Temporal Package

The *Temporal* package allows one to indicate and constrain the time at which an *ES* can/has to be initiated or finished.

During run-time, *Temporal Specifications* and *Order Specifications* may produce conflicting situations. For example: “Both the lab practice and the exam have to be performed in sequence. The exam has to be started at 16:00.” To know what to do in these cases *Temporal Specifications* are assigned as a priority factor.

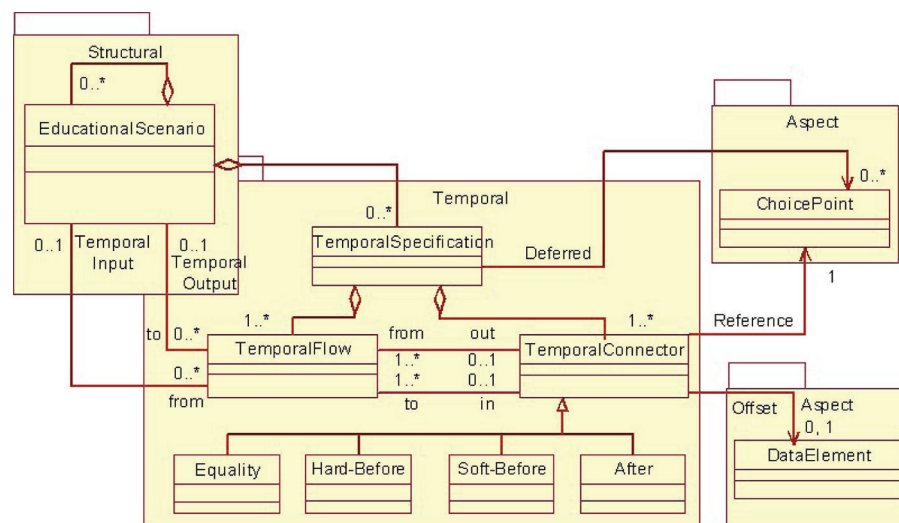
Elements Involved

Temporal indications and constraints are specified in *Temporal Specifications*. For an *ES*, several *Temporal Specifications* can be included in the same model. During the execution one or none of the *Temporal Specifications* may be activated in accordance with a *Choice Point*.

Each *Temporal Specification* is composed by elements depicted in Figure 15:

- The *Temporal Flow* element enables the specification of links between *ESs* and *Temporal Connectors*.
- The *Temporal Connector* element is used to indicate different temporal relations. It can be associated with a *Choice Point* or a *Data Element*. If it is associated with a *Data Element*, that element represents an absolute time (e.g., February 14th, 2007). In the other case, when a *Temporal Connector* is associated with a *Choice Point* it acts as a temporal reference (i.e., the time at which an event is produced). In this case an *Offset* can be included to indicate a delay to the

Figure 15. Main elements and relationships of the Temporal package



relative time. These issues affect the four *Temporal Connectors*:

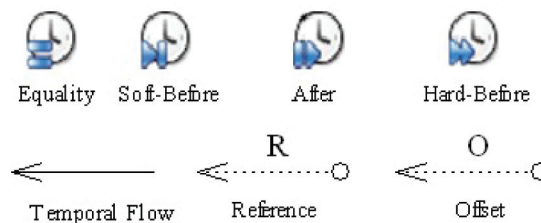
- **Equality:** To specify that action A has to be performed just when another action B is produced. For example: “The exam has to be initiated just when the lab practice has been finished,” “The course starts on September 19th.”
- **Hard-Before:** To specify that action A has to be performed before another action B is produced. If action B is produced and A has not yet been produced then action A is forced to be performed. For example: “The lab practice has to be finished *hard-before* the test activity is finished.”
- **Soft-Before:** To specify than action A can be performed before another action B is produced. If action B is produced and A has not been produced yet then action A cannot be performed. For example: “An optional activity can be initiated *soft-before* the examination has been initiated.”
- **After:** To specify that an action A can be performed after action B is produced. For example: “The video session can be initiated after the debate has been initiated.”

Graphical Representation

Figure 16 shows the graphic representation of the elements of this package. The dependencies are used in the following ways:

- The *Temporal Flow* connects an *ES Temporal Input* or *Temporal Output* with a *Temporal Connector*.
- A *Reference (R)* dependency is provided to link *Temporal Connectors* to *Choice Points* or *Data Elements* indicating relative or absolute temporal references, respectively.

Figure 16. Graphical representation of the elements of the Temporal package



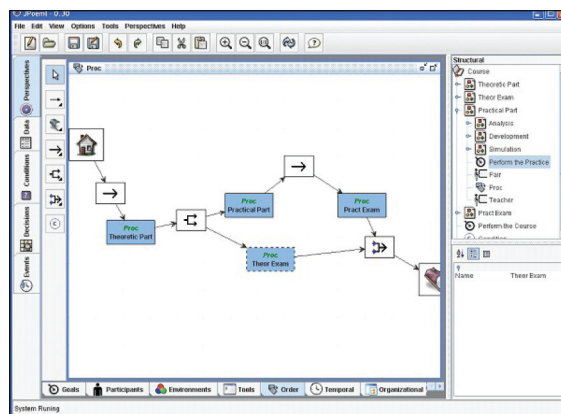
- An *Offset (O)* dependency is provided to link *Temporal Connectors* to *Data Elements* to indicate an offset on the temporal specification.

THE JPOEML EDITOR

JPoEML is an authoring tool that enables the design of educational unit models in accordance with the poEML structure and organization (see Figure 17). It is available at <http://www.poeml.com>. This application permits us to approach the design of educational units by focusing on each *perspective* and on each *aspect* each time. In this way, it is an appropriate tool to test the ID capabilities of the language.

The JPoEML graphical interface is separated in two main areas:

Figure 17. JPoEML editor graphical interface with an *OrderSpecification* in edition



- The right side of the screen includes two panels to provide permanent information about model elements. It is composed of two panels:
 - The top panel is used to represent the structure of the educational unit model. It shows the hierarchical tree structure of *ESs* and contained elements. This panel provides a permanent and global view of the educational unit model.
 - The bottom panel is an area where the properties (e.g., name, description, type) of the active element are displayed. Depending on the active element (e.g., *ES*, *Goal*, *Role*) different data fields are provided.
- The central portion of the screen is the more important part of the JPoEML editor. It permits the graphical representation of each perspective and aspect. At a given moment only one perspective or aspect can be represented. Perspectives and aspects are indicated at tabs in the bottom side and left side of this panel respectively. In addition, a contextual panel with tools for each perspective and aspect is available on the left side.

AN EXAMPLE

This section describes an example of an educational unit model. Another example can be found in chapter XVI of this handbook. This educational unit is made up by a theoretical part and a practical part with separated examinations.

poEML enables the incremental design of educational units. The following sections show the models for the functional, structural, participants, environments and order perspectives.

The Goals Model

The *Goals* perspective is an appropriate starting point to initiate the design. The idea is to specify the goals that indicate what participants have to do. The *Goals* specification may be done incrementally, first indicating the main *Goals* and then refining these *Goals* into more detail by specifying aggregated goals, specialized goals and other features.

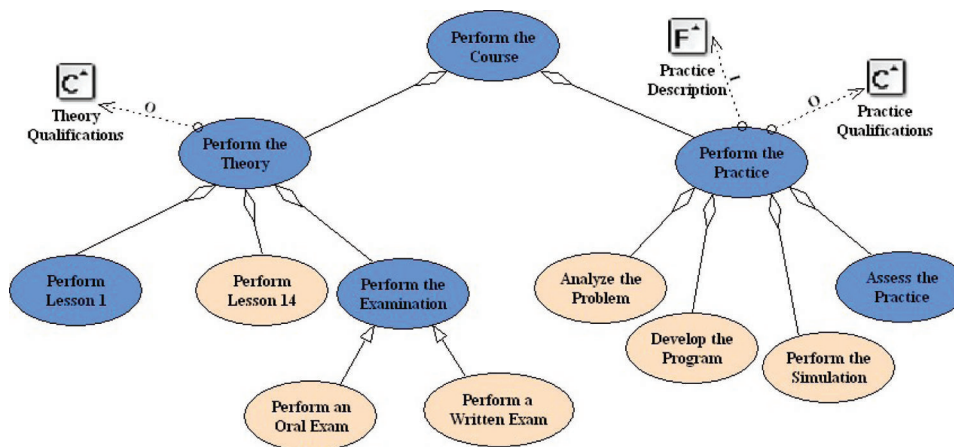
Figure 18 depicts the graphical representation of the case study functional goals' model. This representation is incomplete as some goals may be further subdivided, and additional elements at each goal may be included. The "root" *Goal* is "Perform the Course." It breaks down into two *sub-Goals*: "Perform the Theory" and "Perform the Practice." The first one includes an *Output Parameter* (a *Composed Data Element*) and the second one includes an *Input Parameter* and an *Output Parameter*. These goals are further divided. Some of the *sub-Goals* are depicted in a light brown color indicating that they are optional. The "Perform the Examination" *sub-Goal* of the theory has two specializations: "Perform an Oral Exam" and "Perform a Written Exam." During execution, only one is required.

The Structural Model

The *Structural* perspective may also be used to initiate the design of educational unit models. In this case, it has been performed after the *Goals* were available. This is how the previous *Goals* are assigned to the *ESs*.

Figure 19 shows the example structure. The course breaks down into four main *ESs*: two for the theoretical and practical parts and two for the examinations. In addition, these main *ESs* also break down into other *sub-ESs*. At this design stage these *ESs* only include the *Goals*. *Roles*, *Environments* and the rest of elements will be added to each *ES* in accordance with the perspectives.

Figure 18. Graphical representation of the simulation course Goals perspective



The Participants Model

Figure 20 shows the *Participants* model. The course *Roles* are represented in the top of the figure: a *Learner* and a *Teacher*. The *Learner* has two associations of type *Number Instances* with *Condition Elements*. They are included to indicate the minimum and maximum number of learners that may be involved. Similarly, the *Teacher* has an association of type *Number Instances* connected with an *Integer Data Element*, fixing the number required teachers (in this example two).

The *Roles* of other *ESs* also have associations of type *Number Instances*. Notice that the theoretical *ES* only includes a *Learner Role* with one instance. Obviously, all the learners have to perform the theoretical part of the course. To do it, the theoretical *ES* is assigned a number of instances equal to the eventual number of learners. In this way, each learner will work in a particular instance of the theoretical *ES*. The same is applied to the practical part *ES*, where two *Roles* are involved: a *Pair* of two *Learners* and a *Teacher*.

Notice that the *Pair* has an association *Number Instances* with an *Integer Data Element*. In the *Condition-based* aspect this element takes the value number of learners divided by 2 plus 1. This is the number of *Pairs* that have to be created.

The diagram also includes *Role Connectors* and *Role Flows* to indicate how participants are transferred from *Role* to *Role*. These connectors are of type *Election* and *Relation*. The *Election*

Figure 19. Graphical representation of the simulation course Structural perspective

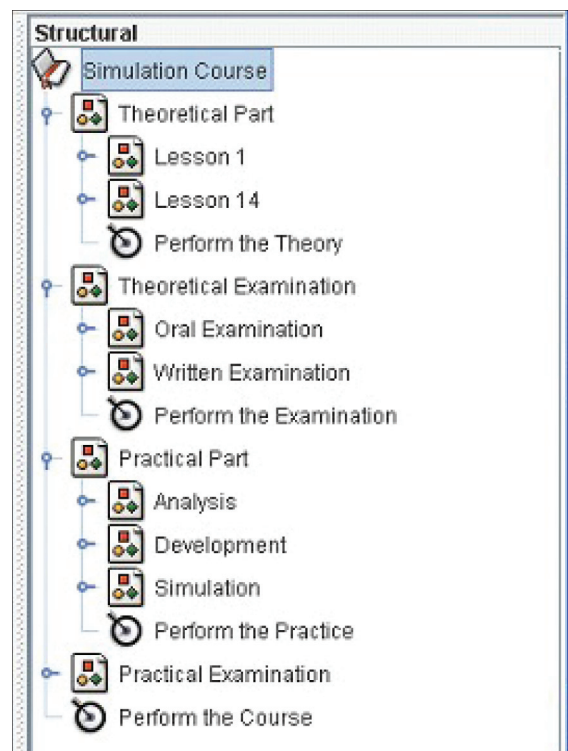
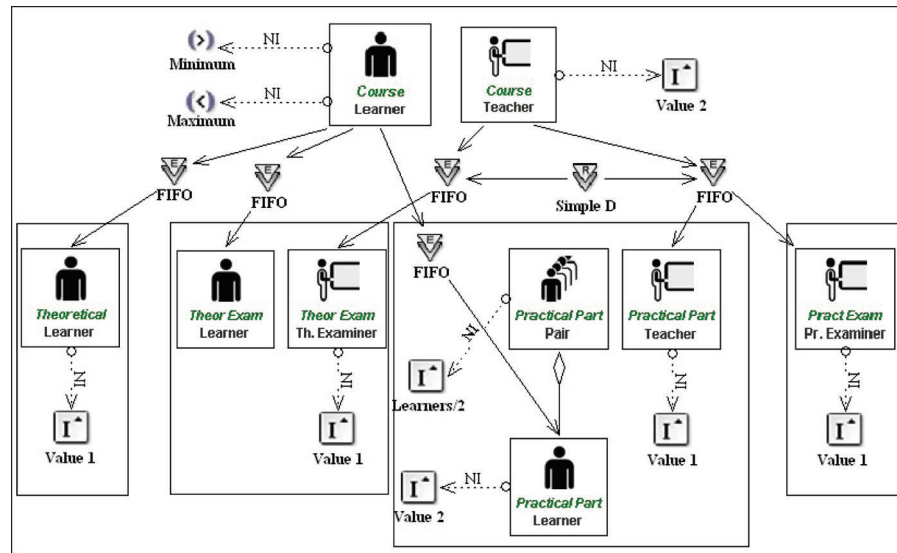


Figure 20. Graphical representation of the simulation course Participants perspective



uses a “FIFO” (First-In-First-Out) algorithm establishing that learners are assigned in the order they are enrolled in the course. The *Selection* involves a “Difference” mode, establishing that the teacher assigned to the *Theoretical Exam* has to be different from the teacher assigned to the *Practical Part*.

The Environments Model

For this example, the instruction has been considered as a blended course where the theoretical part examination has to be performed face-to-face and the other parts are performed on the Web. Figure 21 shows the *Environments* for the main example *ESs*. In the “root” *ES* two *Environments* are specified: the “Course Env.” contains a file with general information about the course and the “Teacher Environments” provides information for teachers. This environment should be visible and accessible for teachers (this can be specified with the elements of the *Authorization* package). The rest of the *ESs* includes particular environments containing different artifacts and tools. Notice that the theo-

retical exam *ES* includes two environments: a *Physical Environment* named as “Aula Magna,” that is fixed using *Reference* association with *Data URI Element* to a particular room; and a *Virtual Environment* named as “Assessment” that contains a *Data Composed Element*. This last environment is also used in the practice examination *ES*. To do it, a *Virtual Environment* is specified in such *ES* and connected using a *Reference* to the previous one.

The Order Model

Figure 22 shows an *Order Specification* for the *ESs* under the “root” *ES*. It involves three types of *Order Connectors*: *Sequence*, *Parallel Split* and *Synchronization*. In accordance with this specification the course is initiated with the theoretical part *ES*. When it is complete, it is possible to initiate the practical part and to perform the theoretical exam. When the practical part is finished it is possible to perform the practical examination. The course ends when all the *ESs* are completed.

Figure 21. Graphical representation of the simulation course Environments perspective

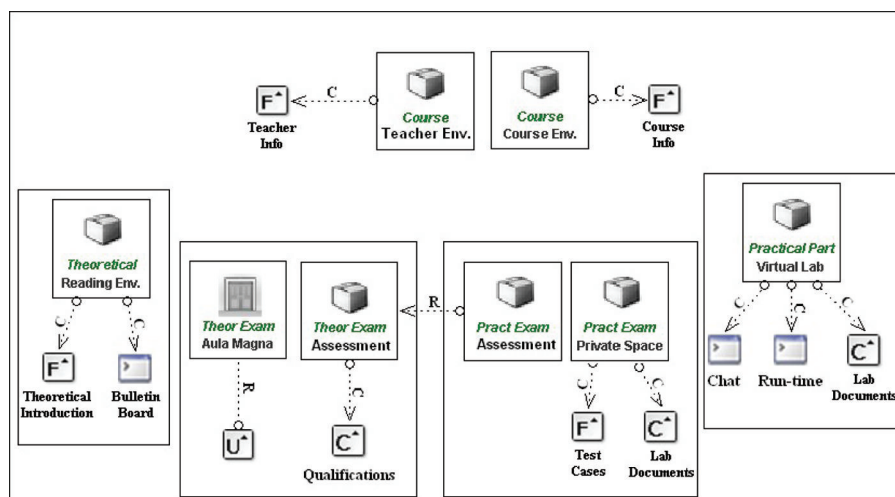
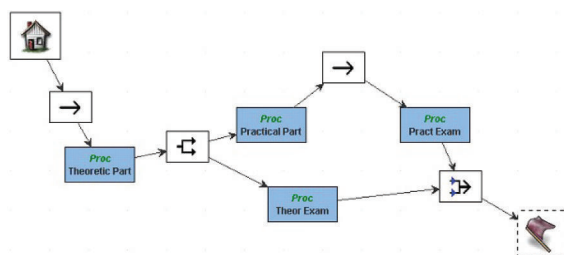


Figure 22. Graphical representation of the simulation course Order perspective



CONCLUSION

This chapter introduces poEML focusing on its ID capabilities. poEML has been proposed to contribute to the modeling of educational units in the context of EMLs. This language is oriented towards several goals: expressive power, formality, flexibility and adaptability. The eventual achievement of all these goals is not an easy task. It is likely that a large improvement process involving several steps will be required to improve the poEML language. Currently, it is not clear in which direction and which steps should be taken to improve EML and poEML is an attempt to explore a particular direction: separation-of-concerns.

Following a separation-of-concerns approach poEML breaks down the modeling of educational units into a set of separated parts that can be specified step-by-step. In this way, the expressiveness of the language is enhanced as it is possible to notate more issues and behaviors of educational units at each part. The formality of the solution is also enhanced, to make it easier to support the computational processing of the models by considering each part independently. In addition, models are adaptable, to make it possible to include several alternatives and consider their activation during run-time using *Choice Points*; and flexible, so that the modeling of a perspective/aspect can be changed affecting other perspectives in a controlled way. Based on these assumptions, poEML and its graphical notation may be a valuable tool for ID.

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Chapter 3.14

SEAMAN: A Visual Language–Based Tool for E–Learning Processes

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ABSTRACT

One of the crucial activities in the development of e-learning courses concerns the design phase. In this phase, instructional designers define the e-learning processes by specifying the activities students should carry out (knowledge objects, assessment, practice, etc.) and their temporal sequence. This phase is usually performed using an iterative process, with step-by-step refinements. Thus, it can greatly benefit of the availability of tools that assist instruction designers to carry out their work. In particular, a rapid prototyping approach could be effectively supported if the

tool is also able to automatically generate the courses starting from the supplied specification. Moreover, such a tool should also provide support for reuse. To fulfil these requirements, in this chapter we present a tool based on a suite of visual languages, which has been specifically conceived to support instructional designers in the definition and creation of learning processes. The use of visual languages is motivated by the success they have achieved in other contexts (e.g., software engineering) for the construction of suitable models that allows to focus only on the features of interest and to provide more effective descriptions and reasoning. The proposed suite of visual languages includes the learning activity diagram, which extends UML activity diagrams to make

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them suitable for modelling e-learning processes, the Self-Consistent Learning Object language used to define knowledge contents, and the Test Maker Language for specifying assessment and self-assessment tests. The visual languages have been then implemented in SEAMAN (System for E-Learning Activity MANagement), a system prototype conceived to support instructional designers in the design, the generation, and the deployment of e-learning processes.

INTRODUCTION

E-learning or electronic learning is a general term used to refer to computer-enhanced learning. The most notable advantages of e-learning are flexibility, convenience, and the ability to work at your own pace. In particular, groups of students participate and complete coursework enjoying e-learning activities in accordance with their daily commitments, thus making e-learning a viable alternative for learners with disabilities or those that have other commitments such as family or work.

One of the crucial activities in the development of e-learning courses concerns the design phase. In this phase, instructional designers define the e-learning processes by specifying the activities students should carry out (knowledge objects, assessment, practice, etc.) and their temporal sequence. The e-learning evolution proposes a good number of approaches and tools aimed at assisting instructional designers during the analysis, design, and delivery of instruction (Bruce & Sleeman, 2000; Campbell & Mahling, 1999; Designer's Edge, 2003; Goodyear, 1997; Schar & Kriger, 2000; Vrasidas, 2002). Many instruction design approaches proposed in the literature are based on traditional pedagogical learning approaches, or on the object-oriented paradigm. Indeed, existing models of instruction design have been influenced by linear or object-oriented software development processes. Nowadays, the new trend consists of

exploiting ideas and benefits of component-based approaches for implementing and delivering learning environments. In particular, the idea is to compose an e-learning process reusing learning components or activities, at different granularity levels (Rosenberg, 2001).

In this chapter we describe a visual language-based approach aimed at supporting the definition of e-learning processes assembling predefined didactic contents. The learning contents can be broken down and structured into a hierarchy from smaller, lower order blocks of material to higher, more complicated levels of learning. In particular, we have identified three different granularity levels referring to the size of knowledge contents. The use and assembling of these knowledge components provides the instruction designer with a modular paradigm to create distance courses, which resembles software development processes based on visual languages (Ferrucci et al., 2002; OMG Group, 1993). Hence, it has been defined a hierarchy of three visual languages to be employed during the different phases of the distance courses design process. Based on these languages we have constructed the System for E-Learning Activity MANagement (SEAMAN) to provide automated design support. The system and the underlying approach are particularly suitable for learning methodologies centred on didactic materials and assessment rules.

The first visual language we propose extends the activity diagrams of UML (unified modelling language) (OMG Group, 1993) to enable the specification of didactic contents, assessment activities, and their relationships. For that reason such diagrams are named learning activity diagrams (LAD). They provide an explicit way to represent complex relationships between structural and behavioural e-learning activities. Any activity specified in a LAD sentence can be further refined by reusing previously defined e-learning activities or using a visual sentence belonging to either the self-consistent learning object (SCLO) language or the test maker language (TML). SCLO

is a special case of state transition diagrams, and enables the instruction designer to define learning content objects. Instead, TML extends state diagrams to enable the design of assessment and self-assessment tests. It lets us describe tests that adapt themselves to student's answers. It is worth noting that tests play an important role in our approach, allowing us to define learning processes adapting themselves to student performance.

The chapter is organized as follows. The next section provides an overview of related work. Then the proposed visual languages are presented. The description of the SEAMAN system architecture, its facilities, and a sample application follows. Finally, a discussion on the achieved results and future work concludes the chapter.

RELATED WORK

Many activities regarding the e-learning process development are today accomplished by software tools that support instructional designers in their job (Bruce & Sleeman, 2000; Campbell & Mahling, 1999; Designer's Edge, 2003; Goodyear, 1997; Vrasidas, 2002). In particular, the e-learning evolution proposes a good number of tools assisting instructional designers during the analysis, design, implementation, and delivery of instruction via the Web (Bruce & Sleeman, 2000). If, on one side, an automated support should be provided by authoring tools (Campbell & Mahling, 1998; Chang et al., 1996; Kasowitz, 1997; Thomson & Cooke, 2000), on the other side these tools should implement suitable e-learning process design methodologies (Douglas, 2001; Goodyear, 1997; Muraida & Spector, 1997; Vrasidas, 2002).

Muraïda and Spector (1997), and Kasowitz (1997) review much of the work done in automated instruction design support tools. In particular, Muraida and Spector (1997) assert that there is "a lack of instructional designer expertise, pressure for increased productivity of designers, and the need to standardize products and ensure the

effectiveness of product." Thus, tools supporting instruction design during all the phases of the learning process definition are desirable. Goodyear views the instruction design as falling within four main approaches (Goodyear, 1997). These approaches allow the instruction designer to generate e-learning activities from given specifications by means of tools supporting the design of course structure, the selection of presentation templates, the reuse of design elements, and the coordination of activities accomplished by a design team. Moreover, Goodyear also proposes an approach for analyzing and designing distance courses that is divided into neat parts (Goodyear, 1999). The first part of Goodyear's approach resembles the work of other people (outside education) who are interested in the design of technology supporting the work of information systems designers, requirements engineers, human factors specialists, and so on. The second part is instead focused on the design of good learning tasks exploiting traditional analysis and design processes. Often, these tools are not able to compensate the lack of expertise of instruction designers. Jones et al. (2003) have presented an information systems design theory for the design of information systems to be used in Web-based education. Vrasidas (2002) presents and discusses a system to develop hypermedia approaches as part of courses and learning environments delivered on the World Wide Web. It details the structuring of information, branching and interactivity, user interface, and navigation through Web-based distance courses.

Opposed to these approaches, which are based on traditional models of instruction design, there are approaches and tools relying on object-oriented models. Douglas (2001) proposes an instruction design methodology based on the object-oriented paradigm. Designer's Edge (2003) provides another interesting approach and tool for instruction design based on the object-oriented paradigm.

Differently from the approaches we discussed above, AIMS (2004) Project describes a theoretical framework in which the knowledge domain edit-

ing and the course editing are distinguished. First the instructional designer constructs the domain model in terms of concepts and links. Finally, he/she defines the course structure starting from that description. Similarly, Thomson and Cooke (2000) propose the APHID method to support designers during the course creation by using instructional patterns. They also provide patterns describing teaching strategies known to be successful in particular situation. These patterns are used to design hypermedia applications.

New trends seek means to exploit ideas and benefits of component-based approaches for implementing and delivering learning environments. In particular, the idea is to reuse learning components, at different granularity levels. At the topmost level there are existing self-consistent learning contents that may be composed of learning objects, which in turn may be composed of raw contents (Rosenberg, 2001). It is worth noting that the self-consistent learning materials can be seen as a framework in which instruction designers insert learning contents and raw contents specifying their interrelations and dependencies. Therefore, it could be interesting to reuse a self-contained learning content and possibly also the associated learning objects.

Lin et al. (2002) suggest the use of workflow technology to define and manage the coordination of e-learning activities. In particular, the authors introduce an e-learning environment, called Flex-eL, which has been built upon workflow technology. The workflow functionality of Flex-eL manages the coordination of learning and assessment activities of the course process between students and teaching staff. In particular, this environment provides a unique environment for teachers to design and develop process-centric courses and to monitor student progress. A process-modelling tool called FlowMake is also proposed in order to define e-learning processes. A process model is defined as workflow graph containing tasks and workflow modelling structures. Tasks are associated with roles and applications. The

course activities and associated roles are identified and modelled using FlowMake. Personalization of the learning processes according to learners' diversities is not provided. Differently, Carchiolo et al. (2002) present a prototype of a Web-based e-learning environment through which students can follow dynamically adapted learning process. In particular, the environment provides students with all formative paths moving from an initial to a desired knowledge, and where paths are adapted according to the student needs and capabilities, and dynamically modified according to the learners' and teachers' feedbacks.

VISUAL LANGUAGES

Visual and diagrammatic representations play a central role in several application domains, since they provide important tools for describing and reasoning. As visual languages have been applied to new application domains, such as spatial databases, education, software engineering, and so on, many different types of visual notations have been devised. In particular, in the software engineering domain they are widely employed for supporting the phases of the development process, such as requirements specification, analysis, and design. The numerous analogies between the software development and the instruction design processes suggested us to exploit visual languages to support several tasks of the instruction design process. Thus, the three visual languages we propose extend or resemble languages that have been successfully and largely used in the software engineering field to design software systems.

The main language is the learning activity diagrams (LAD), which extends UML activity diagrams with means to model the workflows of learning processes (OMG Group, 1993). LAD can be used to model e-learning activities composed of distance modules, assessment, and self-assessment tests. States in LAD are activities, and most of the transitions are implicitly triggered

upon the completion of the actions associated to the e-learning activities. The second visual language we have defined is used to refine the learning content objects, whereas the third one is employed to design the assessment and self-assessment tests. These visual languages have been introduced to refine the basic objects used within learning activity diagrams. They are named self-consistent learning content objects (SCLO) and test maker language (TML). We describe them in the following subsections.

Learning Activity Diagrams

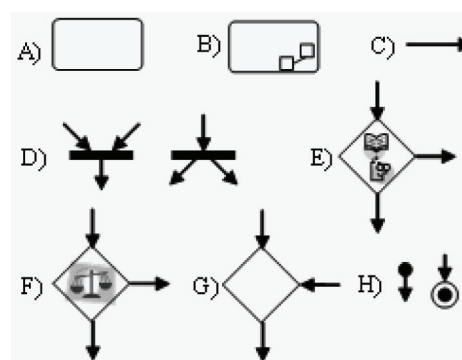
The purpose of the LAD language is to model workflows associated to distance educational processes. As consequence, it allows instruction designers to describe educational materials, dependences, and assessment rules. Material dependences allow the author to vary the degree of control over the order in which the students must explore the materials spread in SCLO objects. Moreover, using the results of assessment or self-assessment tests, the flow of the learning process is adapted to the learner performance. For example, before taking up a course the instruction designer can define a student test whose result may be used for assessing the knowledge, and to properly adapt the student learning process.

The visual language symbols are shown in Figure 1. The first symbol (Figure 1A) represents a SCLO object, or content object for short. The name of the object can be placed in the symbol. This symbol represents a state of a learning process that is left when the associated learning object is completely executed. Every learning object can in turn be separately analysed and refined by using another visual language (Figure 1B). When this happens the icon shows a nested structure. The arrow (Figure 1C) represents the transition symbol, and it can contain a label. When the transition is not labelled, the only result of interest is content object completion. In those cases where it is important to know which content object has been

completed, we associate different coloured coins to content objects execution. The synchronization symbol (Figure 1D) is a thick horizontal bar, and is used to coordinate content objects. The actions underlying content objects may be concurrently executed more than once. The number of concurrent invocations is determined at runtime by a concurrency expression. The synchronization bar provides a simple way to express concepts like waiting for concurrent content objects to finish before proceeding forward along the learning process (join), and the starting of several content objects in parallel (fork). It is worth noting that by removing the synchronization bar elements from the LAD language we derive a special case of flow diagram, but with a considerably reduced language power. In fact, we cannot describe activities without dependences; hence all the activities have to be consumed in a sequential fashion. In the definition of processes focused on flows, and driven by internal processing, like for example industrial, didactic and software processes, this type of behaviour is vital.

Let us now introduce two symbols describing assessment and self-assessment activities. The assessment test symbol (Figure 1F) is used to represent an activity aiming to evaluate the

Figure 1. LAD icons: A) SCLO object; B) refined self-consistent learning content object; C) transition element; D) synchronization bar element; E) self-assessment element; F) assessment element; G) merge element; H) start and stop marker



learner knowledge. The self-assessment activity (Figure 1E) is meant to be accomplished by the student to assess his/her knowledge. As a consequence, we differentiated the notations for these two symbols. Both symbols are used to represent decisions. As an alternative to guards on separate transitions leaving the same state, the aim of these objects is also to synchronize the incoming activities. These have one or more incoming arrows, and one or more outgoing arrows. The guard conditions are used to indicate different possible transitions that depend on test results. A decision may be shown by labelling multiple output transitions of an action with different guard conditions. These guard conditions may depend on self-consistent learning content objects that the instructor has to assess.

We have used a merge symbol (Figure 1G) to merge back decision branches. A merge has two or more incoming arrows and one outgoing arrow. As opposed to the synchronization bar, the incoming transitions are not synchronized.

Content experts, instruction designers, instruction technologists, media developers, and evaluation specialists are all professional figures that could be involved in the distance learning development process. For this reason, learning objects may be organized into swim lanes; the lanes can be used to organize learning objects with respect to these professional figures.

The last two symbols (Figure 1H) are the start and the stop markers. They are used to indicate the initial and final states of a diagram.

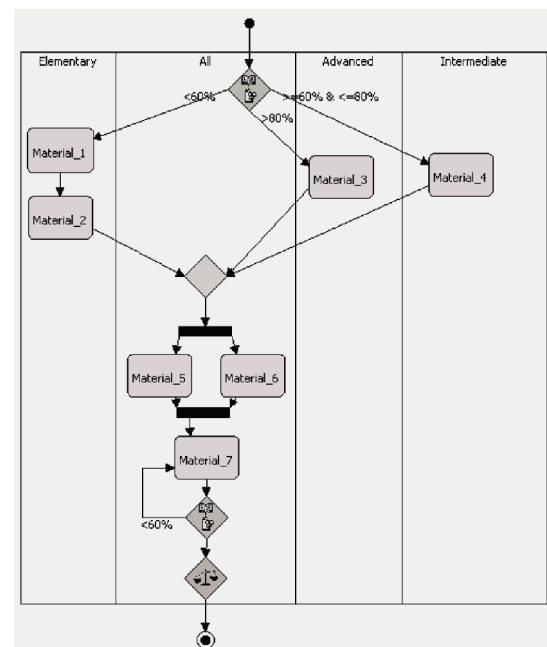
Figure 2 shows an example of LAD visual sentence, which represents a set of e-learning activities that have been structured into 4 swimlanes based on the learner knowledge. The student knowledge is assessed using the first test, so if the student has a score less than 60% then his/her knowledge is considered elementary. Thus, the learner has to study in depth the content presented in Material_1, and Material_2 before going on. Vice versa, when the test result is between 60% and 80% the contents presented to the learner will be those

of Material_4. Finally, Material_3 is presented to the learner with advanced knowledge. After that, there are two parallel e-learning activities, which do not depend on the student knowledge. Following Material_7 there is an assessment test, so if one student has a learning deficiency in that self-consistent e-learning activity then he/she must revise it and repeat the associated test. This means that the self-assessment element needs memory to remember the test result.

Self-Consistent Learning Object Language

The SCLO language is a kind of state transition language. Before defining it, we have investigated several languages used in multimedia software engineering (MSE). However, most of MSE languages have turned out to be complicated, requiring high expertise to be used. However, our aim was to formalize a visual language to be easily used by the target user within the visual environment implementing it. Thus, we have first

Figure 2. A LAD sentence



defined a graph language to describe multimedia contents of learning processes.

Four icons have been used to define this language. These are the multimedia node, multimedia link, start and stop marker node. Multimedia nodes (Figure 3A) represent the educational content that will be presented to the student. Typically they are composed by one or more multimedia raw contents. Thus, this node can be an atomic element or it may be composed aggregating atomic multimedia contents. The atomic content elements can be single Web page or simple multimedia objects, for example, short movies, songs, jokes, images, simulations, and so on. The multimedia object can have one or more incoming arrows, and one or more outgoing arrows (Figure 3B). Two multimedia nodes can be joined through a multimedia link. This represents the fact that students can browse multimedia contents by crossing links connecting objects. The last two symbols are the start and the stop markers (Figure 3C and 3D). These are used to indicate the initial and final state. The system prototype we present in the chapter implements this visual environment by presenting a predefined page layout to the lecturer that he/she can use for managing knowledge content objects.

Figure 4 shows a visual sentence example of the SCLO visual language.

Test Maker Language

Student assessment and self-assessment is a critical task in the knowledge process (Cynthia et al., 2000; Safoutin et al., 2000). The literature proposes a wide range of authoring tools to construct tests. Often, these tools do not have an associated visual environment to describe the test structure and its contents. In this chapter we introduce the test maker language (TML), a visual language supporting teachers during the design and implementation of tests. The language provides means to describe tests that adapt their contents to student answers. TML has five different symbols and three link types. The symbols are: question, aggregation symbol, multimedia object, and start and stop markers. The three link types define transitions between language symbols. Each of them has a different colour.

The instructor can use the question symbol to represent one question and its associated answers, or he/she may refine it by using symbol annota-

Figure 3. The visual language elements: A) multimedia node or knowledge fragment; B) multimedia link; C) start marker node; D) stop marker node

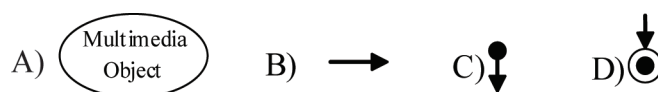
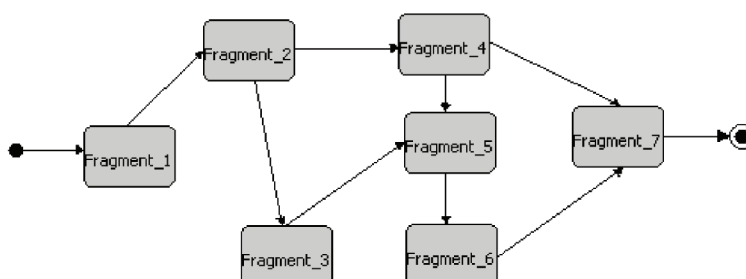


Figure 4. A visual sentence representing a learning content object



tions. Annotation is performed by using visual sentences from the same language.

Question symbols (Figure 5A) are grouped with respect to knowledge contents and swim lanes. These are also used to give an execution order to regrouped answers associated to knowledge contents; the swim lanes order is from left to right.

Links are used to model answers to questions. Thus, when a language sentence has an *any link* (Figure 5D) it means that the following question does not depend on the answer. Conversely, the false and true links (Figure 5E and 5F) modify the student test structure. The last symbol (Figure 5C) is recommended to motivate answers.

An example of visual sentence from the TML is depicted in Figure 6. It is worth noting that swimlane tags can be used to declare the score that the learner must achieve in order to pass the tests.

SYSTEM PROTOTYPE

In this section we present SEAMAN (system for e-learning activity management), a prototype based on the described visual language hierarchy. SEAMAN assists instructors during the specification and implementation of e-learning processes and their associated e-learning activities, supporting the delivery of instruction via the Web. The system integrates modules for several authoring activities, such as knowledge contents, assessment, and self-assessment tests. The system can be configured as a centralized application so that the instruction

designers can share and reuse content objects at different granularity levels.

To better understand the functionality of SEAMAN, let us consider the use case diagram in Figure 7 showing the relationships among use cases, instruction designer, and the framework used to deliver learning processes. In particular, two actors were identified, namely the instructional designer and the e-learning framework. The former actor can define the learning process flow of e-learning courses, the knowledge content objects, and the tests using SEAMAN tool. Once the definition of learning process flow and its e-learning activities is completed, the course can be generated. The generation process releases instruction contents to be deployed via Web, and will be available using an e-learning framework, as for example E-World (Casella et al., 2007).

Figure 8 shows the layered architecture of SEAMAN. It includes three visual editors, one for each presented visual language, an application logic layer, corresponding to the generation engine module, and a repository. The LAD editor allows the instructional designer to describe and model

Figure 5. TML elements: A) question node; B) start and stop marker C) multimedia symbol; D-E-F) joint lines

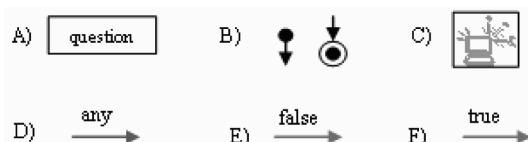


Figure 6. A visual sentence representing a student assessment process

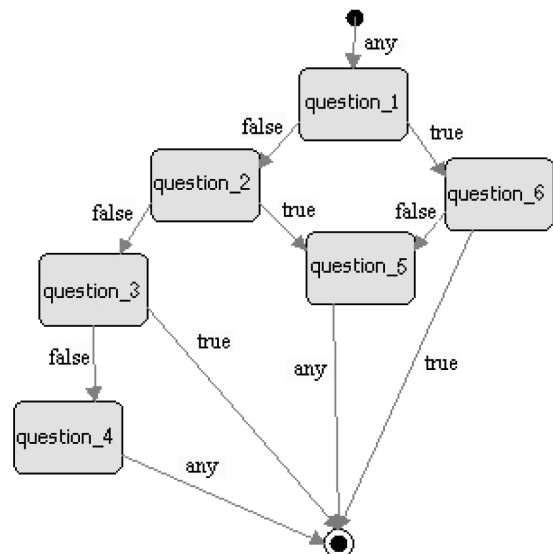
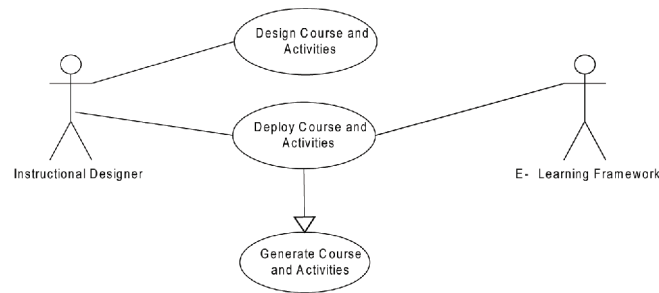


Figure 7. A SEAMAN use case diagram



the learning process flow based on knowledge content objects, assessment, and self-assessment tests, and their dependences. The knowledge contents and the tests are defined by using the SCLO editor, and the TML editor, respectively. The generation engine module generates learning processes, knowledge contents, and the tests using the predefined generation rules stored within the repository of the system prototype. Furthermore, the generation engine module produces a zip file that contains didactic resources and configuration files. The didactic resources are composed of HTML files and SVG (scalable vector graphics, 2007) files, which are described by metadata files. Some configuration files to allow the e-learning framework to manage the learning process are also produced. The generated e-learning course and its activities are stored in the repository to enable the instructional designer to eventually successively deploy them in an e-learning framework, for example, E-World (Casella et al., 2007).

The SEAMAN tool is further described by the UML package diagram of Figure 9 and the UML class diagrams of Figure 10. In particular, Figure 9 shows the semantic dependencies among the packages: graphical user interface (GUI), graphic panel, graphic symbols, input & output, and properties. The GUI package is aimed at managing the graphical components, allowing the interaction between SEAMAN tool and the instructional designer. To insert and delete objects in the visual programming environments implemented in SEAMAN the classes in the graphic panel

package have been implemented, while the classes in the graphic symbol package are aimed at visualizing the language objects in SEAMAN visual environments. In particular, this package contains the interface that all the visual objects have to implement since they can be managed by SEAMAN visual environments. The classes implementing the proposed visual objects are in this package too. The input and output of the visual sentences are managed by the classes of input & output package. Finally, the property package is used to manage the users' preferences, and the multilingual menu of SEAMAN.

The class diagram in Figure 10 shows the relations between the classes implementing the three visual editors and the *generation engine*.

Figure 8. The SEAMAN architecture

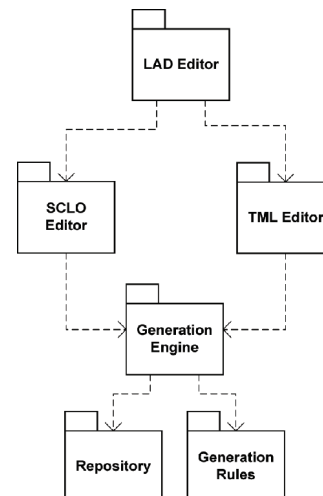
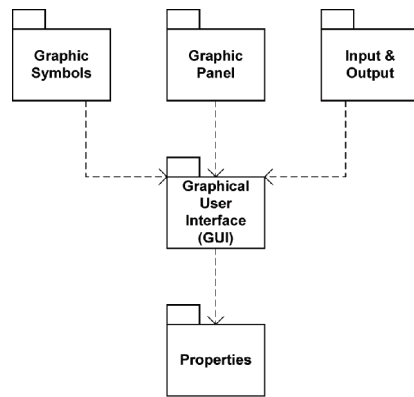


Figure 9. SEAMAN package diagram



This class diagram highlights the extensibility and the flexibility of the proposed system prototype. It is worth noting that extensions or customizations of the proposed visual language hierarchy can be implemented by developers in SEAMAN with little effort. In such a way new types of e-learning activities can also be introduced to complete the formative offer.

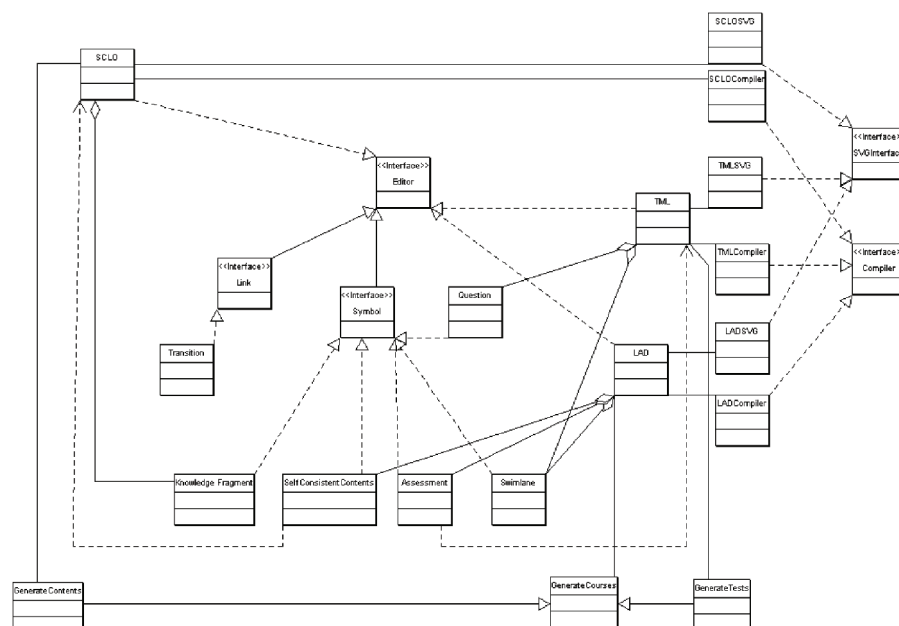
As output of SEAMAN is an e-learning environment that is delivered on the Web, features

such as usability, colours, and graphical layout become crucial for student welfare and e-learning course success. For this reason we defined several predefined graphical layouts that instruction designer chooses for the Web pages implementing the e-learning activities of a given process. Moreover, the prototype allows us to define new layouts or to customize existing ones.

The e-learning activities generated by the prototype are iteratively navigable through a Web browser. Although the e-learning activities generated using the proposed approach are HTML pages, we need sophisticated technologies that only some browsers support. Thus, SEAMAN works for recent versions of Netscape and Internet Explorer.

Although the language aims to support the design and development of learning processes, it has also turned out to be a powerful tool for presenting e-learning activities, and for monitoring student progress. Thus, an animation of diagrams allows students to monitor their progresses. Moreover, thanks to SVG storage format of LAD visual sentences, the student learning process can be

Figure 10. SEAMAN high level class diagram overview



visualized by using a Web browser with a suitable plug-in. The animation is executed only when the activities of a given distance course are deployed in an e-learning platform, implementing the learning traceability through a special conceived software component, such as the SCORM Run Time Environment (ADL, 2003). Moreover, SEAMAN generates a server module interacting with the LMS. The server module is integrated in the platform when the course is delivered. Colouring the activities green when the student finishes them, we provide a high level representation of the learning traceability.

A SAMPLE APPLICATION

Several lecturers at University of Salerno have used SEAMAN to create e-learning courses. In particular, in this section we show its use for the design of the *Programming Language Technologies* course (PLT for short), belonging to the bachelor's degree in computer science at University of Salerno. The aim of the PLT lecturer was to design the e-learning process to provide students with knowledge and expertise in the design and implementation of compilers. After attending the course generated starting from the defined e-learning process, the student should be able to design and implement a language compiler. In particular, as a course project the student is required to implement a subset of functionality of the Java language compiler back-end.

The main steps to create a course with SEAMAN are:

1. Use the LAD environment to define the course structure in terms of contents and tests;
2. Use the SCLO environment to insert content for each SCLO object mentioned in the LAD sentence;

3. Use the TML environment to define assessment and self-assessment tests in the LAD sentence.

Figure 11 depicts the visual sentence describing the learning process of the PLT course within the SEAMAN visual environment. On the other hand, Figure 12 highlights how the same sentence is presented to the student by using a Web browser with SVG plug-in. The sentence does not provide traceability animation because no e-learning activity has been completed. The two figures show that the course is divided in two parts. The former deepens topics about compilers preliminary notions, and basic tools for developing them (such as Lex and Yacc). The second part is conceived for designing and implementing compilers. In particular, the main characteristics of the JAVA, C#, and C++ compilers are shown. There are no dependencies among these topics, so their content can be also completed simultaneously.

Starting from the objectives and the topics of the course the lecturer has introduced three tests,

Figure 11. LAD sentence describing PLT learning process in SEAMAN

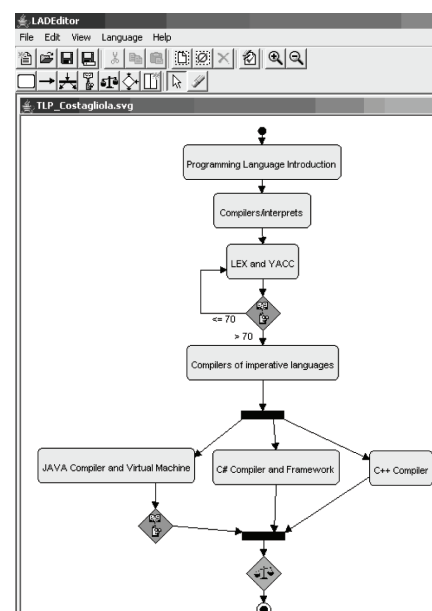
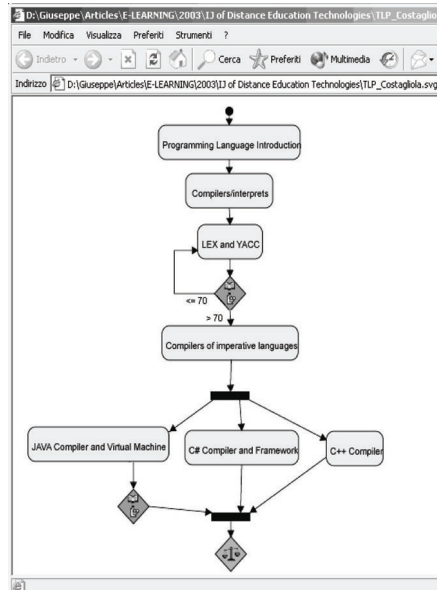


Figure 12. LAD sentence describing PLT learning process displayed using Internet Explorer



two of which are self-assessment and one is assessment. The first self-assessment test, depicted in Figures 11 and 12, regards LEX and YACC tools. Since these tools are considered vital for the realization of the final course project, the lecturer has introduced a test and a feedback on them. Instead, the runtime environment and the

compiler of the Java language are evaluated by using the second self-assessment test depicted in Figures 11 and 12. The visual sentence describing this test is shown in Figure 13. In this picture we can also see an example of question with the associated answers. Finally, the lecturer has created a test for assessing the learners' knowledge on the whole course contents.

The visual sentence in Figure 14 shows the definition of the learning content object "Compilers/Interpreters" depicted in Figures 11 and 12. The main fragment describes the compilation and interpretation processes, whereas subsequent fragments show the detailed activities.

CONCLUSION

Academic and commercial e-learning authoring tools (Apple et al., 2002; Campbell & Mahling, 1998; Douglas, 2001; Goodyear, 1997; Muraida & Spector, 1997) use the basic concepts of the multimedia software engineering (MSE) (Christoffersen & Christoffersen, 1995). This is a new frontier for both software engineering (SE) and visual languages (VL) (Bell & Jackson, 1992; Campbell & Mahling, 1998). As it has happened

Figure 13. TML sentence describing the test on the runtime environment and compiler

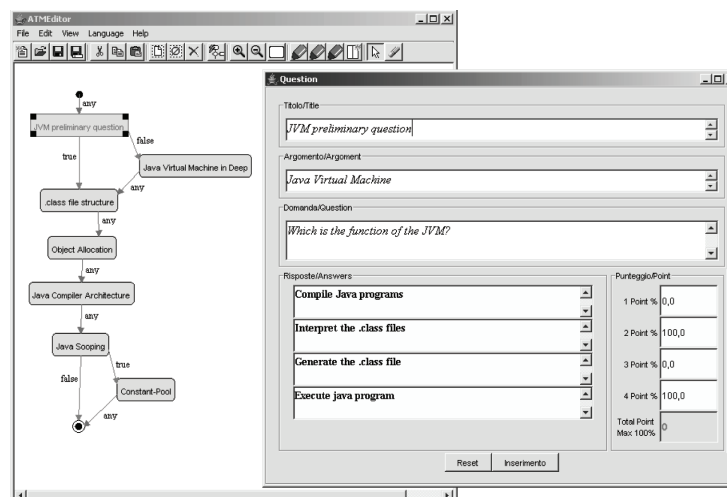
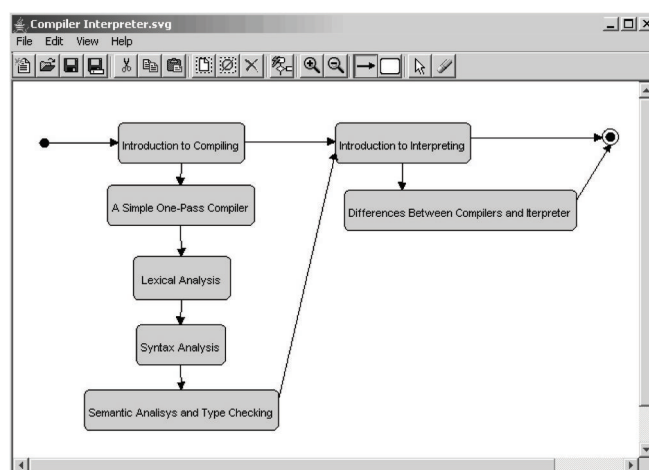


Figure 14. A visual sentence representing the Compiler/Interpreter learning content object



for these fields, also the e-learning field can benefit from the use of visual languages to simplify the work of an instruction designer. To this sake, in this chapter we have presented three visual languages for defining several stages of the e-learning course design process. The languages have been implemented within SEAMAN, a prototype that has been conceived to allow instruction designers to generate friendly learning environments and enhance their welfare. Experimental results have shown that the use of visual languages can encourage the design of distance courses, as opposed to what happened before with tools using more rudimental interaction paradigms.

We also carried out a usability study of SEAMAN using five lecturers at University of Salerno as subjects. The subjects used the SEAMAN system to produce a complete electronic version of their course. In particular, they have redesigned the following five courses from bachelors' degrees related to computer science: Programming Language Technologies, Databases, Discrete Mathematics, Fundamental of Physics, and Business Administration. All the lecturers underwent an introductory course of six hours on the SEAMAN system and its visual notations. After that they were asked to use the system on their course, having the possibility to invoke individual tutor support. Once they had

completed the design of their course with SEAMAN they were asked to fill in a questionnaire to provide feedbacks on system usability issues. In particular, other than the course name and the lecturer familiarity with diagrammatic languages, the form contained the following three categories of questions: intuitiveness of language symbols and visual sentences, training and usage times, and comprehensive tool evaluation with respect to well-known authoring tools.

In general, we noted that familiarity with diagrammatic notations seems to facilitate tool usage. We also observed that non-computer science professors had more difficulties on the LAD language than on the other two visual languages. Probably, this was mainly due to the fact that although workflows should be familiar in business and many other disciplines, mapping the concept of activity synchronization on real-world problems is not immediate. Moreover, the discrete mathematics professor also had some difficulties on the definition of assessment and self-assessment tests with the TML language. More specifically, she found some problems in understanding the meaning of the true, false, and any joint links, and how they affect the test behaviour at run-time. In conclusion, the SCLO language was the easier to understand and use,

whereas the LAD required some effort for people non-familiar with activity diagram notations. The hierarchical visual language organization appeared to be grasped quite intuitively by all of the lecturers. Regarding the time necessary to enter a visual sentence in SEAMAN this mostly reflected the familiarity with the given notation, although most of the lecturers took reasonable times. Finally, looking at the feedbacks of questions in the third group, it seemed that the use of visual languages in SEAMAN makes e-learning process creation somewhat easier as opposed to traditional authoring tools, and that all of the lecturers involved in this experiment expressed the possibility of using the SEAMAN prototype in the future.

Future work will be devoted to extend the visual languages proposed in this chapter. This has a two-fold goal. On one hand, we aim to introduce less technical and more metaphor oriented visual languages to provide further abstraction in the e-learning design process, and consequently increase system usage among non-technical teachers. On the other hand, we aim to extend our visual languages in order to enable the modelling of additional aspects of the e-learning process. Special interest deserves the specification and the realization of collaborative activities, in order to encourage cooperative and problem-based learning (Laister & Koubek, 2001). In this way groups of students can work together to solve problems, while keeping their diversities. As a result, the learning environments will encourage individual accountability, prompt feedback, and high self-expectations.

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Chapter 3.15

coUML: A Visual Language for Modeling Cooperative Environments

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ABSTRACT

In this chapter we present coUML, a visual modeling language for cooperative environments. As modern instructional environments have a highly cooperative nature, coUML is proposed as a powerful and effective language for modeling instructional designs in such environments. Being based on UML, it was conceived and refined through application and experience over multiple years, primarily in a cooperative blended learning environment. We present relevant requirements and applications that contributed to the development of coUML, as well as a detailed specification of model elements, characteristics and features that describe its current state.

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INTRODUCTION

This chapter presents the coUML approach to modeling of cooperative learning designs and environments. coUML stands for “cooperative UML.” Its notation is based on UML, and it extends UML with a modeling profile specifically designed to enable the modeling of complex, cooperative learning environments. While coUML clearly focuses on process modeling in cooperative environments, it also allows modeling and integrating relevant structural information such as goals, documents, and involved roles.

While the name “coUML” was coined during the preparation of this chapter, initial ideas and uses of the coUML language date back to 2002, when we were starting an initiative to discover and

document the e-learning practices at our department. During this project the coUML modeling approach proved to be a valuable aid in creating visual models of our teaching and learning activities for documentation, communication, research, and dissemination purposes. The complete and user-friendly specification of coUML in this chapter along with illustrations and examples, is provided to make this approach available to interested readers and practitioners.

The chapter is structured as follows: In the next section we provide some background information on the roots and requirements of the coUML approach. In the third section a detailed specification of the coUML language is provided, illustrated with examples. In the fourth section we present three application scenarios of coUML. This is followed by a discussion on the coUML features and the presentation of a survey on visual instructional design modeling languages among blended learning experts. In the final section we present a conclusion and an outlook on further coUML-related activities.

THE COUML APPROACH

Background

The coUML approach emerged from practice (cf. Derntl & Motschnig-Pitrik, 2005). About 4 years ago, we were searching for a way to capture our teaching and learning designs. Our primary approach to designing the instructional processes for our courses was based on the principles of blended learning (Garrison & Kanuka, 2004). As a traditional university we build on face-to-face meetings in the courses, and we have gradually started introducing online and distant means of collaboration, evaluation, and delivery into our teaching and learning activities. The goal then was to build a comprehensive library of blended course designs or patterns including verbal descriptions and semi-formal models of scenarios

that were already in use at our department. As no visual modeling language was particularly suited for such a task, we started to employ the following simple procedure: First, we write down a verbal description of a course and its activities, including an outline of relevant teaching and learning goals, and the primary teaching approach employed (e.g., project-based learning). The second step is to visualize the course scenario as one or more threads of activities according to the course description. Initially, we used simple symbols for drawing activities and arrows as connectors between activities. Gradually the notation system evolved from requirements drawn from practice and experience, and was finally based on a more formal, standardized notation system. Additionally it was apparent that the current wave of Web-based tools and enhancements not only penetrated educational environments, but any environment where people cooperate to achieve personal and organizational goals, e.g., in projects or communities. Therefore we present coUML as a language that is rooted in, yet not constrained to educational environments.

Requirements and Need

It was clear that a course was, conceptually, not just a sequential thread of activities; we would need additional control-flow structures such as decisions, concurrent flows, and composite activities. We were also interested in a number of additional, instructionally relevant information to be included in the visual models of teaching and learning activities, which are outlined in the following list of requirements:

R1: *Support for logical/temporal arrangement of activities, as well as decisions and concurrent activities.*

R2: *It should be possible to model activities at different levels of detail, which requires a means of refining composite activities. This should allow*

multiple views on complex activities and help to keep the models clear and understandable, even though this introduces layers of abstraction which might be difficult to grasp for many people.

R3: *It should be possible to attach roles to activities, for example that online chat support for urgent questions is provided by a student tutor and consumed by course participants.*

R4: *Most learning activities “consume” and/or “produce” documents (Web sites, reports, slides, evaluations, data, etc.); modeling and visualizing that information would help in document management efforts mostly on the side of the instructors and administrators.*

R5: *It should be possible to model the learning goals planned for a course, in order to show which activities in the learning process are “responsible” for supporting and achieving certain goals.*

R6: *As we are interested primarily in modeling blended learning course designs, we need to tag activities as proceeding in a present (i.e., face-to-face), Web-based, or blended mode. The rationale behind this distinction is explained later in the language specification.*

Language Choice

An existing modeling language that immediately supported all our requirements was not readily available. While there were a number of languages available which would support the basic control flow requirements (R1 and R2), only UML provided additional built-in support for R3 and R4. Additionally, UML offers extension mechanisms to define custom model elements, e.g., based on the modes of presence defined in R6, or learning goals according to R5; for this purpose it was necessary to define a UML extension for modeling blended activities, as specified in the following section.

COUML LANGUAGE SPECIFICATION

In this section, the coUML language and its usage is specified in detail. First, we outline and describe modeling artifacts created with coUML, and then, building on basic UML prerequisites, we define the model types and elements used by coUML.

coUML Modeling Artifacts

Using coUML to model a course design produces a number of artifacts, i.e., models and additional information. These are separated into *primary*, *secondary*, and *auxiliary* artifacts, as described below. The procedures taken and the modeling “toolkit” to understand and create these artifacts are described in detail in subsequent sections.

Primary Artifacts

Course activity model (CAM): The primary modeling artifact of coUML is the *course activity model (CAM)*. It comprises a number of activity diagrams showing the course’s activities from any desired viewpoint. The CAM aims to provide expressive diagrams showing the chronological order as well as the intent of activities (usually both teaching and learning activities) of the course. coUML allows modeling the CAM diagrams at different, arbitrary levels of detail, which might be helpful with complex course designs.

The CAM is the core of the coUML course model—it can be used to model complete and planned course designs, but it can as well be used to model specific course phases during the course design stage. As such, it can be used as a communication and documentation medium among course designers; by instructors as a handy guide to the conduct of the course; and also by researchers as a conceptual model of the course, e.g., for evaluation or analysis purposes.

Course structure model (CSM): Particularly for modeling complex course designs, another primary artifact is needed, which is the *course*

structure model (CSM). The CSM is created and maintained concurrently with the CAM, as it shows structurally which activity diagrams are used in the CAM to provide a comprehensive course model.

Readers might notice that the CSM—as a complement to the CAM—is not necessarily a mandatory artifact of a coUML course model, as CAM diagrams are still valid without the CSM. However, the CSM acts as an overview or entry point to the CAM, and is therefore also considered a primary artifact, especially from the reader’s or viewer’s points of view.

Secondary Artifacts

The secondary coUML artifacts as listed below are used to complement the primary artifacts. These complements can optionally be created to provide additional, more detailed information regarding the following:

Roles: Activities in the CAM are performed by persons taking over specific roles in the course. Typical roles would be instructor, student, or tutor. The role model displays the roles involved, and optionally how they are related with each other. Additional textual information regarding the roles can be provided in structured form as well.

Goals: From an instructional point of view, course activities are designed to achieve specific learning goals. coUML offers the option of creating goal models, which explicitly depict learning goals and, if desired, their relationships with each other. This allows systematically breaking down overall course goals into more tangible, readily achievable learning goals; these in turn can be attached to activities in the CAM to show which activities are intended to support or achieve a goal.

Documents: Instructors typically provide documents and resources as input to learning and teaching activities, and during these activities additional documents and resources might be created or contributed by course participants. To account for this fact, and to provide an overview of which documents and resources are to be provided and

created, coUML enables modeling of all relevant documents. These models can be used to structure and describe the documents and to connect roles with documents, showing the document providers and consumers.

Auxiliary Artifacts

Course package model (CPM). The CPM is intended to provide condensed information regarding the course, so to say its “fact sheet.” It includes a tabular overview of relevant course parameters, and a model comprising a view of all model packages used for modeling the course. This can be used as an “entry point” to the detail models provided for the course, i.e., roles, documents, goals, CAM, and CSM. It is recommended to create the CPM, as it supports easier usage of and navigation in the course models. However, the fact sheet and model overview are auxiliary and thus optional artifacts.

coUML Modeling Procedures

The coUML modeling procedure to be employed heavily depends on the planned intent of the models and on the concrete ID process for a course, particularly on the current course design status and the desired level of modeling detail. coUML offers a number of features and artifacts for which there may be no use in certain stages of the course design process. For instance, for some courses there might be no explicit information available or needed regarding documents. coUML is flexible enough to separate concerns and allow for detached as well as integrated modeling of such course design artifacts.

There is no particular default procedure for creating a comprehensive coUML model of a course. In the following, we discuss two common usage examples and respective procedures.

Modeling a completed course design: The most straightforward use of coUML is for completed course designs. For example, these models

could be used as a “contract” between course administration and instructors; or as a structured course documentation by instructors and instructional designers. In such cases, there exists a verbal or textual description, or at least a consensus, on the design of a course. It could as well happen that the course to be modeled was finished already. Hence, all available coUML modeling features can be exploited in a chronological procedure, which could look like the following:

1. Create the CAM as the primary artifact.
2. Create role-, goal-, and document models according to available information. Leave out or complement missing information.
3. If desired, refine or complement the CAM to include the secondary artifacts defined in step 2.
4. Create a CSM for the final CAM.
5. Create the CPM by identifying relevant course parameters and providing an overview model.

Modeling design-in-progress: coUML can also be used as a tool during the course design stage, e.g., as a more formal communication “language” among instructional designers, or as a personal aid for instructors during course planning and design. In such cases, the steps outlined in the above procedure can typically not be taken in strict chronological order, as working on a later step may require the refinement of artifacts created during an earlier step. Also, optimal and complete information is usually only available for complete (finished) course designs. If coUML is used during the course design process the procedure taken could look like the following: modeling roles, then CAM, CSM, documents, goals, revision of the CAM and CSM, and finally creating the CPM. As we see, there is no use for a standard procedure in the design-in-progress case, even though the primary artifacts such as the CAM and CSM would likely be the first to be created. For

a given design task it might even be sufficient to experiment with the CAM only.

As an example of the design-in-progress case, we want to show how coUML could support the ADDIE process model. ADDIE defines a simple and frequently used ID process comprising the phases: analysis—design—development—implementation—evaluation. The following list shows how coUML could be used as a “generative” tool for supporting the five phases of the ADDIE model:

1. **Analysis:** In this phase, an initial “map” of the course is created by addressing issues such as characteristics of the learners (e.g., their previous knowledge), desired learning outcomes, delivery options and tools available, suitable pedagogies and strategies, and course objectives (e.g., curricular requirements). With coUML, the analysis results can be written down in the fact sheet provided by the CPM. Initial sketches of involved roles, learning goals, and course/activity structure in the CSM and CAM can be created as well.
2. **Design:** During the design stage the course and learning objectives are elaborated in detail, the course structure and activities are designed in detail, relevant course material is collected and structured, instructional strategies are developed, and the evaluation/assessment strategy is specified. coUML can help in this phase with the learning goal models for course and learning objectives, the document model for specifying and structuring course content, and the CSM and CAM for modeling course structure and activities. Integrating coUML secondary artifacts (goals, documents, roles) into the CAM may further facilitate course design.
3. **Development:** For the development of the course content and support systems the coUML models created in the previous model represent a comprehensive documentation of the design; they can be used as a “con-

tract” among developers and instructional designers.

4. **Implementation:** In this phase, a training and delivery plan is developed. The coUML models, in particular the CAM and also the document model, show the crucial points in the instruction to be considered for training and preparing instructors and students, as well as for provision of required tools and learning material.
5. **Evaluation:** coUML models can be used as visual documentation of the whole ADDIE process and thus inform formative evaluation procedures. Summative evaluation procedures can, for example, be supported by the CAM and learning goal models (e.g., for matching actual learning outcomes with learning goals).

UML Prerequisites

Before approaching the specification of coUML model types and elements, we first introduce the relevant model types and elements of UML, upon which all coUML modeling artifacts are based.

UML is a conceptual modeling language that was primarily conceived for modeling static and dynamic aspects of software systems. It was standardized by the Object Management Group (OMG; <http://www.omg.org>) in 1997 and its current version is 2.0. In the past decade it has been established as the “lingua franca” in computer science. It does not explicitly rely on any particular software design process, nor is it restricted to modeling computer systems and software systems. It also offers extension mechanisms that allow modelers to define their own model types and modeling elements, both formally and visually. Hence, UML allows modeling static and dynamic aspects of any system or concept.

UML in its current specification offers about a dozen different model types, of which we only need two, namely activity diagrams and static structure diagrams (commonly referred to as

“class diagrams”). These two model types and their respective elements provide the basic syntax and semantics of all coUML models. Therefore the following sub-sections briefly introduce these model types and their uses for creating coUML modeling artifacts. Understanding these basic UML model types is required for understanding coUML modeling artifacts, which are specified in detail in the coUML specification section below.

All readers who are already familiar with or interested in UML please note that we do not define a full, formally correct UML extension profile in this chapter. This would require including lots of technical background on and references to UML meta-model and semantics, which would contradict the intended practical nature of this chapter. Therefore all relevant coUML model elements and extensions are introduced and described first and only when needed, that is at the point where the respective coUML model types and elements are explained. Also, UML elements and features not needed by coUML are ignored in the following introduction.

Static Structure Diagrams

A static structure diagram, commonly referred to as “class diagram,” is a model type used to build the static structure of a system’s analysis or design model by primarily modeling *classes* and their *relationships* (Eriksson & Penker, 1998). A class is a structural element that represents a concept of the application area as it models a set of objects with shared properties and behavior. For instance, all students share some common properties like postal address, date of birth, attended courses, etc., as well as some common behavior like moving to a new address, attending courses, taking exams, and so on. The class representing these properties and the behavior of persons would be “Student”. Each student would be an *instance* of this class, with concrete values for each property. In UML a class is visually represented by a solid-outline rectangle carrying the name of the class (see Figure 1).

Figure 1. Class “Student”



Classes, or the concepts that they represent, may maintain relationships with other classes. The most important relationships, which are also relevant for coUML, are:

- **Association:** Describes a shared relationship among instances of classes connected through the association. Visually, an association is drawn as a solid-line path between two classes. For example, students can be related to courses they attend; this would require an association relationship between classes “Student” and “Course” (see Figure 2).
- **Aggregation:** An aggregation is a special kind of association representing a part-whole relationship. Thereby, one participating class acts as the aggregate and the other class represents the parts. For example, when each course consists of multiple course units, class “Course” would be the aggregate and class “Course unit” would represent the parts of the aggregate. Visually, an aggregation is drawn like an association adding a hollow diamond at the end of the aggregate class (see Figure 3). On the other end of the aggregation (i.e., at the class representing the parts) the modeler may note the number of parts consti-
- tuting each instance of the aggregate class, either as a range or as a fixed number. So Figure 3 models that a course consists of five course units.
- **Generalization:** A generalization relationship connects a more specific concept with a more general concept. Thereby, the more specific concept “inherits” all features of the more general concept and may add new features. Generalizations are used to (hierarchically) refine concepts. For example, a student is a person and an instructor is a person as well, because both have a date of birth, address, etc., but both may also have special properties which are not common to all persons. Visually, a generalization is drawn as a solid line with a hollow triangle at one end pointing to the more general concept (see Figure 4). The generalization arrow can be verbalized as an “is a” relationship; Figure 4 therefore states that an “instructor is a person” and that a “student is a person.”
- **Dependency:** A dependency constitutes a “weak” association among classes that is usually not structurally relevant to any of the participating classes. For example, a dependency might show that a tutor supports the instructor during a course, which is structurally irrelevant, but still valuable information. Visually, this is depicted by a dashed arrow between involved classes (see Figure 5).

Finally, it is possible to group related model elements together in *packages*. Thereby, a package symbol is drawn around the respective model elements belonging to the package. Visually, a package is drawn as a rectangle with a tab on top of its top-left corner carrying the name of the package (see Figure 6).

Figure 2. Association relationship

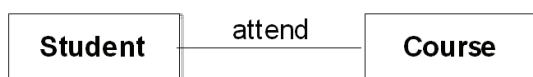


Figure 3. Aggregation relationship



Figure 4. Generalization relationship

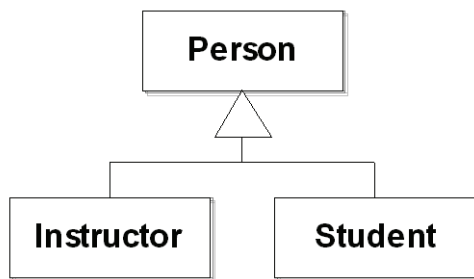


Figure 5. Dependency relationship

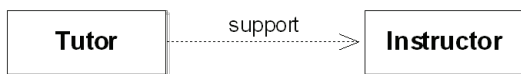
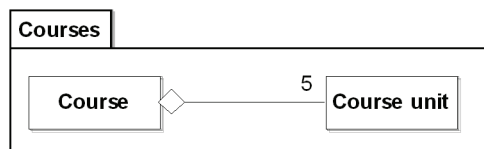


Figure 6. Package



Activity Diagrams

Activity diagrams are used to model the behavior of a system, demonstrating how the objects modeled in the structural model interact dynamically. Mapping this general definition to ID modeling, the target “system” would be the course or instruction to be modeled. In coUML, activity diagrams are used for modeling the course activity model (CAM).

Put simply, activity diagrams mainly consist of *activities*, i.e., states in the process where some action is performed, and directed *transitions*

among activities. After an activity is completed, the outgoing transition moves the current process state to the activity at which the transition is directed. This is to say that activity diagrams arrange activities performed in a process in chronological order. Visually, an activity is drawn as a rectangle with round edges, and a transition is drawn as an arrow (see Figure 7).

There is a special kind of activity which can be used in much the same way as a normal activity; yet it acts as a placeholder for a number of more specific activities. This is called a “*subactivity*”. Subactivities are used to decompose complex activity diagrams into different layers, each with different levels of detail. For example, the subactivity “enroll in a course” would link to a more detailed diagram showing the concrete activities performed by students enrolling in a course, which could be “enter student registration number” followed by “select course” and finished by “confirm enrollment.” Visually, subactivities carry a small icon connecting two circles in the lower right corner (see the example in Figure 8).

Figure 7. Activities and transitions

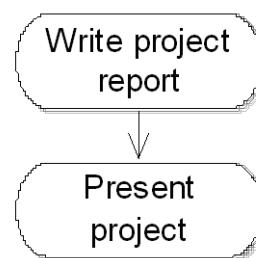
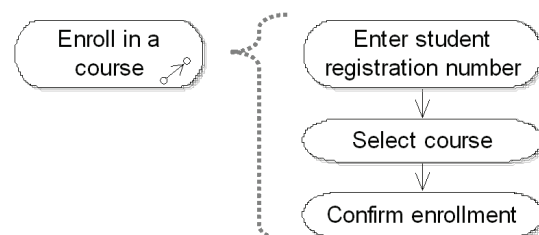


Figure 8. Subactivity linking to a set of activities



There might be points in a process, where the next step has to be chosen among a number of alternative steps. Activity diagrams account for such cases by offering *decision* nodes that can have multiple outgoing transitions, of which exactly one transition will become active depending on conditions defined by the modeler. Therefore, decision nodes split up the flow of an activity diagram into multiple alternative flows. For example, “write project report” is succeeded by a decision offering as alternatives “revise project report” and “present project report” as next steps (see Figure 9). The decision would depend on the quality of the project report. Good reports are approved for presentation, while bad reports need to be rewritten first. Visually, decision nodes are drawn as hollow diamonds. Often, alternative flows offered through decisions need to be joined back together at a certain (later) point in the diagram. This is done by drawing another decision node at that point, this time acting as a *join* node with multiple incoming transitions. In Figure 9, the decision symbol is used both as a decision and a join node at the same time.

Additionally, there might be phases in a process, where various activities need to be done concurrently. For example, students would “work on projects,” and concurrently “use the online discussion forum.” In activity diagrams this is possible by splitting up a transition into multiple concurrent (or synchronized) transitions through a *synchronization bar*. Visually this is drawn as a thick, solid horizontal line. The end of concurrent activities is indicated through another synchronization bar, which continues the process only when all its incoming transitions are active. This means that all concurrent activities have to be completed before the process can continue (see Figure 10).

Finally, each activity diagram has exactly one *start node*, which may carry outgoing transitions only, and at least one *end node*, which may have ingoing transitions only. Visually, a start node is drawn as a filled circle carrying the title or name

of the activity diagram, and an end node is drawn as a hollow circle comprising a smaller, filled circle inside (see Figure 11).

Extending UML Elements

Each existing model element in UML can be *stereotyped* to represent a more specific concept. The stereotype is named after the specific concept to be introduced. Such new modeling elements can be introduced and readily used without much effort. Visually, the modeler can define his/her own graphical representation of the new model element, or he/se can just attach the stereotype name as text within matched guillemets (« ») to the element. This extension mechanism is powerful and highly relevant to our purpose, as coUML derives all special elements from built-in UML elements by adding stereotypes, such as «goal»

Figure 9. Decision among alternative activities

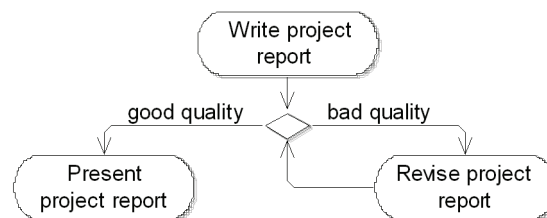


Figure 10. Synchronization of concurrent activities

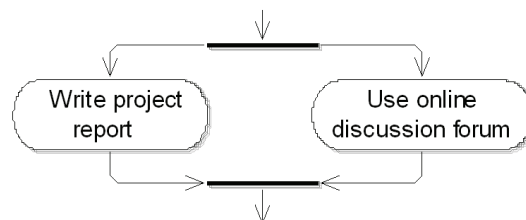


Figure 11. Start node (left) and end node (right)

Web Engineering



to classes in the goal model, or «web-based» to activities in the Course Activity Model. For examples of using stereotypes see the following coUML specification section.

Specification of coUML Model Types and Elements

The following sub-sections specify the model types and elements used for creating the coUML course design artifacts as described earlier. All modeling artifacts are specified using a template consisting of five sections: semantics, syntax, example, modeling procedure, and textual information. Regarding examples we try to illustrate the specified models and elements by using a (simplified) course on Web engineering.

The Web Engineering Course

The Web engineering course (hereafter simply “WE course”) is an undergraduate course in computer science. It consists of seven consecutive course blocks including project-based learning in teams and face-to-face lectures. The lectures are held by an instructor who also coaches the team projects (where he/she is assisted by a tutor). All documents for projects and lectures are managed on a Web-based learning platform.

The seven blocks are organized as follows: After an introductory block, five blocks are dedicated to advancing knowledge and experience in Web engineering through applying techniques and theories presented in the lectures on team projects. This includes Web technology basics, requirements engineering, conceptual modeling, Web data management, and Web programming. The arrangement of these topics allows for completing the projects in an incremental development process. The final course block concludes the course with a grading procedure and a course quality assessment.

More details on the course are introduced as required for the specification of new elements.

Note that in this section we only model those aspects of the WE course required for the introduction of the coUML language elements. A more complete case study on modeling a whole course using coUML is provided in Chapter XVI of this handbook.

Course Package Model (CPM)

Semantics

The CPM shows which primary and secondary coUML modeling artifacts are provided for a specific course design. As such, the CPM acts both as an overview and entry point to all coUML artifacts provided for a course design.

Syntax

The CPM is modeled as a class diagram with one super-ordinate package carrying the course title. This package includes other packages, each representing (a group of) a primary or secondary coUML artifact. No relationships are used in the CPM.

Example

The WE course is modeled using coUML including examples of the CAM, the CSM, and the secondary artifacts. The CAM and CSM are contained in dedicated packages, and each secondary artifact (i.e., roles, goals, and documents) is also contained in a dedicated package. The CPM for this course would look like Figure 12.

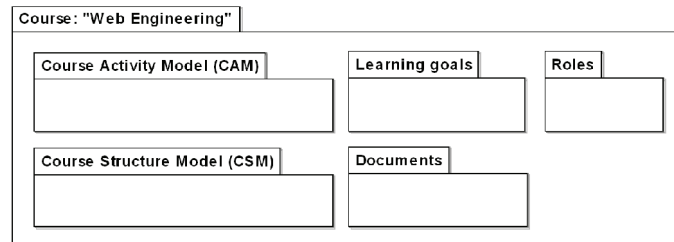
Modeling Procedure

It is easier to model the CPM when all artifacts are already known and available. However, the CPM may also represent the planned or in-progress state of artifacts. In this case, the CPM would have to be updated if any artifact is added, removed, or renamed.

Textual Information

The CPM is complemented by the course’s “fact sheet” including relevant course parameters. This

Figure 12. CPM for the Web engineering (WE) course



can be used as a quick overview of course facts by course designers, teaching staff, and even students. The fact sheet is presented as a table comprising two columns: parameter and description. The head row of the table shows the course name, and all subsequent rows include relevant parameters in the left column and their respective values in the right column. We propose the following set of parameters, which may be reduced or extended according to specific needs:

- **Summary:** A short summary of the course content and intent.
- **Structure:** A description of the structural organization of the course, e.g., division into multiple blocks with dedicated topics, or weekly lectures, etc.
- **Mode of presence:** Indicates whether the primary mode of presence in the course is face-to-face, online, or blended.
- **Online support:** Lists available online tools and resources, such as course Web sites, learning management systems, etc.
- **Participants:** How many and who are the participants?
- **Teaching staff:** Teaching staff involved in the course, such as instructor, supervisor, tutor, external guest, etc.
- **Instructional strategy:** Description of main instructional strategy employed in the course, such as project-based learning, case-based lab practice, etc.
- **coUML models:** A list of coUML models or artifacts provided for the course design.

Table 1 shows a brief fact sheet of the WE course.

Models for Roles

Semantics

The model for roles is intended to depict roles involved in a course. As a secondary artifact, the role model is created only if deemed to be of significant use to the design team. There are considerable benefits of modeling roles: First, each role must carry a clear and unique name, which facilitates communication and understanding. Second, they can be used as additional information in the document model and the CAM. In the document model, roles are represented as providers and consumers of documents, while in the CAM the roles are used to show areas of responsibility in the course phases and activities. On the other hand, if roles are used in the document model or the CAM, the model of the role must be provided to maintain the internal consistency of the models. In either case, modeling roles requires additional effort and also adds to the complexity of the overall coUML model.

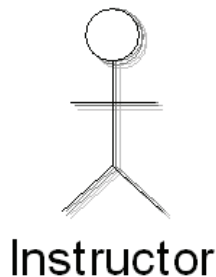
Syntax

Roles are modeled in class diagrams. Technically, a role is represented by a class with stereotype «role». We define our own custom visual representation for this, which is a stick-figure with the role name written below it (see Figure 13; UML experts may note that we reuse the built-in UML

Table 1. Fact sheet of the WE course

“Web Engineering”	
Summary	Integrated lecture and lab course in computer science, held in a blended mode. Relevant Web engineering theory and techniques are presented by the instructor and applied hands-on by the students their team projects.
Structure	The course comprises seven consecutive blocks; each block is conducted in a blended mode integrating face-to-face and online activities.
Presence mode	Blended face-to-face and online
Online support	A Web-based learning platform is available; any required tools for projects are available in the laboratory.
Participants	Twenty undergraduate computer science students with basic knowledge in computers, Internet technologies, and computer programming
Teaching staff	One instructor, one tutor
Instructional strategy	Lectures and project-based learning using a blended learning approach. Projects and subject matter are elaborated in a stepwise, incremental fashion (synchronized with theory input during the lectures).
coUML models	CPM, CSM, CAM, roles, learning goals, documents

Figure 13. The “Instructor” role



actor symbol). Packages may be used to group related roles together.

The following relationships are possible between roles:

- **Aggregation:** Means that each instance of the aggregate role consists of a number of instances of the other role. A typical example would be the “team” role that aggregates the “student” role in the sense that each student team consists of a number of students (see Figure 14 showing that each team comprises four students).
- **Generalization:** This means that a more general role is refined by more specific roles. The more general role provides structural and/or behavioral elements for

each specialized role. For example, there might be activities in a course where both instructor and student roles actively participate; these two roles could then be generalized through a “participant” role (see Figure 15). Consequently, if the participant role is partaking in any course activity in the CAM we implicitly know that both instructor and student roles can be involved.

- **Dependency:** A dependency relationship between two roles indicates that one role supports the other role in course activities. For instance, the tutor role typically supports the instructor role, which is modeled as a dependency carrying the stereotype «support» (see Figure 16). While coUML only specifies the «support» stereotype, the modeler may introduce additional stereotypes as needed. Modeling dependencies among roles is optional; usage of this feature might increase the informational content of the role model, but it also tends to overload the model.

Optionally, roles and role hierarchies can be divided into multiple packages in one or more class diagrams. For example in a more complex role hierarchy it might be useful to separate teach-

Figure 14. Role aggregation

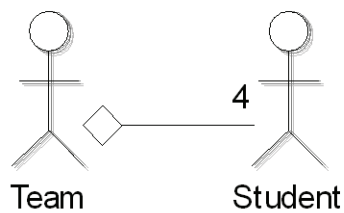


Figure 15. Role generalization

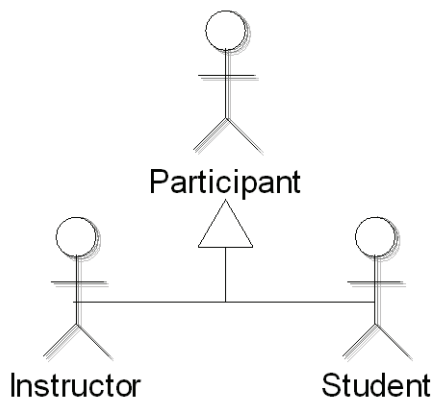


Figure 16. “Support dependency” between two roles

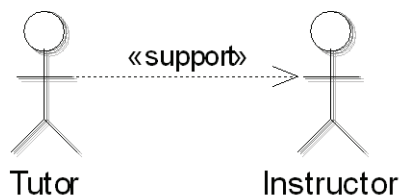
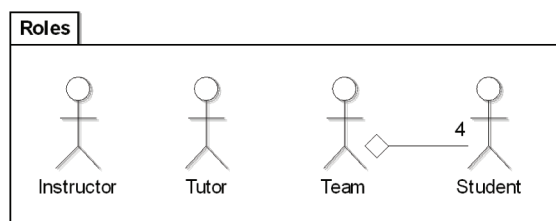


Figure 17. Role model of the WE course



ing roles from learner roles. The decision on this is left to the modeler (see the remarks for “modeling procedure” below).

Example

In the WE course, active roles include the instructor, the tutor, and students. Additionally, we identify the “team” role: In the first session, students are organized into teams of four to work on their web engineering projects for the rest of the course. Therefore, the team role is modeled as an aggregation of the student role. At the student role end of the aggregation, the number “4” indicates that each team consists of four students. Activities performed by the team role for one of the WE course blocks can be seen in the CAM example (see Figure 42).

Modeling Procedure

Identifying the roles for a course is straightforward. Most courses involve at least the instructor, student, and tutor roles. It might be easier to identify roles after the first attempts to model the CAM diagrams, as it makes little sense to conceptually define a role which does not partake in any course activity. Also, with most or all course activities available, identification of participating roles is easier.

As coUML makes no assumptions on role granularity, it would also be possible to refine the role hierarchy into greater detail according to the activities in which they partake. For example the student role could be split up into more specific roles that students take on in different activities. Consider the peer evaluation of student projects: the “student” role could be divided into a “project-contributor” role and a “peer-reviewer” role. The final decision on the granularity of the role model is left to the modeler, however with the advice that fewer roles are clearly easier to handle.

Textual Information

The role model is complemented by a tabular description of the roles. The two columns of the

table expose the role name and a short description for each role. For example the role description for the tutor in the WE course would be, “Supports the students and the instructor during various activities, e.g., facilitating/helping project teams, collecting documents from students, maintaining the online content, seeing through online activity, etc.”

Goal Model

Semantics

The goal model can optionally be used to explicitly model and describe learning goals as well as their relationships with each other. Like the role model, the goal model is considered as a secondary modeling artifact that can be omitted if not needed. However, this model is useful as a tool to explicitly name and relate goals with each other. The modeler is free in setting the focus for the goal model, which means that coUML does not suggest any underlying taxonomy (e.g., Bloom’s taxonomy of learning goals—cf. Bloom, 1956), nor any other assumptions about the learning goals. Nevertheless, coUML allows assigning priorities to learning goals.

If the modeler decides to create this model, the learning goals can subsequently be used as additional content in the CAM, where activities can be connected to learning goals. This is useful for showing which activities support or achieve which learning goals.

Syntax

Goals are modeled in class diagrams. Each goal is drawn as a class with stereotype «goal» above the learning goal name. Additionally a goal identifier (ID) can be placed in the top-left corner of the class symbol, allowing referring to a goal by its ID (can be a number, an acronym, etc.), which is typically shorter than its name. To avoid introducing yet another icon, we reuse the already known class symbol and restrain from defining our own icon for goals (see Figure 18).

Figure 18. Learning goal “Understand basic Web technology” having ID “7”



Note that some existing goal modeling approaches use the UML use-case symbol for modeling goals, while others use stereotyped class symbols. For coUML we preferred to use the latter option as we consider goals as being structural elements; use cases on the other hand are behavioral elements typically used to represent interactions (or events) preformed by users and the system to achieve some goal. With coUML the achievement of goals can be modeled in the CAM.

Goals are modeled in packages and it is also possible to group related goals together. This is achieved by placing the respective goals inside a grouping box, which is drawn as a rectangle with an attached name for the goal group (see Figure 19).

It is possible to assign priorities to goals, if desired. There are several options of doing so: we could attach a text note to the goal that defines its priority (e.g., “Priority 1”); we could group together learning goals belonging to the same priority by using a grouping element like the one in Figure 19; or we could create a diagram consisting of vertical layers, where each layer represents one priority level. The choice is left to the modeler.

The following relationships are possible between goals:

- **Aggregation:** Means that the aggregate goal is decomposed into a number of smaller, typically more concrete goals. Thereby, the aggregate goal is considered

Figure 19. Grouping of cognitive learning goals in the WE course



as achieved after all its sub-goals have been achieved. Figure 20 shows an example of goal aggregation in the context of the WE course. Goal 1 can be achieved by achieving all of its sub-goals 2, 3, and 6.

- **Dependency:** A dependency relationship between two goals indicates that one goal plays a role in achieving or supporting the other goal. Dependencies may be stereotyped to express the particular type of dependency between two goals. The following two stereotypes are defined by coUML (note that this list can be extended according to the modeler's needs):

1. **«require»**, meaning that a goal requires another goal to be achieved first. For example to achieve the learning goal “Implement an application concept in teamwork” in the WE course requires the goal “Understand Web script programming” to be achieved first, as one cannot reasonably implement a Web application without being familiar with Web programming (see Figure 21).
2. **«support»**, meaning that working towards a goal supports the achievement of another goal. This could be interpreted as a weak, inverse form of «require». We could modify the example above to state that Web script programming supports implementation of application concepts, which could also be argued in certain cases (see Figure 22). We see that the choice of dependency relies on the modeler's es-

timation of the real relationship among two goals, so multiple interpretations are possible.

- **Generalization:** This means that a goal is refined by more specific goals. This is an advanced feature which can lead to more confusion than to better understanding among novices. However, generalizing goals is also a powerful concept, as the general goal can be used to provide shared properties for multiple sub-goals: If, for example in a course on writing research papers, learning goal *A* (“Writing research papers”) is a generalization of learning goals *B* (“Writing case-study papers”) and *C* (“Writing empirical papers”), then each relationship that *A* maintains with other learning goals (e.g., with learning goal *D* – “Structuring of research papers”) is inherited by both *B* and *C*. So if *A* requires *D* to be achieved, then *B* and *C* require *D* as well (see Figure 23).

Figure 20. Goal aggregation

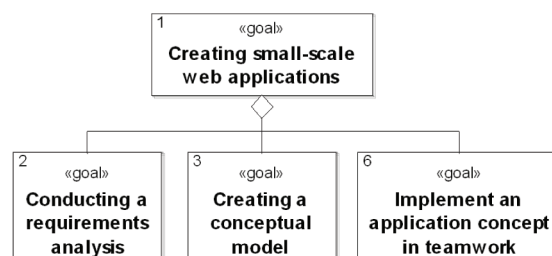


Figure 21. “Require dependency” between two learning goals



Figure 22. “Support dependency” among two learning goals

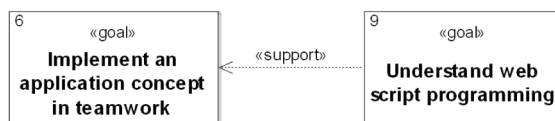
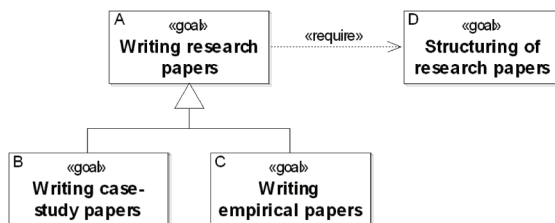


Figure 23. Generalization of goals

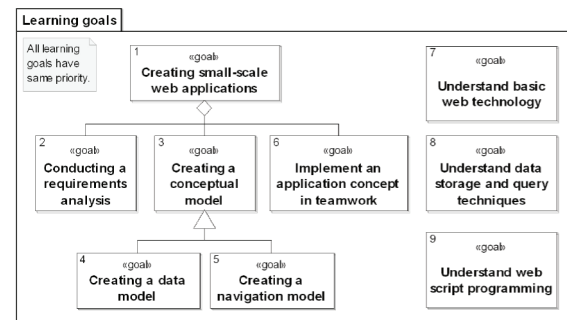


Like the role model, the goal model can be divided into multiple packages in one or more class diagrams.

Example

Figure 24 shows the goal model for the learning goals of the WE course. Consider a list of learning goals specified textually by the instructor: To create our goal model, we provide a short name and attach a numerical ID for each relevant. Additionally we include the information that goal 1 is an aggregation of goals 2, 3, and 6, and that goals 4 and 5 are generalized by goal 3. While these relationships might not explicitly be stated in the textual description of the learning goals, the modeler should try to identify the most appropriate representation for goal relationships.

Figure 24. Learning goal model for the WE course



Modeling Procedure

If learning goals are available in structured text form, they can be modeled by identifying relevant learning goals, assigning a short name and an optional ID, and finally – if considered useful – by modeling relationships among goals.

There might be no explicit textual description available for many courses, especially in early design stages. In such cases it would be reasonable to think about and specify learning goals textually and proceed with modeling. If it is not intended to explicitly write down learning goals, it is valid to omit the goal model altogether, or to try to extract the goals from the course activities or other available course information.

Textual Information

The goal model can be complemented by a tabular description of the goals. The two columns of the table expose the ID or the name of the goal and a more detailed description, respectively. See the case study in Chapter XVI for an example.

Document Model

Semantics

The document model shows a structured overview of all documents that are created, provided, and/or used in a course. Moreover, it is possible to show for each document: who are the providers and who are the consumers. This is achieved by

connecting roles from the role model to documents in the document model.

The obvious benefit of creating this modeling artifact is that it is easy to identify, for example, which documents have to be created prior to the course, which documents have to be provided by teaching staff throughout the course, which documents are produced by students, or which resources are generally available. Creating a document model can provide substantial support in the tedious, yet indispensable task of document management in a course.

As we will show in the specification of the CAM, modeling a document model subsequently allows connecting documents with activities in the CAM, to show which documents are input to and output from activities.

Syntax

The document model is provided in class diagrams. Each document is drawn as a class with stereotype «document» above the document name. No special visual icon is defined for documents. Similar to the goal model, a document ID can be placed in the top-left corner of the class symbol, allowing referral to a document by its ID (see Figure 25).

Documents are modeled in packages and it is possible to group related documents together, for example document resources for student projects. This is achieved by placing the respective documents inside a grouping box (see Figure 26) in the same way as in the goal model.

The following relationships are possible between documents:

- **Aggregation:** Means that the aggregate document consists of a number of sub-documents. Figure 27 shows an example of document aggregation in the context the WE projects. The final project report consists of the sub-documents: project assignment, project plan, and project results. The project report is created at the end of the

course, after all sub-documents have been written.

- **Dependency:** A dependency relationship between two documents indicates that one document plays a role in the provision or usage of the other document. Dependencies among documents may be stereotyped to convey the particular type of dependency. Only one stereotype is suggested by coUML (note that the modeler may introduce additional stereotypes as needed): «require», meaning that a document requires another document to be available before it can be provided or used. A typical example would be written feedback: One can only provide feedback on a project report when the project report is already available (see Figure 28).

It is possible to use a dependency to connect a role defined in the role model with a document and vice versa. This would indicate the “*document flow*” among roles. Note that this is modeled without assigning a stereotype to the dependency.

Figure 25. A case study document on requirements engineering carrying ID “RE 2”

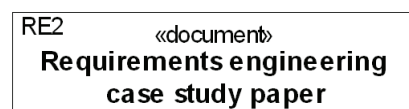


Figure 26. Grouping of project resources

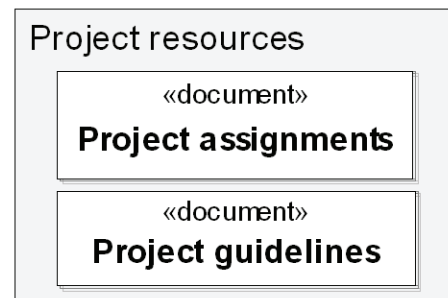


Figure 27. Document aggregation

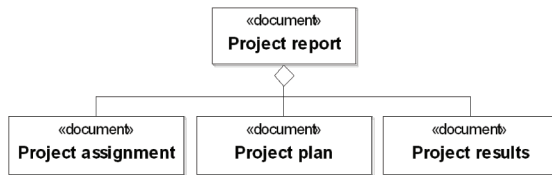


Figure 28. “Require dependency” between two documents



Depending on the direction of the dependency, the following intents are served:

1. A unidirectional dependency pointing from a role to a document means that the document is provided or created by a person embodying that role (see Figure 29).
2. A unidirectional dependency pointing from a document to a role means that the role uses this document for some purpose. So, persons embodying that role are addressees or consumers of the document (see Figure 29).
3. A bidirectional dependency between a document and a role means that the role acts as both provider and consumer of the document (see Figure 30). This constitutes an integration of the two unidirectional cases above.

Like the role model and the goal model, the document model can be divided into multiple packages in one or more class diagrams.

Example

A part of the document model of the WE course is given in Figure 31. It shows which documents are used and created in the third course block (“Block 3: Requirements engineering”): It is apparent that the instructor provides most of the documents,

except the requirements specifications which are created by the project teams and submitted to the instructor.

Modeling Procedure

Documents can be identified by studying the textual course description and particularly by analyzing course activities with respect to their input and output documents. Therefore it might be advisable to defer the creation of the document model until after the CAM is modeled. In this case the document model would have to be refined each time the CAM changes its use of documents.

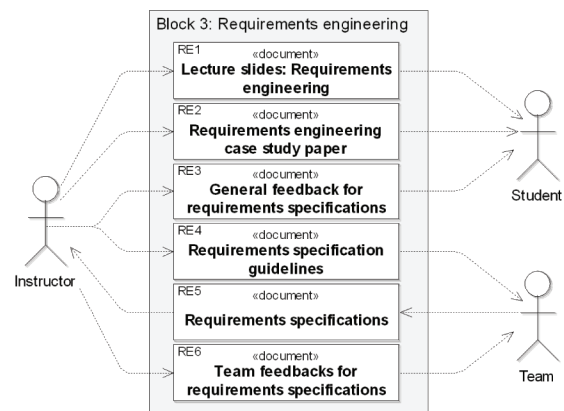
Figure 29. “Document flow” unidirectional dependencies among roles and documents



Figure 30. A bidirectional dependency between the instructor role and a document



Figure 31. Document model for the third WE course block on requirements engineering



Textual Information

A tabular overview of documents is provided as a complement to the document model. Thereby each document can be specified in great detail according to specific needs. coUML suggests at least providing information on the following properties for each document: ID, name, type (e.g., paper, report, Web site, animation, spreadsheet, etc.), description (more detailed information on the content or use of the document), provider (who is responsible for providing/creating the document?), and deadline (a point of time in the course where the document must be available). See the case study in Chapter XVI for an example of a document table. Additional parameters could include: public (is a document available to other roles?), location, online availability, size, already available, and so forth.

Course Activity Model (CAM)

Semantics

The CAM is the primary artifact of a coUML course model. It is used to model the teaching and learning process of a course or instruction. The CAM may provide any number of activity diagrams showing the course activities from any point of view, in any desired level of detail. Its enormous flexibility makes the CAM a very powerful and versatile resource for course analysis, design, and documentation. Moreover, the modeler may reuse secondary artifacts defined in other models and link them to activities in the CAM, e.g., to show which documents of the document model are needed for which activities.

The most basic use of the CAM is for modeling the arrangement of course activities from an organizational point of view, i.e., aligning activities performed by multiple roles in activity diagrams.

Syntax

The CAM comprises a number of activity diagrams. Each activity diagram depicts a phase of a course, or the whole course at a certain level of

detail and from a certain point of view. The level of detail and the point of view are determined by the modeler according to the course activities to be modeled. The following elements are used to model basic activity diagrams:

- **Start Node:** Each activity diagram must have exactly one start node, which acts as the entry point to the “execution” of the diagram. It carries the name of the current diagram, which is usually the course name (if the activity diagram represents the whole course—see Figure 32) or the name of a particular phase or activity in the course (if the activity diagram models only one part of the course). The latter case may be complemented by placing the course name in smaller letters above the name of the current activity diagram (see Figure 33).
- **End Node:** Each activity diagram contains at least one end node, which represents the end of execution of the current activity diagram. This means that each final activity of an activity diagram must be connected to an end node via a transition.

Figure 32. Start node of the WE course activity diagram

Web Engineering



Figure 33. Start node of the activity diagram for block 3 of the WE course

Web Engineering

Block 3: Requirements engineering

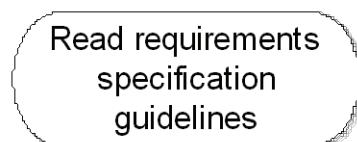


- **Activity:** An activity symbol in an activity diagram represents a state of the execution of the diagram where a specific activity is performed by some role involved in the course. For example, at one point of the course the students have to read a document containing information on the task of creating the requirements specification for their projects. This activity could be modeled as “Read requirements specification guidelines” (see Figure 34). The name chosen for the activity should be meaningful to potential viewers, while keeping in mind that the name should not be too long.

An activity symbol may also be used to represent more than one concrete course activity, which is possible when modeling a diagram at a lower level of detail. Note that, unlike in many other educational modeling languages, in coUML the size of an activity symbol is not related to its estimated or planned execution time. The symbol should just be drawn large enough to accommodate its name. Also, an activity diagram is usually easier to read when all its activities have about the same size.

The modeler may explicitly denote the mode of presence in which the activity is performed, which is either Web-based, face-to-face (present), or blended. This is particularly useful in blended learning environments. With coUML it can be achieved by assigning a *mode-of-presence* stereotype to the activity. The following three stereotypes are defined:

Figure 34. A course activity



1. **«web-based»:** This stereotype means that the activity is primarily performed online, using the Web. It is visualized by filling the activity with light-blue color and by placing the letter “W” (standing for “web-based”) surrounded by a circle in the activity’s right-hand corner. Figure 35 shows an example of the Web-based activity, where requirements specifications for the team projects are submitted online via the Web.
2. **«present»:** This stereotype means that the activity is primarily performed in face-to-face or present mode. It is visualized by filling the activity with light-green color and by placing the letter “P” (standing for “present”) surrounded by a circle in the activity’s right-hand corner. Figure 36 shows an example of a face-to-face lecture activity on requirements engineering.
3. **«blended»:** This stereotype means that the activity is performed in a mixed, blended mode using the Web and face-to-face meetings. This stereotype is visualized by filling the activity with light-red color and by placing the letter “B” (standing for “blended”) surrounded by a circle in the activity’s right-hand corner. Figure 37 shows an example of an activity modeling the blended elaboration of project reports.

Figure 35. Web-based activity

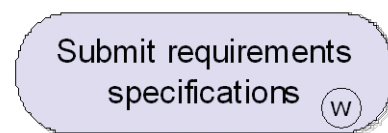
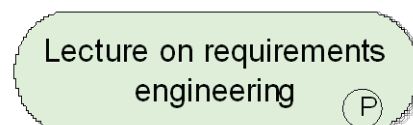


Figure 36. Presence activity

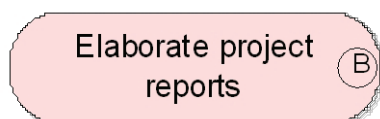


Note that for blended activities the level of detail used in the diagram plays a significant role: At the highest level of detail, blended activities can not be modeled, as each single activity will proceed either Web-based or present. At lower levels of detail, an activity may represent more than one single activity, where presence and face-to-face modes can be mixed. This would make the activity a blended activity like the one in Figure 37. Project reports are elaborated in personal meetings and via the Web by exchanging electronic documents, e-mails, etc., making it a truly blended activity with a low level of modeling detail.

- **Subactivity:** A subactivity is a special kind of activity, which links to another activity diagram. This means that the subactivity represents a number of course activities, which are modeled in more detail in a sub-diagram. Logically, subactivities are only needed when modeling at a relatively low level of detail. The sub-diagram to which the subactivity points, is consequently modeled at a higher level of detail. This means that subactivities are a powerful tool to model course activities at different levels of detail, while providing links between these levels. This supports both the modelers and the viewers, because for example overloaded diagrams can be avoided this way.

Note that for easier recognition the start node of the sub-diagram should carry the name of its parent subactivity. Also note that the modeler can assign a mode of presence to each subactivity in the same way as it is done for normal activities.

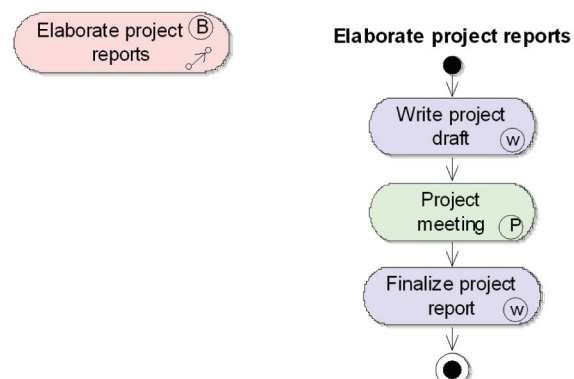
Figure 37. Blended activity



For example, if we want to refine the blended activity in Figure 37 with a sub-diagram showing the concrete activities performed in elaborating project reports, the resulting subactivity and its sub-diagram would look like those in Figure 38.

- **Transition:** As already defined, a transition is a directed connection (drawn as a solid-line arrow) between two nodes in an activity diagram. It can be used to connect activities, subactivities, decisions, concurrencies, and start- and end nodes. A transition maintains the “control flow” in an activity diagram; it becomes active when its source node has completed its actions, and it immediately passes control on to its target node. This allows temporal and logical arrangement of activities and other nodes. For example, the activity diagram on the right-hand side of Figure 38 starts with the activity “Write project draft.” After this activity is completed, the transition becomes active and moves the state of execution to its target activity, which is “Project meeting.” After this, the “Finalize project report” activity becomes active. The last transition is directed at the end node.

Figure 38. Subactivity (on left side) and its sub-diagram (on right side) showing the elaboration of project reports



Through transitions the three activities are arranged in chronological order.

- **Decision:** A decision node (drawn as a hollow diamond) denotes a point in a course where the flow of activities is split up into multiple alternative flows. Exactly one of these alternative flows becomes active. To help decide which of the alternative “routes” to take, each outgoing transition of a decision node carries a so-called *guard condition*. If the guard condition of a transition is satisfied, that transition will become active. A flow split up by decisions can be rejoined later in the diagram by another node which is then called a *join* node that is visually identical to the decision node. Consider Figure 39 for example: The instructor lets students choose whether they want the next course unit on data modeling to be delivered as a lecture by the instructor, or as self-study via the Web. Depending on the preference of students, two alternative activities need to be modeled, i.e., a face-to-face lecture and an online self-study. The following join node reconnects the split flow of activities.
- **Concurrency:** A concurrency is used to model separate activity flows which proceed concurrently with each other. Concurrency has a dedicated start and

end. At the start a single transition is split up into multiple concurrent transitions with a synchronization bar symbol (thick, solid line), and at the end these multiple concurrent transitions are rejoined again with the same symbol. During execution of the activity diagram, at the end of a concurrency the flow can continue only after all incoming concurrent flows are finished. Consider Figure 40 for example. After the “Pick up project assignment” activity is completed, the two activities “Elaborate project reports” and “Keep online project diary” take place concurrently with each other. The end of the concurrency can be seen as a synchronization point: If both concurrent activities are completed, the process can continue with “Submit project report.”

- **Temporal constraints:** It might be necessary or useful to explicitly model time slots or constraints such as deadlines for activities. The modeler is relatively free in the way of adding this information. However, the following is proposed for coUML: Points in time are visualized in activity diagrams by drawing a dotted line with a deadline or other date near the activities to which the deadline is relevant. This feature is used in Figure 42; for example, we can

Figure 39. Decision and join nodes

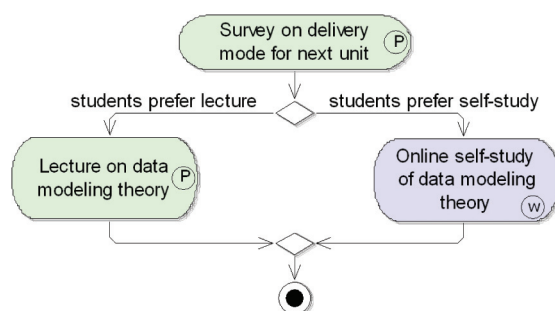
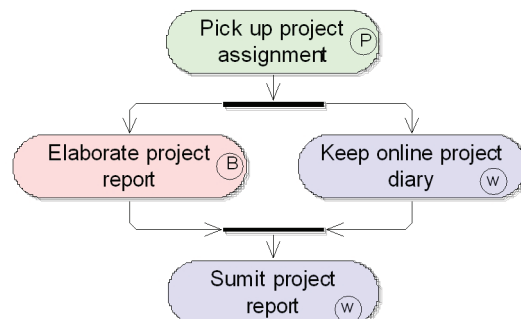


Figure 40. Concurrent (synchronized) activities



see that the submission of requirements specifications by the project teams has to be completed until Sunday in the third week.

Activity diagrams can optionally be extended with elements from secondary artifacts:

- **Roles:** There is a feature for activity diagrams that allows modeling which role is the primary actor in an activity. An area, in which a particular role acts as the primary actor in activities, is surrounded by a so-called “swimlane,” which carries the name of the respective role name. For example, in Figure 42 there are swimlanes for three roles: instructor, teams, and students. Therefore we know that the first activity after the start node (i.e., “Download resources on requirements engineering”) is performed by students. In cases where an activity is performed by multiple roles, the activity can be resized to span or touch multiple swimlanes.
- **Documents:** coUML allows modeling the “document flow” in an activity diagram. To achieve this, simple transitions can be replaced by dashed arrows and an object symbol, which is a rectangle carrying the document name as defined in the document model (if the object represents multiple documents a symbol with two stacked objects is used). The document flow feature is especially useful when a document is direct output of one activity and subsequently direct input to the next activity. For example, in Figure 42, the “Requirements specifications” documents are output of the “Submit requirements specifications” activity and input to the following “Read specifications” activity performed by the instructor. If swimlanes are used for roles, it is a service to viewers to model docu-

ments in the swimlanes of the role or activity that produces the document.

- **Goals:** (Learning) goals can be connected to activities through dependency relationships. In the CAM, learning goals are modeled as objects, just like documents. The name of the object must match the name and/or ID of the goal in the goal model. To explicitly show the specific type of goal dependency, the following stereotypes are suggested:
 - «achieve»: States that the activity achieves a goal.
 - «support»: States that the activity supports the achievement of a goal. This can be considered as a weak form of the «achieve» dependency. See for example Figure 41, where the “Do requirements analysis and specification” activity supports the achievement of the “Conducting a requirements analysis” learning goal.

Interpreting Activity Diagrams

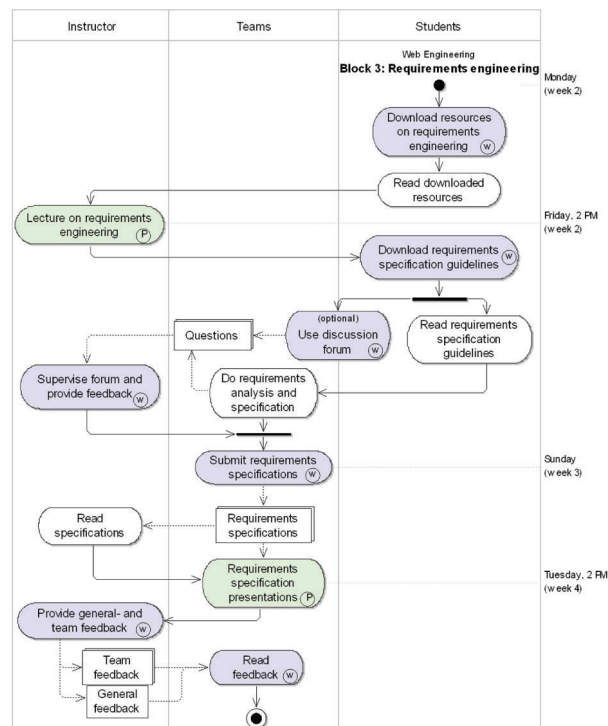
When viewing and trying to interpret an activity diagram, the best approach for novices is to “walk through” the diagram by placing an imaginary execution token at the start node of the diagram. Then, you continue to follow the outgoing transition of the current node, by moving the imaginary token along the transition arrow to the next node:

1. If you reach an *activity* you are at a point of the course where an activity is performed by some role, which can be identified by the containing swimlane of that activity. The

Figure 41. “Support dependency” between an activity and a learning goal



Figure 42. CAM diagram of “Block 3” of the WE course



token remains stationary at this activity until the activity is completed.

2. If you reach a *subactivity*, you follow the (imaginary) link to the activity diagram to which the current subactivity points. The execution token is transferred to the start node of this sub-diagram. After execution of the sub-diagram is finished (i.e., the token reaches an end node), you return the token to the originating subactivity and follow its outgoing transition.
3. If you reach a *decision*, you will notice the multiple outgoing transitions leaving the decision node. It is important that the execution token can only proceed along exactly one of the outgoing transitions. To help decide which outgoing transition to follow, the decision may carry a question to be answered or a condition to be satisfied. Each of the transitions then carries one answer or one possible condition value. You follow the

transition carrying the answer or value that is true/correct for the current token. If you reach a decision node with only one outgoing transition, which represents a join for the most recent decision, you just continue to pass the token along the single outgoing transition.

4. If you reach the start of a *concurrency*, you will also see multiple outgoing transitions. Contrary to decisions, *each one* of the outgoing transitions will become active after the synchronization bar. This can be achieved by splitting the execution token up into a number of concurrent execution tokens matching the number of outgoing transitions. Now place one of the tokens on each transition and concurrently proceed with each token. This concurrent flow of activities is ended by another synchronization bar, which can be recognized by its multiple incoming transitions and only one single outgoing transition.

At this point, you wait until each part token of the previously split-up execution token arrives at the synchronization bar. After the last token has arrived you rejoin the tokens and continue with one single token along the path of the synchronization bar's outgoing transition.

5. If the current transition you follow represents a *document flow* (i.e., a dashed arrow) you pass the token along the document flow, move it past the document node (at this point you know that the current document was produced by the previous activity), and finally on to the following activity or activities.
6. If the current activity node carries an outgoing *dependency* to a learning activity, you know that this activity supports or achieves the respective learning goal. For the execution token, these dependencies can be ignored, i.e., they just provide additional information to the viewer.

Example

Figure 42 shows the activity diagram of the CAM for block 3 of the WE course. Three roles are involved (the *instructor*, the project *teams*, and the *students*) in this blended course block. The temporal constraints also show important points in time during the two weeks covered by the diagram.

Modeling Procedure

Initial attempts at the CAM can be made while ignoring secondary artifacts like documents or learning goals. As an initial step, relevant activities should be modeled at a low level of detail. Each low-detail activity can subsequently be refined in sub-diagrams to achieve a higher level of detail. During modeling it might become apparent that a diagram becomes too complex or bloated, which might require rearrangement or refinement of activities. This process can be iterated until a satisfying and consistent degree of elaboration of

the CAM is achieved. If the modeler decides to add more information, additional elements from secondary artifacts can be included. Typically, roles (swimlanes) are introduced first, followed by the document flow with activities, and finally, if desired, learning goals. Also during modeling, it might be useful to create alternative diagrams for the same course activities, representing a different point of view, a different level of detail, or just to experiment with activity arrangement or available secondary artifacts.

A concrete, effective procedure for a particular modeling/design team and task is best discovered and optimized during modeling practice.

Textual Information

A table should be provided for each activity diagram to describe each activity in more detail. Two columns (name of activity and description) should be sufficient, but additional information can be provided like scheduled start and end time of activities, role responsibility, tool support, etc.

Course Structure Model (CSM)

Semantics

The CSM provides an overview of all activity diagrams modeled in the CAM. As such it acts as a visual aid for users and modelers of a course. Viewers can use it as a guide to “browsing” the CAM.

Syntax

The CSM consists of one or more class diagrams comprising a class symbol for each activity diagram in the CAM. The class symbol carries the name of the respective diagram. There is only one specified relationship between diagrams, which is drawn as a dependency, meaning that the source diagram links to the target diagram through a sub-activity. Packages can be used to group diagrams together. See the following example.

Example

Figure 43 shows the CSM for the WE course. The main activity diagram (indicated with light-gray fill) would be the “Web Engineering” diagram. The CSM shows that this diagram links to seven sub-diagrams detailing each of the seven blocks of this course.

Modeling Procedure

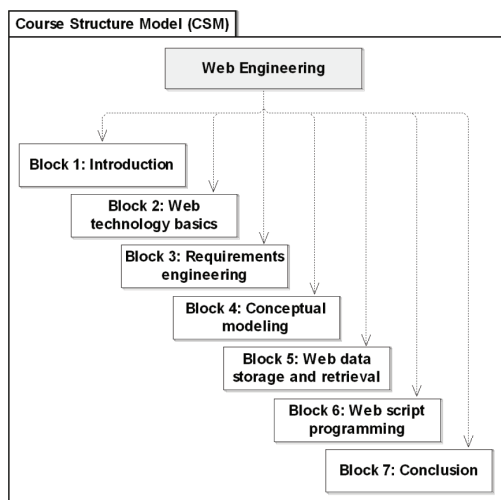
The creation of the CSM follows a straightforward procedure. Start with the main activity diagram representing the whole course, and draw the symbol in the CSM with light-gray fill or pattern. For each subactivity in this diagram, draw a diagram symbol in the CSM and connect the main diagram symbol to it via a dependency. This step is repeated for the whole “tree” of sub-diagrams, sub-sub-diagrams, and so on.

If there are alternative models for certain course activities or phases, another CSM package can be created with links to these diagrams.

Textual Information

The CSM can optionally be complemented with a tabular overview giving a textual description for each diagram.

Figure 43. Course structure model (CSM) for the WE course



COUML APPLICATIONS

This section briefly presents three applications for the coUML approach: first, in its original application area for instructional designs. Second, we expose the coUML language as a means of modeling generic blended learning processes, also referred to as “blended learning patterns,” to enable the reuse of blended learning design experience. And finally, we present a more technology-oriented application for modeling and using the learner context in a course.

Instructional Design

Supporting the instructional design process is perhaps the most relevant use of coUML. As it allows integrated and incremental modeling of structural and dynamic aspects of an educational environment, it can be used in different stages of instructional design, and even when the design process is already completed. A comprehensive example for applying coUML in this respect is provided as a case study on a course on “Introduction to Instructional Design” in Chapter XVI of this handbook. Please refer to the textual case-study description and the respective coUML models provided in that chapter.

Pattern Modeling

The primary objective of the pattern approach (Alexander et al., 1977) is to capture generic scenarios in a way that makes them amenable to reuse. With coUML this can be achieved by providing models of useful and effective courses and scenarios with a higher level of abstraction. The resulting pattern of a scenario can be used as a template or model for instantiating or deriving concrete scenarios in different, but similar contexts. To support this, each pattern is provided with detailed descriptions of intent, motivation, coUML scenario model, parameters, and application examples (Derntl,

2005). Consider for instance the Web-based “Diary” pattern described and modeled in Figure 44 (note that the pattern description in the figure is not given in full detail). The scenario is modeled at a high level of abstraction, featuring only the most essential steps in using Web-based diaries in educational environments. Consequently, the scenario can be applied by adapting it to specific needs, requirements, and available technology- and Web support.

Context-Aware Scenario Modeling

In a recent project (Derntl & Hummel, 2005) coUML was extended by introducing learner context information as an additional secondary modeling artifact. Thereby a learner context model was developed to allow modeling of the learner’s personal context (e.g., name, expertise, etc.), physical context (e.g., location), digital context, and other more technology- and device-related context structures. The learner’s context

can subsequently be attached to activities modeled in the CAM. This extension was used to model a laboratory course that employed wireless devices in an RFID-tagged laboratory environment (RFID stands for Radio Frequency Identification; it allows attaching tags to objects which can be wirelessly scanned by RFID-enabled computers such as laptops or PDA’s). Based on the context-enhanced CAM models a software system was developed that was, for instance, able to display available books and papers on the current course topic if the student entered the laboratory library. This way it was possible to automatically consider and update each learner’s context (e.g., location, learning progress, learning resources, available devices, etc.) during a learning activity.

DISCUSSION

Language Features

coUML is basically an extension of UML. We consider this as an advantage as UML’s semantics are formally specified and well documented. Meanwhile UML has a tradition of being used in several fields such as Web design, business processes and workflows, organizational modeling, context modeling, and many more. For example, there are many commercial and open-source UML modeling toolkits available which could be used for modeling basic coUML diagrams. Additionally, transformation procedures for UML-based modeling (e.g., to XML) are already well-researched and tested, and can be applied to coUML models without “reinventing the wheel.”

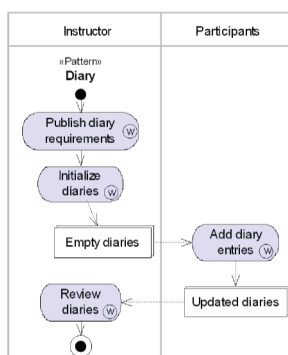
The language-related features of coUML can be characterized as follows: coUML is pedagogically neutral; there are no modeling elements, restrictions, terms or assumptions included which would restrict the user in modeling any particular scenario. It is designed to be simple to learn and use, even for non technically-oriented people.

Figure 44. Excerpt of the Web-based “Diary” pattern

Intent: Make participants’ efforts transparent by making them keep track of their work in diaries, especially in collaborative and/or iterative learning processes.

Motivation: Keeping a diary during learning activities has some positive aspects: First, diaries help memorizing and reflecting on experiences, problems, and achievements encountered during problem-solving processes. So diaries are valuable assets to initiate self-reflective thinking. Second, diaries provide the instructor with valuable insight on working progress, activity, and thoughts of participants. Finally, in teamwork scenarios diaries allow for monitoring the (equal) distribution of activities among team members. All of the above points only hold when participants do not treat diaries as annoying appendages but take a stake in keeping their diaries. To facilitate this, it may be worthwhile to provide writing guidelines for participants (e.g., providing a set of questions and points to be considered) and to transparently disclose the intentions of making them keep diaries.

Scenario:



This has turned out to be a tough goal to achieve, as many people are reluctant to use UML, which generally seems to be considered as a tool for pure computer science use. Despite its (debatable) notational simplicity, coUML can be used for modeling processes at almost any degree of complexity and detail; it includes all necessary control-flow structures, and the composite subactivities allow structural aggregation and hierarchical composition of cooperative scenarios through links between activity diagrams. Finally, it can be used for creating new learning designs, analyzing and redesigning existing learning designs, and as a visual toolkit to documenting learning designs. Another aspect, which is presented as an application is its use as a modeling tool for blended learning patterns.

coUML's features particularly related to its artifacts (i.e., models) are:

- Visual presentation of didactical knowledge, in particular of learning strategies such as problem-based learning, inductive derivation of knowledge, deductive learning, knowledge creation, etc.
- Specification of goals, social settings, and roles of learning activities.
- Presentation of learning processes at various levels of detail and arbitrary switching between levels, if that leads to better understanding.
- Knowledge communication between educational scientists and between educators as well as communication between educational scientists and learning-technology developers.
- Supporting the specification of functional requirements on a supporting learning platform.
- Explicitly captured didactic elements such as course phases, threads, and activities can be analyzed and researched in a targeted way, considering different stakeholders' perspectives.

- Specification of the interdependence between process and content flow. This allows for the subsequent derivation of learning activity models and for example the integration of e-content modules.
- Specification, identification, and explicit integration of various means of quality assurance activities into learning scenarios to improve learning processes.
- Specification of different roles as well as modes of presence and interaction involved in cooperative environments. While this is a central feature of coUML, we add that the language is not restricted to modeling of cooperative activities. In fact, it could as well be used to model non-cooperative learning environments.

Language Classification

Using the visual instructional design language (VIDL) classification scheme introduced by Botturi, Derntl, Boot and Figl (2006), coUML's feature and application classification is presented in Table 2.

Expert Survey on Modeling Support

In order to find out whether there is a broader need among researchers and practitioners for visual modeling support in designing blended course environments, we conducted a survey during a business meeting of the "Forum New Media Austria" in November 2005, which was attended by e-learning experts (both researchers and practitioners) from diverse fields such as psychology, pedagogy, mathematics, educational technology, or computer science. During a workshop on blended-learning modeling, we distributed a questionnaire among the participants (N = 27) aiming to survey general perceptions and estimations on modeling support for blended learning. Analysis of questionnaire data indicates that researchers and practitioners are in need of

Table 2. coUML feature and application classification

Classification of features	
<i>Stratification</i>	Layered , as it allows modeling entities of different types and at different levels of detail.
<i>Formalization</i>	Semi-formal ; it inherits formal elements and semantics of UML, yet it allows the modeler to be creative in providing additional visual and textual information.
<i>Elaboration</i>	The primary intent of coUML is mostly conceptual , but it is also possible to model at the levels of specification and implementation.
<i>Perspective</i>	Multiple , as it is possible to model structural (i.e., goals, roles, and documents) and dynamic (i.e., activities) concepts from different perspectives and at different levels of abstraction.
<i>Notation system</i>	Visual , based on UML, with extensions and additional textual descriptions.
Classification of application	
<i>Communication</i>	Can be used as a reflective and communicative tool, depending on involved stakeholders' skills and preferences.
<i>Creativity</i>	Can be used for both generative (design-in-progress) and finalist (documentation) purposes. However, Its origin lies in finalist use.

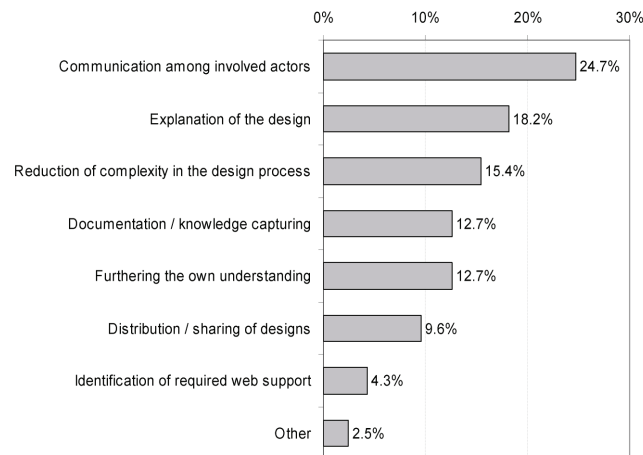
a visual modeling language to support them in their efforts. While the survey was not specifically focused on coUML, the following general results seem noteworthy:

1. The use of visual modeling techniques (e.g., sketches of processes, overview diagrams) in supporting the design or reorganization of a blended learning course is considered highly useful; $M = 6.88$, $SD = 1.51$, on a scale ranging from 1 ("not at all") to 8 ("very much").
2. More than two-thirds of the participants were aware of existing visual modeling techniques and almost as many are using them in their daily practice: 40% use informal modeling notations like sketches or block diagrams; another 22% use "real" modeling languages like UML or IMS Learning Design (IMS Global, 2003).
3. It is sometimes argued that strict and more formal visual notations are interesting and useful for computer-science people only. The participants unanimously voted against this proposition, even though they admitted that more formalized languages are often difficult to understand and use.

4. We were also interested in the experts' estimate of the use of visual modeling languages for instructional design. A number of relevant use cases were provided in the questionnaire, and participants' responses are highly supportive for coUML's focus: According to the experts, the top-three uses of visual modeling for learning design are "communication among involved actors" (24.7%), "explanation of the design" (18.2%), and "reduction of complexity in the design process" (15.4%). The full distribution of responses to this question is given in the histogram in Figure 45.

Even though the questionnaire was not directly related to coUML, the results show that there is considerable attention towards, and appreciation of, visual instructional design languages. Practitioners seem prepared and willing to use these languages and they are aware of potential support provided by these languages, e.g., for communication among involved actors, for explicating, sharing, and documenting learning designs, or for reducing the complexity in the design process. We hope that the current chapter does convey that these factors were also considered highly relevant in the development of coUML.

Figure 45. Experts' estimate of relevant uses of visual modeling languages for learning design



CONCLUSION

coUML is a simple, powerful visual modeling language for modeling instructional designs. Its notational power unfolds best in a blended course environment, when different modes of presence are aligned to achieve instructional objectives. It is based on UML, which is a standardized modeling language; we used UML's built-in extension mechanisms to define required modeling elements in addition to its basic set of structural and dynamic elements.

ID is an exceptionally diverse and complex discipline, making it an appropriate application area for visual modeling support. In this respect, the primary intended ID application for coUML is modeling of structural and dynamic aspects of blended course designs. We presented results of a small study among blended learning experts, which substantiates our presumption that blended learning designers and instructors are in need of a visual, conceptual toolkit to help them effectively create, analyze, and communicate their designs. We have experienced that the diagrammatic notation can help in sharing the learning design with colleagues and in organizing and researching courses. Also, the choice of proper

abstractions, names, and the provision of multiple grain sizes have proved essential in communicating cooperative designs in general and in contributing to technology-enhanced learning elements in particular.

Future work on coUML will proceed in several major directions. First, we want to extend our efforts of modeling external courses from more subject domains and "teaching cultures" and include these in our pattern knowledge base (see <http://elearn.pri.univie.ac.at/patterns>). In this respect, readers are invited to provide feedback and share their own course designs and experiences. Second, we are working on an easy-to-use modeling tool for coUML users, easing the modeling process with computer tool support. Third, we plan to evaluate the use of the language for different cooperative processes outside of the instructional domain, such as professional community building, interdisciplinary curriculum development, and project management. Last but not least, through this chapter we want to promote the use of coUML among researchers and practitioners for feedback and further improvement.

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Chapter 3.16

Modeling Learning Units by Capturing Context with IMS LD

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ABSTRACT

In this chapter, we describe the process of modeling different theory-, research-, and best-practice-based learning designs into IMS-LD, a standardized modeling language. We reflect on the conceptual and practical difficulties that arise when modeling with IMS-LD, especially the question of granularity and the necessary and sufficient elements of learning design. We propose a four-layer model both to ensure the quality of the modeling process and as a necessary step towards a 'holistic' consideration and integration of the design process. These discussions speak

to the core of IMS-LD integration, address the question of usability and end-user friendliness, and urge that more research and design needs to be conducted not only to mainstream (a) the use of IMS-LD and related visual instructional design languages, but also (b) the debate on appropriate and best instructional design practices.

INTRODUCTION

Instructional design is essential for every teaching, training, or instructing position. Where other design fields, like architecture, industrial design, and engineering, have very precise languages to communicate and share design specifications

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within their respective communities, the field of education does not possess such languages (Gibbons & Brewer, 2005). In the field of education, forms of sharing innovations include lesson plans and learning objects, products which implicitly embed design considerations, but do not explicitly address them. Crucial information on the context, the embedded instructional strategies, the theoretical foundations of the design, and the reflections of the teachers or designers are either not explicitly captured as in the case of learning objects, or are not accessible through a general standardized language as in the case of lesson plans.

In the last couple of years, the field of education saw several attempts to fill this gap by developing specific metalanguages or visual instructional design languages (VIDLs; see Botturi, 2005 for an overview). IMS-LD, an extension of the educational modeling language (EML) specification, is a prominent representative of VIDL. IMS-LD was developed to allow lesson plans and best practices to be structured using a common language based on a formal representation, to exist within an XML schema, and to be archived in a machine readable and searchable repository.

As powerful as the design language is, instructional designers, instructors, or teachers are still left with a variety of design decisions, which are not captured by the design language. For example: Which design is the most appropriate for a specific learning outcome? How much detail should be included in the design specification? Which elements are flexible or need to be modified by the context of the implementation? What context information does the design have to include to provide meaningful and sufficient information to subsequent designers, instructors, and so on? In view of these concerns, there are two purposes of this chapter:

- To provide a critical analysis of different design decisions that are pertinent for the use and implementation of IMS-LD, in-

cluding: (a) the questions of boundaries, granularity, and details of the design; (b) the modularity and reusability of smaller learning objects within larger learning objects; (c) sufficient and necessary conditions of a successful reuse of a learning design; (d) the usefulness of detail in the design and reuse of learning designs; and (e) particulars of mapping of activities through IMS-LD.

- To provide a four-layer evaluation model for determining the quality of IMS-LD design. These four layers are: (1) syntax and grammar; (2) best design approaches to model a certain activity; (3) how accurate is the model representing what the learning design was; and (4) how well the models match sound theories or evidence-based research. These two purposes aim to reflect on the usefulness of IMS-LD as a communicative device to share and communicate learning design issues, including the variety of different ways to design the same instructional activity.

This chapter describes the experience developed over a year-long project in which best practice, theory-based, and evidence-based learning designs were formally described with IMS-LD. The presented arguments will be illustrated with a variety of designs, modeled from theories and activities, including behaviorist, cognitivist, and constructivist models, problem-based learning, and lesson plans from the area of K–12 education.

BACKGROUND

IMS LD

The purpose of educational modeling languages (EMLs) and the IMS Learning Design (IMS-LD) specification is to support the crafting of diverse

learning experiences, embodying different kinds of activities and in different contexts. IMS-LD is a metalanguage that focuses on the settings (e.g., courses, course components, programs of study, etc.), associations of settings with content (e.g., multimedia, task descriptions, tests, assignments, etc.), and instructional and pedagogical strategies (e.g., roles, relations, interactions, and activities of students and teachers, etc.). In comparison to pure learning object frameworks, which focus entirely on content, in IMS-LD, activities and roles of students and teachers are directly specified.

The IMS Learning Design is a language that gives bindings in XML to specify learning content and processes. IMS-LD was developed to promote technical specifications for learning technology (IMS Global, 2003). Historically, the basis of IMS-LD is educational modeling language (EML; Tattersall & Koper, 2003), which was developed by the Open University of the Netherlands. Compared to other languages, like “PCeL patterns,” for example (Derntl, 2005), it is independent of any specific pedagogy, and its main focus is to support any kind of instructional design. IMS-LD models who does what, when and which materials or learning services are used to achieve learning objectives. Elements like resources, instructions for learning activities, templates for interactions, and pedagogical models like problem-based learning, learning goals and outcomes, as well as assessment tools are included (IMS Global, 2004). The specification gives a binding in XML, resulting in an XML manifest for each learning process. This XML manifest can then be interpreted by an IMS-LD compliant application.

IMS-LD consists of three parts: Level A, B, and C. There are different XML schemas provided for each level, and each level extends the previous one. Level A is concerned with the basics. At level A, time ordered activities, which are performed by teachers and learners (roles), are specified within an environment of learning objects and services (IMS Global, 2003). At level B, there are also

properties (additional information about persons or roles) and conditions. Notifications, which are added at level C, can trigger new activities, for example, noting whether a teacher has student questions to answer. In order to complete these levels, the best practice guide (IMS Global, 2003) recommends using a narrative description in order to initiate the analysis of an instructional scenario. In the next step, semiformal UML (unified modeling language) diagrams are drawn. Based on the UML activity diagram, the XML document instance is created.

IMS-LD stands as a prototype for the “shift in the e-learning focus from content to process—or activity” (de Filho Moura & Derycke, 2005, p. 2). As de Filho Moura and Derycke (2005) further argue, content issues, the primary focus of learning objects, have distracted and polarized the e-learning community from other important issues and so with IMS-LD, the field could begin turning its attention not only to what to learn but also how to learn.

Since IMS-LD claims to be pedagogically neutral (for a discussion, see Nodenot, 2006), meaning it does not enforce a particular instructional strategy or model (such as problem-based learning, drill and practice, guided, or inquiry), the decisions of design are left to the instructor or instructional designer. Because different instructional models consist of varying assumptions of what: (a) the teachers’ role is; (b) the learners’ role is; (c) activities students are engaging in; (d) which support structures and activities that need to be in place; and (e) sequence or path the students are following or choosing (see an overview by Reigeluth, 1999), there can be no template or even similar design structures when modeling different interactions. For example, since group work in an inquiry based project is different from group work in a guided Web quest, it becomes additionally important how granular the models are and how different interaction patterns can be best represented in IMS-LD.

Main Focus

In the next sections, we describe a year-long project in which we formally described best-practice, theory-based, and evidence-based learning scenarios using IMS-LD. The best-practice and evidence-based scenarios are derived from real lesson plans available at the Web site of LEARN Recit (a service agency for English school boards in the province of Quebec). The Web address is <http://www.learnquebec.ca>. The IMS-LD models are available at Paloma (<http://helios.liceftelugu.quebec.ca:8080/PalomaWebGlobe/>), a learning object repository maintained by Télé-université, Québec. We reflect our modeling process, including our selection process and different learning scenarios, which we modeled with IMS-LD.

We worked with MOT Plus™ (Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006), an IMS-LD software editor (Level A currently implemented) that allows a visual modeling of learning design and an automatic translation from graphical designs into machine-readable IMS-LD XML files. All of the visual representa-

tions of the models presented in this chapter were created using MOT Plus™. We particularly chose a graphical interface for our learning designs to make our argument more accessible to end users like teachers and instructional designers. We felt the raw XML binding is harder to communicate to novices of IMS-LD than a visual representation.

Context of the Models

The project team decided to work with two different type of scenarios: (1) theory- and evidence-based instructional models and (b) best-practice cases. The theory- and evidence-based models included a behaviorist, a cognitivist, and a constructivist based model. These models were “translations” of theoretical literature and research studies into IMS-LD models. For an overview and a short description of the different models, see Table 1.

The best-practice cases were selected from a publicly available Web site maintained by RECIT/Learn, a nonprofit educational foundation supported by funding from the Québec-Canada Entente for Minority Language Education. RECIT/Learn

Table 1.

Title	Type of model	Pedagogical type	Model describes	Environment structure	Comments
Figure 1: Model of Fieldtrip	Best practice	Inquiry-based learning	Communication process/Collaborative learning	Two or more matched distance separated classes	Define simultaneous interaction
Figure 2: Snapshot of selected area in IMS-Model of constructivist learning	Theory-based	Constructivism	Generic structure for teaching within a constructivist design and teaching paradigm	Nonlinear/flexible	Difficult to model flexibility of choices and sequences
Figure 3: Model of behaviorist teaching	Theory-based	Behaviorism	Generic structure for teaching within a behaviorist design and teaching paradigm	Linear/sequential	Difficult to determine level of detail required for model
Figure 4: Snapshot of model on cognitivist teaching	Theory-based	Cognitivism	Generic structure for teaching within a cognitivist design and teaching paradigm	Linear/sequential	Difficult to operationalize the different steps without a particular context: deeper or broader?
Figure 5: Model of “True Story” learning activity	Best practice	Cross curricular: Language Arts, Math, Art	Collaboration: Brainstorming, problem solving	Linear/sequential	Struggled with questions of granularity

supports and promotes pedagogical collaboration and innovation with information technology and modeling of best practices, primarily by providing teacher professional development in technology integration into the new learner-centered Quebec curriculum. The cases on the Web site were annotated with links to resources, contributed by teachers in the Quebec English Schools Network. Some of the cases included design considerations and reflections by the teachers. As displayed in

Table 2, we designed a rubric to select existing lesson plans for inclusion in our project. The rubric contains criteria which were aimed to: (a) assess the quality of the instructional model and (b) provide quantity and quality indices of the description of the activities, roles, content, and so forth. The rubric served two purposes: (a) to select sound models of instructional design and (b) to ensure that enough high quality information is accessible to transfer the model into IMS-LD.

Table 2. Rubric to select best-practice models

Category	0	1	2	3
Theory/Design	Cannot determine pedagogical theory or instructional design.	Material relies on an unstructured combination or not fully realized collection of theories and design principles.	Material relies on a structured or defined theory or set of ID rules. Could be more complete.	Theory and/or design is easily identified. Modifications are explained.
Qualitative Components	Example contains material that is incomplete – offers little to no detail.	Example contains material that has vague or sketchy details.	Example contains complete material but is lacking information related to teacher and/or student guidelines.	Example contains complete material that offers detail as well as information related to teacher and student guidelines.
Quantitative Components	Example contains too few components to work with.	Example contains some elements but has holes in some areas.	Example contains material in all areas but lacks reference to some resources.	Example contains enough material to create a complete model as well as links to available resources.
Criteria for Assessment	Example contains no criteria for assessment.	Assessment criteria are vague.	Assessment criteria is complete but is missing some information.	Assessment criteria is clear and easy to work with.
Learning Objectives and/or Learning Outcomes	Learning objectives or outcomes are not stated.	Learning objectives and outcomes are poorly stated. Vague. Do not follow theory or ID.	Learning objectives and outcomes follow theory and design but could be more complete.	Learning objectives or outcomes are complete and closely follow identifiable learning theory and/or instructional design models.
Classroom Student–Teacher Interactions	Not applicable or not discussed.	Only vague or very brief guidelines.	Guidelines for interaction are included but could be more complete or more realistic.	Comprehensive and realistic guidelines for interaction are included
Preparation/Pre-Activity Instructional Design	Not discussed. No preparatory ID appears needed or possible, or else discussion of ID includes fundamental misunderstandings of the process or fallacies.	Vague or insufficiently detailed discussion of preparation needed. Some evidence that preparatory ID is needed, but discussion is vague or lacking in detail.	Discussion of preparation and preparatory ID is included but could be more complete.	Discussion of preparation and preparatory ID is complete. Discussion of preparatory ID reflects mastery of ID principles and process.

We utilized this rubric to translate existing learning designs, such as lesson plans, so they could be visualized and shared in different “languages” and modeled with IMS-LD. This rubric can be similarly employed to evaluate the quality of existing IMS-LD models and learning objects. For all the models we created, one person on the team assumed primary responsibility. However, project meetings were utilized to co-model and discuss components of the models.

In the next section, we discuss the individual learning designs, the models (which will be at least partially depicted in graphical format), issues that arose from the modeling, and a preliminary reflection. After we describe our process through a set of models, we will synthesize the reflections by connecting them to literature on IMS-LD modeling and instructional design.

MODEL 1: CONNECTING A VIRTUAL FIELD TRIP WITH OTHER CLASSES

The Context

This model describes the design of a collaborative virtual experience, which also includes an actual field trip. A class that takes the field trip invites other classes, which cannot make the field trip, to join them virtually. Participating classes can send questions, hints, and already researched topics to the field trip class in order to uncover more information. The classes are in secondary education, and the model describes the communication process and the collaborative work used in answering questions.

The Process

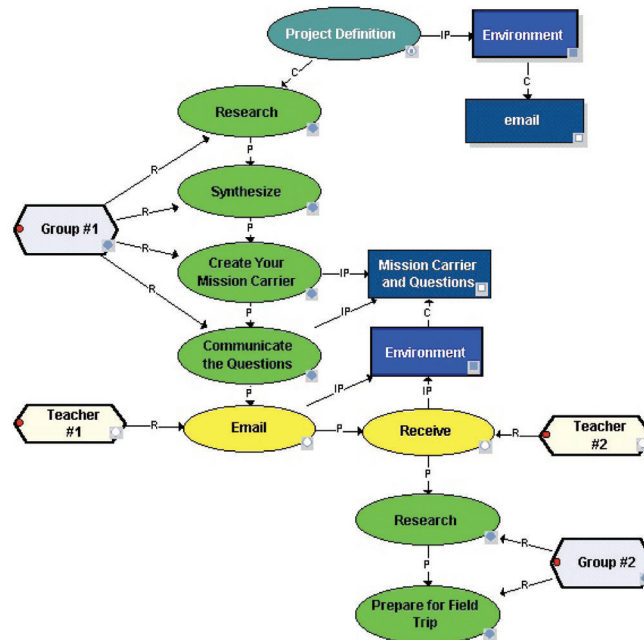
This model is a best-practices model, meaning we modeled an existing course activity. The main selection criteria for the activity were the uniqueness of the lesson design, the utilization of a sound, theory-based pedagogical model,

and the availability of accompanying material. For this model, we started building the smallest units first, such as how classes were matched, how questions were answered, which content was available at which stage of the activity, and so forth. After fine-tuning these individual aspects, we designed the overall structure and then modeled the relationships between the different elements. The smaller units or nuggets (Bailey, Zalfan, Davis, Fill, & Conole, 2006) were modeled as autonomous and closed units to ensure that they made sense by themselves and to avoid later reusability concerns. See Figure 1.

Reflection

By modeling this activity, we faced many challenges. The first challenge was to define a unit or nugget in a way that was consistent and had boundaries that were set. In this course, the different activities were intertwined, could be employed nonsequentially, but had a fixed timeline (sequence). In many of the activities, several groups were supposed to be doing the same activity in parallel, and afterwards, they were to forward their results to the other groups. The challenge here was to define these interactions being precise regarding who is sending and who is receiving information. An additional challenge pertained to the distinction between necessary and sufficient information. For example, students were communicating the results back to the other classes via e-mail. For this design to work and for other designers to reuse the design, the decision to use e-mail is not a necessary one. The same communication could have been achieved via video-conferencing, chatting, or producing a Web site. Nevertheless, the concrete activity (e-mail) requires a different model than the use of a discussion board or the creation of a Web site. Therefore, questions remain concerning: (a) how to model the variety of activities or media that could be used; (b) modeling the particulars of the design; and (c) communicating the difference between necessary

Figure 1. Model of field-trip learning activity (based on <http://www.qesnrecit.qc.ca/cc/partners/indexen.htm>)



and optional aspects of the design. By modeling just one activity (e-mail), we felt the design was not as reusable as it could have been. Additionally, the differentiation between two different classes of smaller units seemed important either (a) nuggets, which described a particularly defined activity, or (b) nuggets that served to connect other nuggets to form a larger unit. While the first class is easier to reuse, the second class is much more contextual to the model at hand and harder to reuse.

MODEL 2: CONSTRUCTIVIST TEACHING MODEL

The Context

This theory-based model provides a generic structure for teaching within a constructivist design and teaching paradigm. The constructivist paradigm is characterized by nonlinear content interaction, complex and ill-structured prob-

lems, nonsequential pathways, and a variety of situation and context-sensitive support structures, like scaffolding, modeling, and coaching (for an overview, see Jonassen & Land, 2000). The constructivist paradigm cannot serve as a concrete design application of how to structure, for example, a discussion group around a particular class context. However, the constructivist-based design can provide a design template for building nonsequential, open-ended learning activities within the formalized IMS-LD model. Because it has a clear theory base, the model is more aptly described as a metamodel abstracting concepts from the many different design and teaching situations that were used to inform theory building.

The Process

Because constructivism entails many different forms, our discourse was dominated by how its principles can be operationalized in a design model. Since we worked without the context

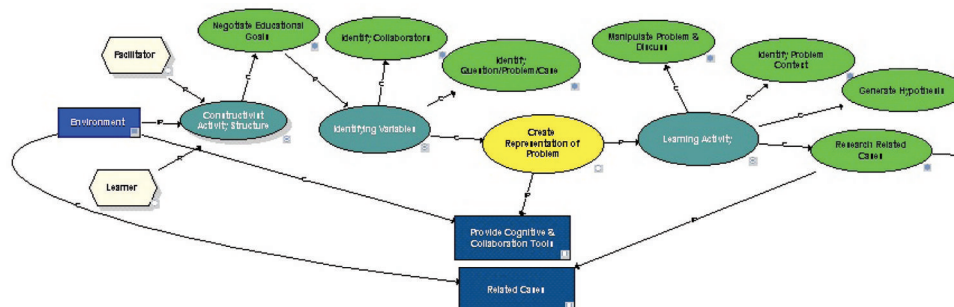
of a particular instructional intervention, the components of the design stayed at an abstract level. We struggled with certain components of the process more than with others. For example, in many constructivist design models, not many fixed sequences exist and many student activities are iterative. This learner flexibility means there is a great deal of free choice regarding resource and activity selections, which are repeated with different content or different guiding questions. Our challenge was to design activities and acts that were coherent within the design, which represented the flexibility of the activities and the adaptability of the resources and were not restricted by the design model as to when the activities had to be completed. Additionally, many microlevel elements were hard to incorporate due to the flexible nature of the theoretical underpinnings. Since many decisions within a constructivist learning situation are made by students in cooperation with each other and with the teacher, many conditional aspects needed to be modeled, and many alternative ways of achieving the same learning outcomes needed to be included. See Figure 2.

Reflection

The design of this model raised different questions and provided many challenges for the design team. The main challenge was whether one model would suffice for constructivism, not just because constructivism is an abstract model, but also be-

cause the models can have so many variations. The pedagogical strategies and philosophical assumptions of the paradigm we modeled greatly influenced our approach to modeling. General questions arose, especially concerning how different prototypes of the same model looked when created by different people. We realized different ways of modeling and found that the appearance of any one model was dependent on the personal preferences of the designer and his/her style of modeling. After determining that these idiosyncratic, abstract models of constructivism were syntactically correct with respect to the underlying coding language and were compliant with IMS-LD, questions arose concerning the best way to model a specific constructivist learning activity. Each one of us developed a unique style of modeling resulting in multiple ways of modeling a particular component, each of which was still compliant with IMS-LD. Modeling of learning scenarios was not a standardized activity with a single, clearly described model. It was a process that depended more on the expertise of the modeler, the anticipated level of expertise of the audience, and the preferred styles of visual arrangement, which were used to highlight key instructional elements. These constraints and conditions, however, did not find their way into the models or into IMS-LD itself. In short, by struggling with the design of a constructivist model, we were in need of an annotation language to clarify our IMS-LD models, which we were not

Figure 2. Snapshot of selected area in IMS-Model of constructivist learning



able to do within the model itself. Additionally, we found the need for “best-practice” models on how to model in IMS-LD.

MODEL 3: BEHAVIORIST TEACHING MODEL

The Context

This is a theory-based model, which provides a generic structure for teaching within a behaviorist teaching paradigm. Though it cannot serve as a template for structuring communication pattern in courses, it can provide a design template for aligning smaller aspects of course design within an overall structure. The model is a metamodel abstracting from the many different design and teaching situations that can be classified as behaviorist.

The Process

In this template, it was important for us to connect the classroom activities of the instructor with those of the students along with the preparation of the instructor. In dealing with instructor preparation, the model needed to also explicate what follows in the class. To do so, we spent some time exploring different components in the 2/3D dimensional space of MOT+. The feedback structure of behaviorism made it difficult to place every component in a way that was visually easy to follow. Although not as important as the design aspects, the visual aspects of arrangement, color-coding, and so forth are challenging ones for novice model builders.

The overall structure of the design was determined by the theoretical underpinnings; nevertheless, the modeling process raised additional questions especially with regard to the sequence in which the model had to be expanded. In our experience, determining the level of detail in the model was always a struggle. How much detail should the design contain? In best practice cases,

the availability of material or insights into the design process was often the determining factor, even when we wanted to go into greater depth. In theory-based cases, the material and approaches were endless, and it was so much more difficult to set the boundaries. See Figure 3.

Reflection

The model was a great device for us to develop a better understanding of behaviorist forms of instruction. By engaging in the process, the discussion became focused on the model itself. A big challenge was the syntax and the design process itself. We found ourselves agreeing on the design sooner than on its visual representation and on its compliance with IMS-LD. For the design exercise, the many different ways of representing one element led us to question the validity and utility of a best practices approach to IMS-LD design.

MODEL 4: COGNITIVIST TEACHING MODEL

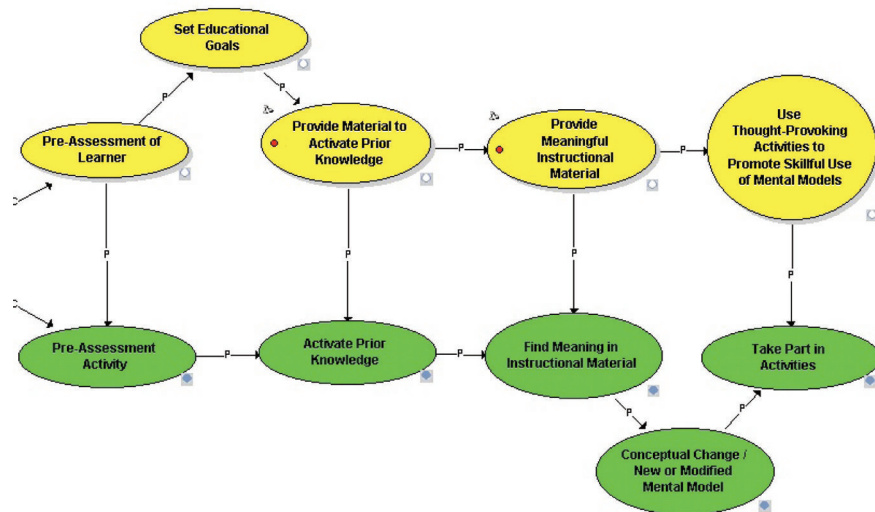
The Context

This is a theory-based model, and we had to make deliberate choices regarding which body of literature to rely on and operationalize. Though it cannot serve to illustrate the design of communication pattern in courses, the cognitivist approach can provide an IMS-LD design template for aligning smaller aspects of design with overall course structure. The model itself is a metamodel, which abstracts the many different design and teaching situations that can be classified as cognitivist.

The Process

The development of the cognitive model proved challenging. Like the other theory-based approaches, in a cognitivist model, it is hard to operationalize the different steps without having

Figure 4. Snapshot of model on cognitivist teaching

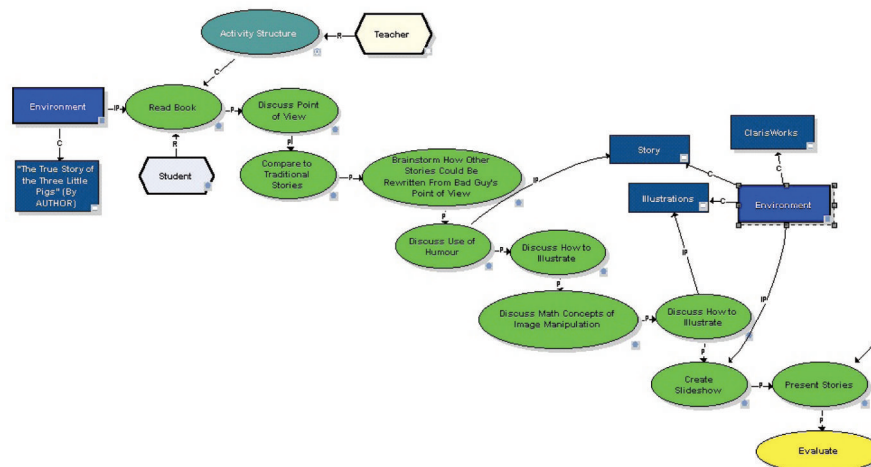


evaluation tasks in which they had to compare one story account with another. Beyond that particular context, the model can be utilized as a template to build cross-curricula instruction and allow the integration of math-, language-, and technology-rich class activities.

The Process

This model took a best-practices approach by modeling an existing lesson. We developed the model following the systematic description that the instructor outlined in the lesson plan. Similar to most of our modeling, we ran into the problem of representing depth and breadth of instruction. Additionally, since we modeled a rather large sec-

Figure 5. Model of “true story” learning activity



tion of a class activity, we questioned the value of modeling this large section and not just little nuggets. Other ones could replace most all of the activities that we built. For example, the discussion of the book could have been done in a multitude of ways. Furthermore, by not directly specifying the discussion process, the instructor left a considerable amount of detail out of the lesson plan. This detail will need to be determined by the individual instructor who reuses the model. The value of the particular structure lays more in the entirety of the plan. The challenge for us was how to model the activities as independently from each other as possible so other usable nuggets could easily replace the existing ones. A particular difficulty of modeling in this “object-oriented” way is that transitional aspects of the model (like leading from one activity to the other) become secondary or redundant.

For our own modeling purposes, we yet have to come up with a way of consistently and systematically distinguishing between core elements of the design and redundant, exchangeable, or even negligible elements within the model. In other words, what are the necessary and what are the sufficient elements and attributes of certain designs? Another example might highlight this difficulty. A set of students (A) is using a discussion board to communicate the results of a research study to another set of students (B) who can ask questions or make requests for additional research in return. While group A utilized a discussion board, they could have used other forms of two-way communication (blogs, e-mails, video-conferencing, etc.). Each form of communication would require different training, calls for different exchange patterns, requires different preparation time between communication periods, and so forth. For the overall design of the course, it is important to model that students engage in two-way communication, but how important is it to model the specific way of communicating and the specific activities associated with the means of communicating? Another teacher trying to adapt the learning design is left

to decide which of the elements are pedagogically crucial, exchangeable, or even negligible for his/her own teaching. To identify the adaptability or redundancy of certain design elements, either pedagogical and instructional knowledge of the design is necessary or the original instructional designer should somehow embed appropriate alternatives.

Reflection

As mentioned earlier, the modeling process is a valuable communicative device to plan and discuss learning design. Additionally, the modeling process becomes a reflective device. Through the modeling of approximately 15 designs, we found ourselves questioning instructional decisions in lesson planning. Unfortunately, it is not very visible within the process how the design grew before we modeled it. Additionally, since most instructors build and adapt their teaching from session to session, we do not see in the modeling process the different alterations and changes the instructor utilized. In that sense, the model has no history or is incapable of keeping history.

SYNTHESIS AND DISCUSSION

We described our process of modeling specific theory and best-practices learning activities. In the following section, we will synthesize issues arising from the modeling experience and discuss and situate them within the larger body of literature on learning design and instructional design.

Granularity

By breaking down and assembling structures and complex performances of instruction, the question emerges as to what constitutes an “atomic” chunk or part. In other words, what is the smallest meaningful unit of modeling and what should the degree of granularity be? The definition of granularity

has implications not only for the boundaries of a model but for the reuse of model components in different designs.

The topic of granularity is not new to the field of instructional design and appears frequently in the learning design and the learning objects literature. Many instructional design guidelines argue for breaking down complex structures into smaller sizes, for example, as argued by learning taxonomy proponents (e.g., Bloom, 1956) and as illustrated in instructional design models (see Reigeluth's 1999 elaboration theory as an example). Traditional conceptualizations of granularity are delivery-centric or as Wiley, Gibbons, and Recker (2000) call it, "media centric." In a delivery-centric view, pieces of the design are well-defined by the hierarchies of a course, the course being the largest grain size and a text element in a course description being the smallest "atomic" element. IMS-LD distinguishes between the smallest elements, combined small elements (which become level 1), and combined level 1 elements (which become level 2).

There appears to be a move away from the conceptualization of granularity as mainly an issue of the size of a learning object to a more "holistic" view in which more factors of the instructional design process are considered. "In determining the robust granularity of a learning object, one might ask, 'what elements of the model, message, instructional strategy, representation, and media-logic layers are compressed within this learning object?' The larger the count, the larger the grain size of the learning object" (Wiley et al., 2000, p. 5).

The move to a "robust" or "holistic" approach to granularity would address several issues: (a) It could provide an alternative picture to the simplistic view of teaching as delivery of disaggregated learning objects assembled in a well-defined preconceived combination (the course structure; see Russell, 2003 for a further argument). (b) It could highlight the very complexity of the instructional design process embedded in

the learning object and so preserve some of the context which learning objects were criticized for leaving behind (see Jonassen & Churchill, 2004 for a detailed criticism).

This move to a more "holistic" approach means that granular or smaller objects of design are similarly complex as larger pieces, so by breaking down complex learning design, we will not facilitate a more manageable task of "divide and conquer" but create rather hydra's head, the beast in Greek mythology which grows two heads for everyone cut off. Implications of this "hydra head" model are numerous: (a) the size of a learning object does not communicate something about the simplicity of complexity of the learning object, (b) there are no simple learning objects, and (c) the larger context or the relationship with other learning objects become more important in order to create or reuse the learning object.

Boundaries/Details

In many of our models, we encountered the problem of specifying the boundaries of a particular learning activity (i.e., how to integrate prior or subsequent learning activities which are linked to the activity at hand). Similarly, issues of external boundaries arose when we debated whether to include the teacher's or instructional designer's activities within our model of a learning activity. This question becomes particularly important considering that most models are not blindly reused but are carefully selected and adapted by other instructional designers or teachers, so additional information on the design process might be useful and provide more context.

In addition to external boundaries (whether and how to include events and material outside the learning activity per se into the design model), internal boundaries of the design have also to be considered. The question of "how much detail should the model include?" sets the direction of the internal boundary of the design model. The structure of IMS-LD with its stage metaphor, in-

cluding activities and acts, might be perceived as already determining the question, however IMS-LD does not provide an answer about the depth of detail. For example, is it sufficient to describe that students are supposed to work in teams or do details on the structure of the teamwork need to be included?

Sufficient and Necessary Conditions/Possibilities

A related question to the issue of boundaries is the determination between necessary and sufficient information. As seen earlier in the model of the field trip (see Model 1), the design asked students to communicate their field-trip results back to other classes. In this particular instance, students used e-mail as the communication medium. However, the design could have asked the students to communicate via a discussion board, video-conference, or by creating their own Web site. All of these interventions fulfill the goal of this aspect of the activity—to communicate results. When breaking down the activities into smaller, detailed acts and processes, all of these different interventions require different kinds of material, training for students, teacher roles, and actions by students. We argue that the goal to communicate is a necessary condition to be modeled, meaning it cannot be missed, but the modeled activity of e-mailing is only a sufficient condition, meaning it can be replaced with other activities, which fulfill the same goal. To illustrate the distinction, consider the following: If somebody is trying to reuse the learning design in another context, the goal needs to be shared (to communicate), but the designer should also be able to integrate other technologies, activities, and associated actions to fulfill this goal. In IMS-LD, no space is provided to communicate sufficient uses or necessary conditions. This does not allow designers to share crucial design decisions. By just modeling one activity (i.e., e-mail), the design would not be as

reusable, especially when certain technologies do not exist.

Ultimately, this could mean that the learning design of an activity would need to draw from a large bank of substitute components, which could replace the actual modeled structure when constraints of a new design require that. Additional metadata on the necessity of the components and an alert on which crucial parts of the design need to be expanded are necessary. If in our example, e-mail communication was exchanged with the creation of students' own Web sites, training for the Web site creation might be a necessary addition when designing the activity.

Furthermore, an additional distinction can be drawn between two classes of design components. There are activity and material components, which describe which activities students are engaged in and which material is utilized. The design model contains also bridge components, elements that are necessary to connect activities with other activities or with necessary resources. In the learning design, bridge components are secondary, because they do not carry many instructions, but rather provide segues between the core designs. IMS-LD does not distinguish between bridge and core components.

Usability and User-Friendliness of IMS-LD

Our experience in the role of end users with IMS-LD through a visual editor confirmed previous systematic usability testing of formal standardized languages to capture learning designs. As van Rosmalen, Vogten, Van Es, Passier, Poelmans, and Koper (2006) describe, the weaknesses of IMS-LD are that the required knowledge of IMS-LD and the complexity of the IMS-LD specific concepts assumes a great deal of knowledge and the editor itself requires considerable training. Finally, the interface is based on a technological view of learning design rather than an educational view (see van Rosmalen et al., 2006, p. 8 for a

detailed description). We experienced very similar issues with the usability and user-friendly aspects of IMS-LD.

The usability of both IMS-LD and the graphical tool cannot be reduced to the techniques, technologies, and processes of modeling, however important they are. There are other large questions of usability in this context. How does IMS-LD connect with the practice and experience of end users? Is the language mature enough to become an every-day tool in the hands of instructors and instructional designers? What other barriers exist before IMS-LD is integrated into every-day practice. These questions go beyond the typical usability questions such as are concepts well-explained, buttons well-placed, and processes well-described. Throughout the work on our particular project, these larger usability questions moved from the background to the foreground. IMS-LD and its graphical editors in their current stage are not sufficient to support IMS-LD becoming mainstream and becoming usable for instructors or instructional designers. Much literature and debate on learning design are still too technical for the layperson to understand and are lacking a connection to the every-day practices of designers and instructors.

FOUR-LAYER MODEL OF DESIGN

Apparent throughout the modeling exercise and the issues addressed in our synthesis, the pedagogical neutrality of IMS-LD adds a layer of complexity and leaves questions which need to be adequately addressed. Of particular importance is the question of the quality of the learning design as modeled by IMS-LD. In this last part of this chapter, we argue for a four-layered model of quality assurance when utilizing IMS-LD. This four-layer model includes pedagogical and instructional criteria not addressed by IMS-LD, but essential for the quality of the learning objects and designs it produces. As can be seen in Figure 6, the four

layers are (1) syntax and grammar, (2) best design approaches, (3) accuracy of the models, and (4) implementation and compliance.

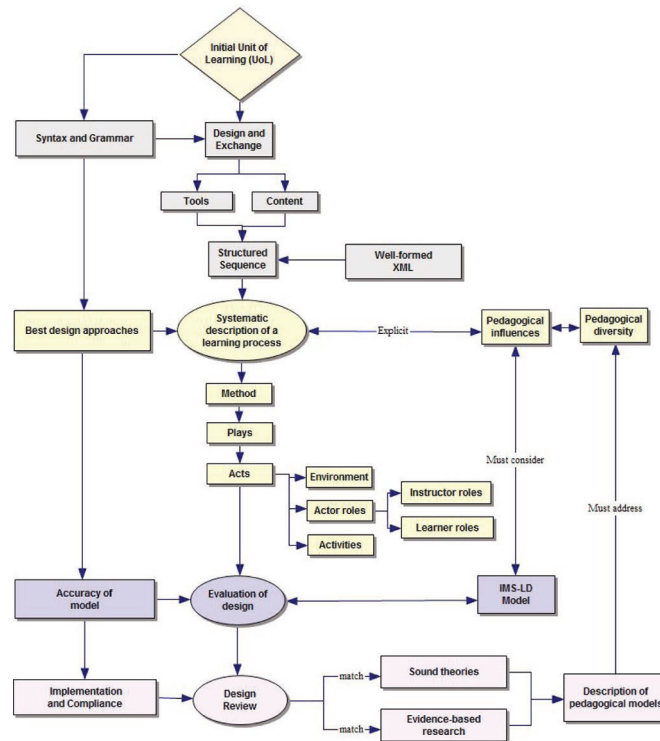
Syntax and Grammar

In the syntax and grammar level, the focus lays on the correct use of the IMS-LD specification to appropriately design the unit and ensure compliance in the exchange process. This includes the correct labeling of relationships between individual components (sequential, free choice), the proper breakdown of the initial unit of learning into activities, actions, roles, and the associated materials and settings (tools and content of the instructional unit). Additional value is placed on the appearance of a structured sequence that maps the learning activity and the sufficient support through proper tools and content resources. Quality in this level is measured by the compliance to the XML structure and whether the design produces well-formed XML. Through its orientation on XML compliance, this level is very technically oriented and does not address pedagogical or instructional quality issues. Most papers, which address the quality of IMS-LD, address this particular level (see for an example Berlanga & Garcia, 2005).

Best Approaches to Model a Certain Activity

Compliance with the IMS-LD data structure (as measured in layer 1) does not guarantee the most appropriate breakdown of the unit of learning into components that make stronger sense than others. Since everybody in our team was modeling components and even the same unit of learning, the question emerged: What determines the better model? Not only could the same activities be modeled differently, some models use more extensively bridge components or nested activity structures, in which activities are embedded in other activities. Some modeling solutions of the same activity in our visual editor became easier to communicate

Figure 6. Four layers of quality in modeling learning context with IMS-LD



or were more elegant or minimalist in their approach. From this level forward, the IMS-LD model should become a communicative device that facilitates the process of clarification between different instructional designers or teachers.

Accuracy of the Model

Going beyond the compliance with IMS-LD standard specifications (layer 1) and the question of the most appropriate way of representing the same learning design (layer 2), the design has to be verified against the initial description of the activities, the interaction of learners, and the lesson plan. The actions of learners and teachers, the interaction between activities and roles, and the material and resources of the model have to be checked to determine whether they are a true representation of what was happening in a classroom or if the model matches the narrative plans for a particular learning unit. At this level,

elements in the learning design are in the spotlight either for being vaguely planned or lacking in information on how they were implemented. Any ambiguities in the process of validation raise additional questions of whether the language is precise enough or whether the process of design needs to be more detailed.

Implementation and Compliance

Since IMS-LD is pedagogically neutral, there is no place to discuss the appropriateness of certain design choices to the learning process within the IMS-LD model. For sharing instructional design and learning design models to guide reuse and inform practice, information on the design rationale in light of appropriate learning theories and models requires sufficient space. This can be captured by either including aspects of the design process in the learning design model itself (i.e., a teacher planning activity component) or by

supplementing the design with links to theoretical or evidence-based research literature.

FUTURE TRENDS

Our proposed four-layered model integrates IMS-LD within the larger context of instructional design and introduces pedagogically sound design back into a standard, which was designed and proclaimed to be pedagogically neutral. Many questions we raised concerning the complexity of instructional design and the intersection with IMS-LD would suggest that IMS-LD's claim of pedagogical neutrality is difficult to uphold. Inevitably, when designing models in IMS-LD, pedagogies find their form, but do not yet find a space to be labeled or reflected upon. While IMS-LD does support different models of instructional design, the process of evaluation and sound learning design is not equally supported in the design of units of learning. While IMS-LD as a technical standard to model learning activities might be mature, the tools available and the standardized language are far from being usable at an end-user level, especially for teachers. More research is necessary to investigate designers' use of IMS-LD and different training strategies to further support IMS-LD becoming a mainstream application.

CONCLUSION

In this chapter, we described the process of modeling different theoretical and best-practices learning designs into IMS-LD, a standardized modeling language. We reflected on the conceptual and practical difficulties that arise when modeling with IMS-LD, especially the question of granularity and necessary and sufficient elements of design. We proposed a four-layer model to ensure the quality of the modeling process and as a necessary step towards a "holistic" consideration and integration of the design process. Finally, we raised the question of usability and end-user friendliness of the IMS-LD specification

and urge that more research and design needs to be conducted not only to (a) mainstream the use of IMS-LD and related visual instructional design languages, but also (b) to mainstream the debate on appropriate and best instructional design practices.

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KEY TERMS AND DEFINITIONS

Boundaries of Design: Refers to the scope of the design model and which borders are drawn.

Granularity: Refers to the definition of size of a learning object. There is a distinction between delivery-centric and holistic granularity. Delivery-centric granularity is structurally oriented on a course (activities, assessment). Holistic granularity is focused on the embedded instructional design in every object and not just in the role the object plays within a course structure.

IMS-LD: An XML-based language for specifying learning content and processes.

learning design: The entirety of design that is invested to create a learning environment, including material design, media design, instructional design, and activity and assessment design.

Nugget: Refers to small stand-alone learning objects, which can be combined with others to build larger units.

Syntax of Design: In this chapter, the syntax of the design refers to IMS-LD specifications as implemented in the XML structure. Compliance with the XML specifications is one step of the proposed four-layer model.

Visual Instructional Design Languages (VIDLs): Visual languages or notation systems

that let instructional designers represent their instructional design visually. VIDLs are often compared to blue prints of buildings or architectural drawings. Examples are the Educational Environment Modeling Language (E²ML) or IMS-LD.

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Section IV

Utilization and Application

This section discusses a variety of applications and opportunities available that can be considered by practitioners in developing viable and effective instructional design programs and processes. This section includes over 30 chapters which review certain utilizations and applications of instructional design, such as Internet citizenship and expanded access for the visual and auditory impaired. Further chapters show case studies in Africa and Australia, and the impact of globalization and standardizing languages for instructional design. The wide ranging nature of subject matter in this section manages to be both intriguing and highly educational.

Chapter 4.1

Wireless Computer Labs

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INTRODUCTION

In February 2000, three seemingly unrelated events came together to present a unique challenge at one mid-Atlantic university—a challenge that is being experienced more and more by colleges and universities across the country.

First, the faculty approved a new undergraduate teacher preparation curriculum that would include instructional technology in both the first two semesters of the freshman year and three semesters in their junior and senior years—12 new sections of technology-based training. Second, a graduate degree in instructional technology was growing beyond even its most optimistic predictions. In less than four semesters, enrollment increased from 24 to 140 students. Third, funds, staffing support, and classroom space had not been pro-

grammed for yet another much-needed computer facility and renovations to available space were cost-prohibitive.

To meet the demands for more technology resources, a new multimedia classroom was proposed. Estimated to cost over \$200,000, the proposal was rejected by senior administrators due to budgetary considerations. It was clear that to resolve this dilemma, the program director needed to think “outside the box”.

Enter the wireless lab. With 29 multimedia-ready classroom and student computer labs already on campus, weaknesses in pedagogy had been recognized for years. Increasingly, labs contain outdated hardware and software. The inflexibility of scheduling, location, and access to desktop capabilities made computer labs unattractive to many faculty members. And the cost! For the price of a single multimedia-ready classroom, a department can purchase 3-4 portable wireless

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labs, incorporating the power of technology with the more traditional classroom. Wireless carts can be rolled into classrooms, making scheduling conflicts a thing of the past. CDROM, printers, and overhead projectors can be appended to the cart with little hassle. And, perhaps most important, with the deployment of a wireless access point, only one network connection is required to make all 24 computers Internet-ready.

The wireless lab was identified as the most promising technology to address these issues. It enables an entire class to be online at the same time—simultaneously surfing different Web sites, accessing e-mail, creating documents, and swapping files through a single Internet connection. It seems the perfect cost-effective solution for schools with limited budgets and facilities at capacity or those who simply want a more flexible networking solution. The specific advantages of a wireless lab are best represented by examining how it was integrated into six university courses and programs.

The university's *Introduction to Educational Technology* course is similar to many such first-year familiarization courses. It provides an introduction to the various classroom technologies. Students use the wireless lab to master the complete set of basic skills and competencies required before entering the masters program. Using the laptops, students are introduced to word processing, spreadsheets, graphics presentation, and the Internet. The lab offers students more opportunities for both abstract and concrete, practical hands-on experiences. Using wireless labs frees the multimedia facility for more classroom-centered teaching (and technology-intensive applications) while offering the complete suite of software, hardware, and network concepts demanded of the graduate program in technology. One anecdotal comment lifted from a student's evaluation claimed, "When then instructor rolled in that wireless lab, learning really took off."

A companion course, *Assessment of Instructional Technology*, evaluates "best practices" for

using instructional technology in the classroom and was previously taught without technology due to space and access considerations. The wireless lab allows students to simulate online quizzes, download test banks, and demonstrate educational software. The flexibility provided by the wireless lab made all the difference in student understanding of the material while providing them the ability to work at their own pace.

Two other non-technical courses, *Social Studies Methods* and *Elementary School Administration*, advanced the practical applications of the wireless lab. Two faculty members needed online access at the same time, so another innovation was initiated in the school. The wireless lab was divided into two to serve both classes simultaneously. Faculty simply rolled the cart into the third floor hallway, distributed 14 machines to one class and 10 machines to the other—and both classes were up and running within minutes.

Even more flexibility was demonstrated in the *Behavioral Disorders* course for special education teachers. Providing a current overview of the field of education for persons with serious emotional disturbances, research is paramount as students explore diagnosis, assessment, treatment, intervention, and prevention strategies. The course validated on-demand technology in the classroom. The wireless lab was used several times during the semester when the class explored factors contributing to behavioral classroom disorders. The instructor was not always able to plan exactly when the research phase of each topic would begin; as a result, scheduling was haphazard and conflicts were common. Using the wireless lab as an on-demand technology resource created the flexibility to re-locate the cart to any classroom equipped with a single network connection. Theory and "book learning" were the previous means of exploring these topics. With the introduction of the wireless lab, students were able to conduct both individual and group discovery learning exercises. Initial feedback from students was extremely positive, some even claiming that the

portable computers helped them understand the practical side of special education.

A special program for preparing school district superintendents found the wireless lab a perfect tool for introducing senior administrators to laptop, wireless technology. The lab was brought into their seminar room and, together, the participants explored the Internet locating information pertinent to school board issues, budget and funding school districts, in-service training programs for their teachers, computer purchases, student safety issues, and so forth. Practicing administrators found a resource suitable for small group learning situations, from 3-5 student seminar rooms with an overhead projection system and printing capability suitable for classroom discussion. The wireless lab was equally effective in this small seminar room environment. The portable laptops permitted the instructor to break down the class into focus groups, with each group using the computers to access information particular to their assigned topic. Participant comments included: "The wireless lab was absolutely wonderful. Convenience and practicality are just two words to describe this innovation. I would love to have this in our schools." (Assistant Superintendent of Schools, Pittsburgh). Here's another, "...very innovative approach in linking us to technology to work together as a team on a grant proposal as we were circled about each at one table. I found that the lab provided us convenience (never leaving our classroom), accessibility to the Internet, better communication in working as a team, and personal instruction" (Director, Special Education).

ISSUES

Of course, with any technology, serious debates are needed to ensure the appropriate application of the technology for teaching and learning, so, too with wireless labs. Here are some particularly poignant concerns for consider.

Keeping Laptops Safe

Most student desks do not provide adequate space for a laptop which can lead to accidents. Security can also be an issue with laptop computers; their size makes them easy targets to slip one out of the classroom undetected. In fact, a recent theft from one middle school computer lab reduced the number of laptops from 51 to 32 in one week-end incident. Most schools will lock down their carts when not in use and store them in a secure location. Often theft is reduced by the demand for laptops to recharge after each extended use, making them tied to a power source that is often dedicated only to the cart and contained within a secure area. Laptops are most vulnerable at the end of a class period when instructors as well as students are moving quickly to their next class. After school opportunities for theft are also numerous. A balance must be maintained with the flexibility of laptops, the convenience of wireless carts, and the vulnerability of both to pilfering. It takes a diligent teacher to keep laptops from being broken, vandalized, or stolen outright.

Maintenance Issues

The most time-consuming maintenance task associated with computer labs of any kind is updating software and removing viruses. Although, theoretically, wireless laptops can be updated in their cart, often the wireless network bandwidth has not been sufficient to allow the simultaneous updates. Although the technology is advancing geometrically, most schools must connect their laptops to a local area network in an existing computer lab to appreciate the much higher data transfer speed (100MB) needed to complete these tasks in a reasonable time frame. Another solution to this problem is to reconfigure the laptops to use Ethernet for updates, or individually update each laptop, both of which are time-intensive processes.

Response Issues

As mentioned earlier, the technology is moving rapidly; however, for most educational environments, wireless protocols continue to present problems, especially in technology-intensive courses. For instance, 30 laptops accessing the access point simultaneously inevitably results in dropped connections or extremely slow transfer rates. Slow response rates are also a particular problem at the end of class when students clamor to save their work to the server or when the instructor leads students through a step-by-step example. Since the wireless lab is being used in the classroom, an educational technician is not usually available resulting in frustrated teachers and irate students. A nearby technician ready to troubleshoot (or at least recognize and explain) these issues encourages wider use of mobile labs.

Flexibility and Savings

Although continuously improving, wireless still lags behind hard-wired connections in terms of speed. However, its tremendous flexibility proves attractive to many school systems. Wireless networking removes barriers to school-wide network access and provides more flexibility when designing new school systems and their desired learning environments with respect to effective technology-oriented learning space layouts. Teachers with access to wireless technology use them much more frequently. When teachers can simply roll a cart into a room, plug it into an electrical outlet, connect it to a data drop, and pass out computers to each student, the wireless carts become an integral part of the daily curriculum. The speed of wireless is typically adequate for classroom activities (even in higher education) because the communication between the access point and the laptop is minimal. Using wireless laptops, teachers, students, and administrators are connected to anywhere and anyone on campus. In the classroom, students can experiment with

new knowledge, collaborate with their peers and instructors, and provide feedback quickly. In libraries, they conduct their own research and in physical education courses, they track their fitness progress. Carts that contain multiple laptops also come in handy for faculty in-service and administrative meetings.

Another benefit of wireless is its ease and speed of installation. Because it is so easy to incorporate wireless within an existing hard-wired infrastructure, many schools use it as a backup or an extension of their wired local or wide-area network. If fibers are cut, for example, a quick switch to the wireless network maintains uninterrupted connectivity. Handheld devices, which many schools are just beginning to use, also integrate easily into a wireless network. From a technical perspective, wireless provides an environment where solutions are otherwise not feasible.

Wireless is also an excellent choice for schools with small classrooms that lack space for stationary computers or schools that were built in the era of brick and mortar where drilling for hard-wire connectivity is cost-prohibited. Wireless carts can be secured on adjacent locations when not in use, leaving room for other teaching activities. Further, when schools outgrow their facilities and revert to temporary classrooms and administrative offices, wireless is the quickest (and least expensive) way to provide connectivity. Most institutions have integrated wireless connections into their long-term strategic plans. While wireless is not necessarily less expensive than wired connectivity, it is becoming more competitive as schools, companies, even cities are opting for this more flexible networking environment. Most find that they can quickly recoup any initial investment expenses because of the efficiency of the hardware. Instead of hard-wired computers sitting idle in unoccupied classrooms, a cart of laptops is apt to be in constant use as it travels throughout the educational building.

Designing Through the Technology

The designs of educational facilities are changing in response to the increased sophistication of teaching, learning, and administration. Some applications require larger classrooms to accommodate technology. For example, projectors that display data from the teacher's console take up more room than monitors. On the other hand, wireless laptops take up much less room than fixed machines. Power requirements have increased dramatically and air conditioners have increased in size because of the tremendous heat generated by the technology, but not so for wireless laptops. A new computer lab once required planning for electricity as well as connectivity; with laptops, a dedicated circuit to handle recharging of a cart-full of computers is all that is necessary.

Current and future technology needs demand careful planning for renovations and new buildings. Technology can enhance learning and related academic and administrative work only if it is accessible. Architectural structures designed initially with aesthetics in mind may serve a dual purpose as ports that accept wireless signals. The location of data drops is another important consideration. Placed too close to a cabinet or in some out-of-the-way place and connectivity is impeded. In wiring a whole new building, current thinking is that antennas should not be installed in classrooms but in hallways so they can cover the rooms on both sides of the building. For both hard-wired and wireless applications, schools must work closely with architects and engineers in the design of wiring schemes for buildings. All new or updated buildings should consider wireless networks or, at the very minimum, a combination of hard-wired and wireless infrastructure. Such environments promotes learning areas that extend outside the traditional classroom into the cafeteria, hallways, student and faculty lounge areas, video presentation rooms, and technology learning centers.

Planning for Technology

Architects and engineers design buildings and then consider technology—at least that is how buildings were planned. With the emphasis and weight placed on today's instructional technology, buildings are now designed around specific educational needs. Engineers integrate conduits for networking and communications cabling. Architects are asked to consider classroom size and width of hallways with technology in mind. And, proper design of wireless systems ensures available connectivity to cable networks and antennas. The continuing rapid changes in technology make planning ahead a true challenge. Many institutions plan 5 to 10 years into the future. With technology, that is oftentimes impossible. Again, the use of wireless technology contributes to successful long-range planning and simplifies upgrades and renovations along the way. Whether hard-wired or wireless, institutions can translate student learning needs into functional designs by involving users (e.g., students, faculty, administrators, and others) during their engineering, architecture and technology planning, strategic planning efforts, and facility upgrade requirements.

ADVANTAGES/STRENGTHS

In the journal, *From Now On*, author Jamie McKenzie summarizes why wireless networks utilizing mobile computers have become the media of choice preferable to the desktop machines in classrooms and computer labs and, by so doing, offers readers a list of the key strengths of wireless technology (McKenzie, 2001):

- **Ease of Movement:** Stand-alone laptops are readily moved to any location within a building without considerations that make desktop machines seem so inflexible. Wiring, electricity, lighting, special furniture, and so forth are non-factors when us-

ing laptops in a wireless environment. On the down side, battery life remains a strong consideration for classes conducted in several-hour blocks of time. Also, connectivity to other technology resources (backups, printers, etc.) also restricts laptop usage.

- **Strategic Deployment:** Wireless devices are deployed on rolling carts (in the case of laptops) or in a pocket (in the case of handheld devices). They go where they are needed most, creating unique learning opportunities that traditional methods of placing hard-wired computers throughout a school do not provide and are just now being realized by instructors.
- **Flexibility:** Wireless laptops are easily re-configurable to changing conditions, teaching styles, and learner experiences as well as team, group, or individual preferences. Wireless laptops place no additional demands on furniture or space.
- **Cleanliness:** Consider how computer labs looked in the past. Cables and electrical cords introduced numerous tripping hazards, monitors, desktops, keyboards, mice, printers, and speakers all presented clutter and confusion. The elimination of cables, wires, and peripherals not only removes many of these hazards but opens the room to better utilization of space for instruction.
- **Low Profile:** Unlike desktops, students are not prone to hide behind large monitors. The low profile of wireless laptops allows better two-way communications and feedback between instructors and students.
- **Convenience:** Wireless laptops are easily stowed in specially-made carts that make them more likely to be used. A disadvantage for some instructors is the unwieldy size and weight of a fully-loaded cart. However, pre-positioning of a wireless lab reduces lost classroom time for setup and simplified technology demands on the part of instructors and students. For most ap-

plications of wireless, the time has come where the technology itself is becoming secondary to the undertaking of learning.

- **Simplicity:** The simplicity, comfort, and reliability of wireless laptops promote a focus on learning rather than the technology. Simple as that.

CONCLUSION

Wireless access has become the environment of choice for educators, corporate trainers, tech-savvy entrepreneur, and the ordinary business traveler. In addition to laptop computers, cell phones, personal digital assistants (PDAs), two-way pagers, and other compact gadgets all use the same wireless technology that makes hard-wired computer labs a technology on its way out.

Wireless-enabled laptops make it possible for students to use their time more efficiently, access databases and information from the Internet, and work collaboratively. Using conferencing software and portable laptops, learners are able not only to electronically store documents and data and retrieve them instantaneously, but also to successfully engage in document sharing and collaborative writing from various locations on and off a campus environment. With the implementation of more flexible learning approaches, they succeed in selectively incorporating critical input from peers and instructors, then revise documents based on their own interpretation of facts and theory.

Continuous improvements in wireless technologies will only serve to advance new pedagogical practices that take advantage of the full range of educational psychologies. Such learning practices incorporate higher-order skills like problem-solving, reasoning, and reflection. The integration of mobile learning environments and wireless computing also has implications for many other educational venues such as business schools, science programs, corporate training,

medical nursing schools (including nursing), and law schools.

In summary, the advantages of wireless computing include education are its breadth of scope, prolific portability, and broad applicability for both individualized and collaborative learning projects. Access extends to home, office, classroom, leisure, airports—virtually everywhere and all the time, providing the means to integrate computers into every aspect of teaching, learning, and research.

Certainly, wireless labs have proven themselves highly adaptable to both the personal teaching styles of classroom instructors and the learning strategies of traditional and adult students. There are few inherent weaknesses in laptop capability compared to similarly-equipped desktop computers. Plus, they have added advantages and flexibility only laptop computers provide. They seem to support all aspects of teaching and learning, including abstract values and concrete ideas; behavioral, cognitive, and humanistic psychologies of teaching and learning; and, all levels of human development from elementary through post-graduate doctoral students.

For considerably less than a multimedia classroom, the wireless lab provides an appropriate venue for teaching at the college/university level. With the power and flexibility of today's laptops and the requisite pedagogy on which to base teaching with technology appearing more often in the research, schools should at least consider the wireless lab for their next technology enhancement.

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KEY TERMS AND DEFINITIONS

IEEE 802.11 Wireless Standard: 802.11 is the IEEE (Institute of Electrical and Electronics Engineers) standard for wireless networking—sending Ethernet data packets through the air. The standard allows for wireless integration with wired Ethernet networks using devices called access points or base stations. IEEE 802.11 wireless standard supports all standard Ethernet network protocols including TCP/IP, AppleTalk, NetBEUI, and IPX.

Access Points: An access point or base station is a radio receiver and transmitter that connect to a wired Ethernet network. Through these devices, wireless nodes such as desktop computers, notebooks, and laptop computers equipped with wireless network cards, have access to wired local area network services such as e-mail, the Web,

printers, and more. Operating range, management capabilities, wireless network security, and number of users supported are determined by the capabilities of the access point.

Broadband: Faster than modems but slower than Ethernet, several different forms of broadband access are available from local Internet service providers, phone companies, and cable providers. The most common forms of broadband are DSL, ISDN, and cable modems. DSL and ISDN use special adapters to send data over your telephone line without tying it up. Cable modems send data over your cable TV connection. DSL and ISDN availability is limited based on geographic location and telephone line quality. Cable modem availability varies with each cable company.

Data Transmission Modes And Throughput: There are two modes, encapsulation and translation, for transmitting data over a wireless network. Encapsulation mode encloses the 802.3 Ethernet packets inside 802.11 frames for transmission through the air, whereas translation mode converts 802.3 Ethernet packets into 802.11 packets for transmission. Recently translation has emerged as the defacto standard, but support for encapsulation as well ensures maximum flexibility in networks where both addressing modes may be used.

Ethernet: The standard individual connection for many offices, classrooms, labs, and residence hall rooms as well as corporate office and training environments and complexes. Ethernet operates at speeds up to 10 megabits per second, is available 24 hours a day, and does not require a phone line. Fast Ethernet connections that operate at 100 megabits per second are available but usually reserved for server applications.

Local Area Network: The term local area network is usually defined by its size; it is small and

generally contained within a single room, a single building, or perhaps a small cluster of buildings.

Operating Range: Factors that affect the operating range of any wireless device include the strength of the access point, the number of walls inside a building, the construction materials used within a building (concrete vs. steel vs. wood), and the data transmission speed. Most access point manufacturers offer enhanced antennas for increased range. Manufacturers recommend that access points be deployed 150ft. (50m) apart to ensure full coverage and maximum data throughput rates for roaming computer users.

Soft Access Point: As an alternative to deploying an access point for wireless connectivity to a wired Ethernet network, a computer that is physically connected to an Ethernet network, outfitted with a wireless network card, and running a software routing solution, can act as the gateway between the wired network and the wireless network.

Wireless: Wireless networks currently operate at speeds up to 11 megabits per second in both indoor and outdoor locations. A great convenience for mobile computer users, wireless does have some drawbacks. Because it uses radio waves to transmit data, wireless networking is inherently insecure. Also, the bandwidth within each coverage area is shared between all users on that "cell".

Wireless Management and Security: Certain wireless client solutions provide utilities to monitor the strength of the signal and data throughput speeds and provide computing users real-time network statistics. Additional wireless network management capabilities are incorporated into the access point and depend on the manufacturer and model.

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Chapter 4.2

Personalised Learning: A Case Study in Teaching Clinical Educators Instructional Design Skills

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ABSTRACT

The authors consider personalised learning in the context of delivering a specialist postgraduate course – ClinEd 711, ELearning and Clinical Education – at the Faculty of Medical and Health Sciences, University of Auckland. They describe the pedagogical theory underlying the course design and their experience of delivering ClinEd 711 with particular reference to the personalised learning process that the course design facilitated. They present their research results for the student experience of ClinEd 711 and discuss changes made to the course as a result of student feedback. They make reference to the introduction of student-led modules to further personalise the students' learning experience. ClinEd 711 is a specialist postgraduate course with low student

numbers; with this in mind the authors discuss the implications of their pedagogical approach for those educators involved in teaching larger classes. They conclude their paper with a discussion of the role of the educator in personalised learning.

INTRODUCTION

The Learning Technology Unit (<http://www.fmhs.auckland.ac.nz/faculty/ltu/>) and the Centre for Medical & Health Sciences Education (<http://www.fmhs.auckland.ac.nz/faculty/cmhse/default.aspx>) at the Faculty of Medical and Health Sciences, University of Auckland jointly offer a fifteen week course – ELearning and Clinical Education (ClinEd 711) – as part of a clinical education postgraduate degree program. The overall objective of ClinEd 711 is to bring the learners – who are typically educators in the field of medical and

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health sciences – to the point of understanding themselves as instructional designers capable of converting one of their traditional face-to-face courses for flexible/distance delivery. ClinEd 711 was offered for the first time in Semester 1, 2007 as a fully online distance education course. The course was offered for a second time in Semester 1, 2008 and at the time of writing (March 2009) the course is being offered for a third time. From the outset, ClinEd 711 was designed to locate the student at the centre of the learning process in order to provide students with a personalised learning experience. However, as a result of feedback from students and after critical analysis of the first iteration of the course, ClinEd 711 was re-designed to create an even more personalised learning environment. This was achieved through the introduction of student-led modules in which the students had to take responsibility for the creation and delivery of a particular course module to be “studied” by their peers.

In this chapter we: outline our understanding of personalised learning; detail the research approach that we took in designing and evaluating ClinEd 711; explain how the course was designed to situate the learner at the centre of the learning process; describe the personalised learning processes that the approach facilitated; outline the differences between the first and second iteration of the course; and provide the reasoning behind the changes that were made for the second iteration of the course. Our chapter will make particular reference to the student-led modules that were introduced in the second iteration of the course, as the rationale for this innovation was to provide students with greater learning autonomy and with greater responsibility for their learning outcomes. As we shall see, these are two of the central features of personalised learning. We are aware that ClinED 711 is a specialist postgraduate course with a relatively low number of student enrolments and with this fact in mind we will discuss the potential challenges of offering this particular form of personalised learning to larger class

sizes. We conclude our chapter by discussing the relationship between the role of the educator and the independence of the student in a personalised learning environment before briefly considering future research directions.

PERSONALISED LEARNING

A key characteristic of personalised learning is that the student is located at the centre of the learning process. Personalised learning meets the individual learning needs of a diverse range of students whilst encouraging independent learning (Johnson, 2004) through learners taking greater responsibility for their own learning and through learners being more actively engaged in the learning process (Hannafin & Land, 1997; Ong & Hawryszkiewicz, 2003). It is the design of a particular type of learning environment “shaped by its foundations and assumptions about learning, pedagogy and the learner” that provides the conditions for personalised learning (Hannafin & Land, 1997, p. 197). For example, teachers can facilitate personalised learning by adopting teaching strategies that meet the needs, abilities and aptitudes of each student thereby providing for an individual learning pathway (Sun & Williams, 2004). This can be achieved through shifting responsibility from the teacher to the student for discovering, organising, analysing and synthesising content (Brush & Saye, 2000; Downes, 2005). Such strategies can maximise student motivation and attainment so that students realise their full potential (Johnson, 2004). However, the role of the educator remains crucial if students are to succeed (Hannafin & Land, 1997) with the educator fulfilling the necessary roles of facilitator and mentor (Johnson, 2004; McLoughlin & Lee, 2007; Ong & Hawryszkiewicz, 2003).

In cases where class sizes are large with lecturers often being “time-poor” (Goodyear, 2005, p. 2), it has been said that personalised learning must necessarily be about offering students learn-

ing choices within the framework of a particular curriculum or course (Johnson, 2004). In practice this means providing a teaching framework that offers a solution to the problem of teaching to a large group of students whilst also meeting the diverse learning needs of each particular student so that learners, “are actively engaged in the learning experience with their preferred content” (Sun & Williams, 2004, p. 2). The Harvard University virtual world project “River City” – a project to teach school aged children science – provides an excellent example of a development that seeks to achieve a balance between providing a standard framework for learning whilst also offering learners individual choice in order to cater to diverse student abilities (Clarke, Dede, Ketelhut, & Nelson, 2006). In “River City” this balance is achieved through providing standardised features in the virtual world whilst also offering customisable features within the environment. For example, “River City” has an individualised guidance system in which student activities are logged in a database. The database maintains a personalised history of the activities undertaken by each student with levels of guidance in the form of “hints” being offered for each individual student in terms of the student history of interaction in “River City”. This – along with other design features – has enabled the creators of “River City” to offer an educational innovation that meets the diverse needs of learners and educators.

ClinEd 711 is a specialist postgraduate course and the number of students enrolling has been relatively low. We did not, therefore, have to deal with the challenge of providing personalised learning opportunities to a large numbers of students. Even so, we found that it was challenging to create and manage a learning environment that allowed learners to engage in the learning experience in terms of a project of their own choosing and with their preferred content. Whilst creation of ClinEd 711 was time consuming, the essential difficulty that we faced had to do with the demands placed on the tutor in terms of supporting students in

their learning and in terms of marking assessed work. We will discuss both of these challenges in this chapter. We will also discuss the extent to which the learning design implemented for ClinEd 711 might be “scaled up” and implemented on a course with much larger student numbers. This will involve us in critically considering how to provide a standard teaching framework that provides a solution to the problem of offering a personalised learning environment when student numbers are large.

It should not be thought that our conception of personalised learning is synonymous with “individual” learning. Rather, interactional theories of cognitive development (Bruner, 2006; Vygotsky, 1978) posit that the social dimension of learning is crucial in pedagogical terms so that students are exposed to a variety of opinions and perspectives that will challenge and inform their own perspectives (Hannafin & Land, 1997; McLoughlin & Lee, 2007). Thus, students might work cooperatively so that their learning is “participatory and social” (McLoughlin & Lee, 2007, p. 664) whilst retaining choice concerning their learning content, their preferred learning style and their use of particular types of social software for communication and collaboration (McLoughlin & Lee, 2007). Students can also be offered flexibility concerning where and when they learn. ClinEd 711 is very firmly rooted in a social constructivist pedagogical framework. Again, despite relatively low student numbers, managing the ‘social’ component of the learning process led to distinct challenges that will be discussed in this chapter.

BACKGROUND

We deemed design research to be an appropriate research methodology for our ClinEd 711 research project – particularly when compared with research approaches grounded in an objectivist and scientific methodology (Collins, Joseph, & Bielaczyc, 2004; Reeves, Herrington, & Oliver,

2005). Whilst design research has had difficulties gaining traction in the broader research community (Collins et al., 2004), it is a method that is being applied successfully and is championed by a number of prominent researchers (Bannan-Ritland, 2003; Clarke et al., 2006; Herrington, Oliver, & Reeves, 2002; Kelly, 2003; McKenney, Nieveen, & van den Akker, 2006; Reeves, 2000, 2006; Reeves et al., 2005). Our research approach utilised six design research tenets as explicated by Reeves, Herrington, & Oliver (Reeves et al., 2005):

1. A focus on broad-based, complex problems critical to higher education;
2. The integration of known and hypothetical design principles with technological affordances to render plausible solutions to these complex problems;
3. Rigorous and reflective inquiry to test and refine innovative learning environments as well as to reveal new design principles;
4. Long-term engagement involving continual refinement of protocols and questions;
5. Intensive collaboration among researchers and practitioners, and learning communities;
6. A commitment to theory construction and explanation while solving real-world problems.

We considered the question of how to engage lecturers in a “pedagogically principled way” (Burden & Atkinson, 2008, p. 4041) with technologies for teaching and learning to be a challenge that was sufficiently broad based and complex to warrant adopting the design research approach. We also conceived of the creation of ClinED 711 as a real world problem. The reasons for coming to these conclusions included the fact that the Medical Faculty is the largest Faculty within the university with five Schools and, potentially, a pool of very diverse students. Teaching with technologies is an issue that affects all five Schools because of a demand for delivery of flexible/distance postgraduate courses and because of a perceived need to produce technology-enhanced

teaching materials for undergraduate students. In addition, factors at a Faculty and University level – such as lecturer time to learn new skills and prepare new content, cultural ethos, pressure to engage in discipline research and the question of incentives for teaching with technologies – all potentially impact on whether or not students on ClinED 711 actually implement what they have learned. At the outset, we had a long-term commitment to the ClinED 711 research project with the University of Auckland ethics committee approving the research project for a period of three years. A long terms commitment to educational research is important in order to avoid the mistake of conducting an isolated one off study that is of questionable value in terms of meaningful research results. The way in which the remaining tenets of the design research approach have been put into practice will be made evident in the following sections as we describe the creation of ClinED 711 and the revisions that were made in light of our teaching experience on the course.

COURSE DESIGN

Both iterations of ClinED 711 have been based upon social constructivist theory (Gillani, 2003; Mergel, 1998). This pedagogical philosophy (Goodyear, 2005, p. 85) “guides learners to conduct and manage their personalised learning activities and encourage[sic] collaborative and co-operative learning for critical thinking and problem solving” (Sun & Williams, 2004, p. 2479). At the level of the individual, constructivist theory suggests that learning is a search for meaning or significance. Students learn in terms of a pre-existing conceptual schema or framework within which they ideally fit new knowledge. Constructivism should therefore be understood as a description of the way in which individuals might go about their learning rather than as a description of the way in which they do in fact go about learning. It is the job of the educator to provide the conditions

in which constructivist learning might take place. This is achieved through providing an educational framework in which course content and activities might be personally meaningful for the students. At the social level, interaction with others can serve to change an individual's conceptual structure or personal interpretation of particular phenomena whilst simultaneously influencing the collective interpretation of those phenomena. In the context of designing a learning environment, educators can create experiences that are personalised – that is individually meaningful, relevant and tailored as far as possible to a learner's particular needs – whilst also ensuring that the learning experience is social thereby exposing individual learners to the perspectives of other learners.

Regarding the second tenet of design research – the integration of known and hypothetical design principles with technological affordances to render plausible solutions to complex problems – ClinEd 711 was designed around six pedagogical principles with the first principle bearing directly on the constructivist learning philosophy:

- Learning should be meaningful for the learner (Ausubel, 1963; Bransford, Brown, & Cocking, 2000);
- Learning should be organised around core concepts and cognitive flexibility to develop expert rather than novice knowledge (Ausubel, 1963; Bransford et al., 2000; Driscoll, 2005);
- Learning tasks should replicate real world problems in an authentic context (Bransford et al., 2000; Lave & Wenger, 1991; Lemke, 1997);
- Learning should involve the collaborative construction of knowledge thereby providing learners with multiple perspectives on particular issues and concepts (Bruner, 2006; O'Donnell, 2006; Vygotsky, 1978);
- Learning should employ strategies that appeal to multiple sensory modes and cognitive capabilities (Driscoll, 2005; Gardner,

1983; Mayer, 2003; Paivio, 1986; Spiro, Feltovich, Jacobson, & Coulson, 1995);

- Learning tasks should encourage meta-cognitive capabilities and reflective practice (Bransford et al., 2000; Schön, 1987).

In line with recommendations for publishing design research as it unfolds, the research basis for implementing these design principles has been reported elsewhere (Blake & Doherty, 2008; Doherty & Blake, 2007). In this chapter we will be focussing on those aspects of the learning environment that pertain directly to personalised learning and on the challenges of providing personalised learning to students.

COURSE CONTENT AND LEARNING PROCESS

The postgraduate degree programme in clinical education within which ClinEd 711 is offered is aimed at health professionals and academics (doctors, nurses, pharmacists and others) involved in clinical teaching. Students might be full time academics or they might primarily be clinicians with some teaching responsibilities within the Faculty. This is an interesting point with respect to meeting the needs of all learners. Whilst academics with some clinical responsibilities will have a professional identity defined to a significant degree by their teaching, clinicians who teach only part time are much more likely to have a professional identity that is defined by their clinical responsibilities. This point obviously bears upon offering personalised learning to students since the course tutors have to be sensitive to the fact that some students will not come to ClinED 711 with an understanding of themselves as teachers. Students participating in the first 2 iterations of the course have had the characteristics described in Table 1.

Whilst student enrolments have been relatively low, we can see that students on ClinEd

Table 1. Characteristics of ClinEd 711 students, 2007 and 2008

	<i>Field of clinical education practice</i>	<i>University of Auckland staff member?</i>	<i>Resident in Auckland?</i>
First course iteration, 2007 (4 students)	Psychiatry	Yes	Yes
	Palliative care nursing	No	Yes
	General medicine	No	Yes
	Pharmacy	Yes	Yes
Second course iteration, 2008 (6 students)	Anaesthesia	No	Yes
	Surgery	No	No
	Psychiatry	Yes	Yes
	Mental health nursing	No	Yes
	Physiology	Yes	Yes
	Psychology	Yes	No
n (total) = 10		UoA staff = 5	Auck. resident = 8

711 have been diverse in terms of their field of clinical practice. We can also see that the majority of students have been resident in Auckland with half of the students being Auckland University staff. Since this was a wholly distance course, the physical location of the students was not a factor in the student learning experience since all content and interaction was carried out online. Both iterations of ClinEd 711 required students to progress through the course in terms of an eLearning project of their own choosing. In this way, students engaged in authentic, personalised and meaningful learning through selecting one of their own courses for their project and through developing that course for flexible or distance delivery.

The emphasis in ClinEd 711 was on the personal relevance of the learning for the learner's teaching and learning philosophy and for their clinical education practice. The reference to clinical practice is important as it bears upon the sixth tenet of design research, "A commitment to theory construction and explanation while solving real-world problems". ClinED 711 emphasised that students needed to consider how their teaching practice would impact on real world health care problems. There was, therefore, an emphasis in

ClinED 711 on students creating flexible/distance courses that would lead to, for example, improved health care in the workplace. Students were directed to take ownership of their learning from the very beginning of the ClinED 711. This situated them at the heart of the learning process and as a result the course became personally relevant and meaningful to the students. Students typically chose to focus on a course that they were already teaching, although in some cases they chose to create a new course. This provided each student with an individual pathway through ClinEd 711. Progression through the modules of ClinEd 711 was centred on two core instructional design documents that are used within the Learning Technology Unit at the Faculty of Medical and Health Sciences for eLearning project developments. The use of these two core documents provided an authentic, real-world learning scenario in which learners could learn to think like instructional designers.

The first document – Needs Analysis Document – clarifies the potential social and pedagogical usefulness of the project and captures key information necessary for converting a traditional face-to-face course for flexible/distance delivery. The Needs Analysis Document asks for the fol-

lowing information: project goal; project rationale; staff who will contribute to course development; whether the course is university approved; completion date for development work; current course format and mode(s) of delivery; new provisions required; available budget; frequency of updates for the completed development; staff available to carry out the updates and head of school approval. The document therefore functions to ensure that there is a clear reason for converting the course for flexible or distance delivery and completion of the document also indicates broadly that the project is viable in terms of the development work required during the allotted timeframe of fifteen weeks. In project management terminology, the Needs Analysis Document is the functional equivalent of a project mandate document, which serves to determine in broad terms whether, or a not a project is worthwhile. Students on ClinEd 711 were expected to complete the Needs Analysis Document during the early weeks of the course. The course tutor then marked the Needs Analysis Document. In the real world of project management the Needs Analysis Document is crucial as it provides the information required to gauge whether or not the project is viable. The same is true in the context of ClinED 711 and, therefore, students were made aware of the importance of completing the document to a high standard. The course tutor marked the Needs Analysis Document and if the document did not meet the required standard – that is, if the document did not define the project as both worthwhile and viable – students were given the opportunity to revise the document.

The Second Document – Course Development Document – requires students to detail the pedagogical thinking and development work required to successfully convert their course for flexible/distance delivery. This is the project management equivalent of a project initiation document which functions to ensure that the project has a sound basis. Since the Course Development Document is so central to ClinED 711, we have

provided an example of the document in Appendix One. Completion of this document ensures that the student's chosen course is appropriately developed in terms of meaningful course content, meaningful student activities, and meaningful student-teacher and student-student interaction (Hutchins, 2003; Rourke, Anderson, Archer, & Garrison, 1999). This is achieved through requiring the student to detail for their chosen course development project: module topics and associated learning tasks; student roles and activities on the course; delivery mode or modes; teaching and learning resources; tutor support roles; and methods of assessment and feedback. Students on ClinED 711 completed the Course Development Document as they progressed through the course modules so that by the end of the semester the students had a "blueprint" for developing and implementing their own flexible or distance learning course. We can see, therefore, that the student learning was both authentic and personalised as the module content related directly to the students' own projects in terms of completing the Course Development Document.

Subject content for ClinEd 711 was selected in terms of key concepts and knowledge required for the practice of instructional design and the course was structured to foster reflective practice (Bruce, Edwards, & Lupton, 2006, p. 5). The ClinEd 711 modules included:

- The major learning theories of behaviourism, cognitivism and constructivism.
- Instructional design principles and practice;
- Methods for quality assurance in developing flexible and distance courses; and
- Sourcing particular learning objects whilst justifying their pedagogical value, and demonstrating an understanding of copyright issues with respect to their chosen learning object.

The primary theme running through course tasks and assessment was for students to relate course concepts to their personal pedagogical beliefs and their own teaching context. Thus, in addition to the personal relevance of choosing their own eLearning projects, students were encouraged to engage in learning processes that enabled them to see the meaning of what they were learning as it applied to their own teaching practice. With respect to social participatory learning, learners engaged in collaborative exercises through participating in online discussions and through engaging in peer critique exercises. Reflective practice and metacognition were encouraged through peer critique activities, self-reflection activities and through comprehensive feedback provided by the course tutor in accordance with detailed marking rubrics. Finally, the course utilised a variety of media including text, images, multimedia resources and podcasts in order to accommodate different learning preferences.

FIRST ITERATION TEACHING, LEARNING AND ASSESSMENT

The first iteration of ClinEd 711 encouraged personalised learning in terms of students choosing their own eLearning project and in terms of requiring each student to reflect on their own teaching and learning perspectives. For example, having chosen their own course to develop for flexible/distance delivery in ClinED 711, online discussion of topics prompted students to relate course concepts from each module to their own teaching beliefs and teaching practices. The purpose of this self reflection was to encourage students to think about how their beliefs about teaching and learning impacted on their teaching approaches. For example, having learned about constructivist learning theories students might reflect on the educational value of constructivist learning and on whether or not their own approach to teaching included constructivist elements. This

sort of reflection was particularly challenging for students who came to fundamentally question their approach to teaching and the tutor providing feedback on the reflective exercises had to exercise a degree of sensitivity and understanding as students questioned beliefs about teaching that had not previously been considered.

Although learning was personalised for students in these ways, the tutor extensively managed the first iteration of ClinED 711. This was particularly evident in the assessment activities. Each of modules 2-10 required submission of an assessed piece of work. One of the authors acted as primary course tutor and assessor, with the second tutor providing assessment moderation for all student submissions. There was, therefore, a tension between the desire to offer personalised learning – particularly in terms of students taking responsibility for their own learning – and the requirement for students to conform to a rigid assessment schedule throughout the course. The disjoint between the assessed activities and the aim of encouraging students to take responsibility for their own learning only became apparent to the tutors as the course progressed. The tension caused by the assessed modules is evidenced by the following overview of course tasks and assessment activities provided in Table 2.

ClinEd 711 course web pages providing detailed course information and the overview of tasks, interaction, and resources for each module were created using MindManager mind mapping software (<http://www.mindjet.com>). MindManager was chosen because one of the course tutors preferred a visual approach to development work and had used the software extensively. MindManager further recommended itself because it has an export feature that quickly and easily allows the user to export the Mind Map as a set of HTML pages to be uploaded to a server. The exported web pages were hosted within the university's Learning Management System (LMS). Online discussion was facilitated primarily via threaded discussion in the LMS. Students were supported

Table 2. Overview of ClinEd 711 course tasks and assessment (first iteration, 2007)

Coursework item	Module(s)
Online group discussion around course-related material demonstrating critical reflections on your learning and linking of learning to your own context (15%)	Modules 1-10
Completion of Needs Analysis Document (15%) (formative feedback provided prior to final completion)	Module 2
Literature-based development of principles around learning technology and media (5%) (small group/pair assignment)	Module 3
Literature-based development of principles around the role of the teacher (5%) (small group/pair assignment)	Module 5
Sourcing and applying learning objects (10%)	Module 7
Course Development Document (50%), comprising:	
Reflective commentaries on completion of key aspects of the Course Development Document (20%)	Modules 4, 5, 6 & 10
Critique of a peer's draft Course Development Document (10%)	Module 8
Completion of final document (20%)	Modules 9-10

in setting up individual blogs using Blogger (<http://www.blogger.com>) in order that they might post their reflective commentaries. For the two small group/pair assignments (detailed in the table above), students were supported in using PBWiki (<http://pbwiki.com/>) to collaborate, but were also encouraged to experiment with any other collaboration environment of choice. For example, in the second small group/pair assignment, one pair used the collaborative concept mapping application, Bubbl (<http://bubbl.us>).

Despite the low student numbers ($n=4$) on the first iteration of the course, students were relatively active in the threaded discussion forums (135 student messages contributed during the course). Students appeared to have little difficulty with the practical aspects of posting discussion forum messages. Students also found setting up their blogs and wikis relatively easy. We would attribute the lack of difficulty with the various technologies to the fact that students were provided with detailed step-by-step instructions for these tasks. This is one of the ways that we ensured that we designed ClinED 711 in terms of the total student learning experience (Alexander, 2001), taking into account not only course content but also supports required to ensure the quality of the

student learning experience. Although the initial intention had been for students to post their Course Development Documents to their blogs for peer critique, the inability to post file attachments to blogs meant that the LMS discussion forum tool was used for this activity.

As detailed in Table 2 above, students were required to create a reflective commentary on their completion of key aspects of the Course Development Document. Students were provided with a blog to facilitate their reflective practice and a 'blogs' tab was provided within the LMS, with links to each of the student's blog. Because students showed little inclination to post comments in response to their peers' reflective commentaries, the course tutor used a blog conglomeration tool, Blogdigger (<http://blogdigger.com>) to collate all of the blog entries in chronological order on one webpage. The tutor also provided a link to the collated blogs within the LMS. The aim was to make it easier for the students (and the tutor) to review the postings, and to provide more of a sense of connection within the group in relation to their reflective postings. However, students still did not engage in interaction by way of commenting on their peers' blogs. One of the reasons for this may be that no marks were associated with

posting comments on other students' blogs. As we shall see below, we attempted to address this issue in the second iteration of the course.

Students were provided with rubrics detailing the key areas of performance required for each assessed task. The rubrics described 5 levels of performance for each area ranging from exemplary through to inadequate. The course tutor used these rubrics, with an additional column added for comments, to provide feedback to each student on each of the assessed tasks. Students used the Course Development Document rubric to provide critique on their assigned peer's work. Using rubrics in this way worked well to provide clarity on task requirements and to communicate high expectations of performance. However, those high expectations create a matching expectation for quality feedback; if a student was graded as not having achieved exemplary performance within a particular area of a task, then the tutor was responsible for clearly showing how that student had failed to meet expectations. The tutor also had a clear responsibility to show students how they might improve their performance.

In our introduction we made reference to the fact that providing a personalised learning experience for students was challenging on ClinED 711 despite the fact that student numbers for each iteration of the course were relatively low. The challenge concerned the creation of the course in the first instance as we sought to create a course with both standardised elements and individualised elements (Clarke et al., 2006). Whilst the creation of a new course is always time consuming, the commitment to designing a course that would deliver a personalised learning experience for students entailed a substantial number of hours spent in course design. In particular, we spent a lot of hours creating a learning environment that would be personally relevant for the students. We also spent a considerable number of hours in creating authentic or "real world" learning activities. Finally, the creation of the assessed activities together with detailed marking rubrics for each

activity also took a considerable amount of time. Whilst it is not possible to be specific in terms of the time taken to create ClinED 711 compared with the time taken to develop other ClinED courses, we are very aware that we committed considerably more hours to course creation than tutors who followed a more traditional route.

As we shall see below, the time that we spent on creating the course was worthwhile with the external assessor remarking on the quality of the course particularly in terms of the learning activities and tutor teaching practice. With these points in mind we would certainly deem the time and effort spent on ClinEd 711 to have been worthwhile. However, the number of assessed tasks throughout the course combined with the detailed feedback entailed by the marking rubric meant that assessment and feedback activities were extremely time-consuming despite low student numbers. For example, in the first iteration of the course the tutor spent approximately twelve hours assessing the Needs Analysis Document and the Course Development document for the four students. We can see quite clearly that higher enrolments would lead to the need for additional tutors to deal with marking and to monitor the message board. There would certainly come a point at which the format for this course would become unfeasible because we would not be able to commit the requisite tutor time to the course. This would be true even if we employed additional tutors. It is difficult to specify the point at which the ClinEd 711 format would no longer be feasible. However, we can safely say that this level of tutor support would not be possible with a class of two hundred students. Whilst this scenario is unlikely to occur for a specialised Masters course, the question of appropriate learning designs for personalised learning in large classes is a real one.

The difficulty with dealing with large class sizes comes down to offering students an individualised and authentic learning pathway in which they take greater responsibility for their learning in the context of a structured and somewhat

standardised framework provided by the educator. We believe that there is an issue here to do with course creation – discussed above – as the creation of a course that offers personalised learning opportunities is time consuming when compared to offering a course that consists solely of standard components. The second issue is the amount of time that the tutor has to spend supporting each student throughout the course and, in particular, providing appropriate feedback on assessed tasks. Whilst, as already suggested, this problem might be overcome initially by employing additional tutors, this will not always be feasible and even when it is feasible there will come a point when student numbers are too great even with the use of additional tutors. The question then becomes how to continue to offer an individual learning pathway with authentic learning activities in a way that does not place impossible demands on teaching staff.

A peer review process – in which students take responsibility for marking the work of other students – suggests itself as a possibility to overcome demands on tutor time. However this option still requires that tutors oversee the peer review process with a minimum requirement being that they moderate peer reviews across a range of allocated grades. The peer review option also requires an appeal process so that students who feel that they have not been marked fairly by their peers have recourse to the tutor. A second possibility is to reduce the number of assessed tasks. In the case of ClinEd 711, for example, we might reduce the number of assessed activities to two; the first assessed activity would be completion of the Needs Analysis Document and the second assessed activity would be completion of the Course Development Document. Other activities – for example, peer critique of the two core course documents – might be built in to the course structure but not assessed. Students would then be responsible for engaging with others in order to learn from others and to contribute to the learning of others. Unfortunately, our experience

on ClinED 711 together with research in the area would suggest that students engage in online group activities only when marks are allocated for those activities. In the final analysis, motivation is extrinsic; students want to see tangible rewards for their efforts. Reducing the tutor workload through putting more of an emphasis on students' self-learning may not, therefore, be feasible.

The previous paragraph highlights issues that will be encountered when attempting to create a personalised learning environment for a large class. Whilst we have not offered a solution to the problem, we have identified a core issue to do with tutor time spent on providing formative feedback and marking assessed activities. It is our opinion that the learning design for a large class size would of necessity look very different from the learning design for a small class such as ClinED 711. The specialist nature of our course means that we are extremely unlikely to find ourselves in a situation in which we have to fundamentally change our learning design.. However, we know that the learning design is a good one – measured in terms of feedback from the external moderator and in terms of student feedback – and it is therefore a design that we would look to implement for other courses including courses with larger student numbers. We will, therefore, have to continue to think about how to transpose the teaching principles to courses with larger numbers.

FIRST ITERATION RESEARCH RESULTS

In line with the sixth tenet of design research – a commitment to theory construction and explanation while solving real-world problems – the research project associated with ClinEd 711 was originally designed to allow us to answer a number of key questions with respect to teaching clinical educators about developing their courses for flexible or distance delivery. In particular we were concerned with:

- The preparedness of lecturers to teach with technologies;
- The success or otherwise of ClinEd 711 in terms of teaching clinical educators instructional design skills;
- The factors that impacted positively and negatively on lecturers' intentions with respect to flexible or distance learning development once they had completed the course.

For the first iteration of the course, students were given a pre-course survey to determine their extant levels of knowledge concerning teaching with technologies. The same survey was administered at the end of the course. Students also completed a university evaluation questionnaire concerning the course, and following standard procedures for first-time delivery, the course underwent review by an external assessor. Finally, a one-year follow up telephone interview was conducted with students. However, this did not take place before the development of the second iteration of the course and is not reported here.

The outcomes of our research into the first iteration of ClinEd 711 have been reported in detail elsewhere (Blake & Doherty, 2008). In summary, indications were that the course was very effective overall. The external assessor praised the course design and teaching practices writing that, "The creative and practically-oriented assessment tasks are to be lauded. It seems that the course teachers are modelling excellent tutoring techniques." Students reported that: the course motivated them to learn; was intellectually stimulating; and enabled them to enhance their teaching practice. Each student successfully developed a design blueprint for their chosen course, demonstrating learning outcomes that focussed on improved patient care. Areas of concern on the part of the students related to volume of work and the pace of the course. The external assessor also queried the assignment load and recommended greater

assessment weighting for collaborative tasks together with a reduction in the number of assessed components on the course. This bears on the point that the number of assessed activities was at odds with the desire to provide a personalised learning environment and this feedback from the external moderator was considered to be particularly useful. Our experience of teaching the course was one of finding the teaching experience rewarding whilst being aware of several challenges. It should be noted that whilst the number of assessed tasks was deemed problematic, the rationale for including a large number of assessed activities was sound; we wanted to provide students with frequent feedback.

From a teaching perspective, it was very rewarding to be involved with the students as they engaged with learning theory and design issues as part of online discussion, collaboration and reflection tasks, and to see their insights deepen as they developed sound eLearning design blueprints for very worthwhile health education projects. The large number of assessable tasks, each with a detailed rubric, meant that students received frequent and detailed personal feedback. The volume of course tasks however led to expressions of fatigue by students late in the course and meant a fairly high instructor workload despite low student numbers. Although students were generally active in collaboration and communication, the low student numbers also meant that for the most part there was a lack of the 'critical mass' that enables really productive discussion forum exchanges to develop (Blake & Doherty, 2008, p. 100).

In terms of the third tenet of design research – rigorous and reflective inquiry to test and refine innovative learning environments as well as to reveal new design principles – the outcomes of these initial evaluations together the comments from the external moderator and considered reflection on the part of educators, led to a desire to revise the course so that students would:

Personalised Learning

- Experience a greater sense of independence and control over their learning.
- Maintain and deepen their engagement with course concepts while dealing with less assessment.
- Engage in authentic communication and collaboration with their peers beyond the ‘standard’ online threaded discussion.
- Gain more experience of ‘hands-on’ teaching with technologies.
- Be inspired to tap into their creativity to further personalise their learning.

SECOND ITERATION TEACHING LEARNING AND ASSESSMENT

For the second iteration of the course we responded to the assessor and student feedback by:

- Removing the two small-scale collaborative tasks implemented in the first iteration;
- Combining individual reflective tasks within a broader course-long “discussion/research/reflection” assessment category;
- Providing a new academic social networking environment (ClinEd711 Network) for course communication;
- Restructuring the content to reduce the number of modules;
- Introducing student led modules.

An overview of the revised course tasks and assessment is provided in Table 3.

The ClinEd711 Network for course communication and file sharing was facilitated using the open source software, Elgg (<http://elgg.org>). The software was installed and configured on one of the university’s servers by a web administrator, and the course tutor was then able to administer student access. Since there were only six students this was not a particularly onerous task. One can see, however, that administering student access for two hundred students would be a somewhat more time consuming affair. For ease of access, a tab was added within the course in the LMS, providing a link to the Network. Elgg features include a personal profile page for each student, a blog, file storage space, and RSS feeds. All blog entries were collated and presented in date order on a scrolling page to enable students to view peer contributions and to respond by way of comments. The six students who took part in the second iteration participated comfortably in the ClinEd711 Network from the beginning of the course. We did not, therefore, have to spend time supporting students in the use of the social software. Over the duration of the course a total of 124 original blog entries were posted along with 204 comments [note however that this includes the course tutor’s postings, which the threaded discussion forum total of 135 for the first iteration did not]. One of the drawbacks with Elgg was that it did not offer

Table 3. Overview of ClinEd 711 course tasks and assessment (second iteration, 2008)

Coursework item	Module(s)
Online discussion/research/reflection throughout course demonstrating critical reflections on content and others’ contributions, locating and sharing relevant resources, and linking learning to your own context (25%)	Modules 1-8
Completion of Needs Analysis Document (20%)	Modules 2-3
Student-led module: Creation/moderation of content/learning activities/discussion for one module (20%) (small group/pair assignment)	Module 3, 5, or 6
Course Development Document (35%), comprising:	
* Critique of a peer’s draft Course Development Document (10%)	Module 7
* Completion of final document (25%)	Module 8

a feature to easily view the most recently posted comments. At our request, the web administrator reconfigured the software to provide this feature.

Combining all discussion and reflection tasks within a single discussion/research/reflection task (with amended rubric) relieved the pressure on students to post reflections at fixed times and in response to set questions. Pressure on the course tutor to provide rubric-based feedback on these reflections was also relieved, with feedback being provided more informally by comments in the Network from both peers and the tutor. For two of the students, participation levels and depth of reflection were perhaps lower than might have been the case if they had been required to post reflections. To help focus students on the depth of engagement that was expected, the course tutor provided each student with formative feedback half way through the course using the discussion/research/reflection rubric. Unfortunately this did not solve the problem of lack of engagement on the part of the students in question. It is the view of the tutors that the original reflective tasks structure would have obliged the students in question to contribute. The revised structure meant the students were penalised less for their lower level of contribution. This points to a tension between the control exercised through assessed tasks and the responsibility students have for their own learning in a personalised learning environment. Overall, however, the new assessment structure and networking environment appeared to provide a greater level of personalised learning by promoting greater intrinsic motivation to engage with peers and course concepts. Additionally, the course tutor experienced the workload as manageable although it has not been noted that marking the Needs Analysis Document, the Course Development Document and the student led modules (detailed below) still took a considerable amount of time.

STUDENT-LED MODULES

The second iteration of ClinEd 711 provided for students to lead one of three modules (out of a total of eight modules) that had previously been tutor-led in the first iteration of ClinEd 711: Technologies and Media, Role of the Teacher, or Quality in ELearning Design and Teaching. The student-led modules were created as collaborative tasks in which a pair or small groups of students (up to 4) would be assigned to one of the three designated modules. Students were provided with only a brief introduction to the module together with a set of learning objectives that they were to assist their peers to achieve. Each module lasted 2 weeks, with students expected to collaborate ahead of the scheduled start date to ensure their module was ready to 'go live' on the due date. As we have seen, one of the key aspects in personalised learning concerns students taking responsibility for their own learning. Providing student-led modules, therefore, made a significant contribution to ClinED 711 as a personalised learning environment. The social component of ClinED 711 was further enhanced through the fact that students were also taking responsibility for the learning of their fellow students. If the students allocated to a particular module failed to complete the learning activity, then their fellow students would not have the requisite content for that particular module. The overview of the task provided to students is set out in Figure 1.

Of the 20% of the total course mark allocated to the student-led module task, 12% was for the creation of a web-based module resource. The description provided in the rubric for the ideal performance for this task was:

Group members provide an engaging website, wiki, blog or other resource for the allocated module with original content and links to relevant scholarly materials together with case studies or other interactive tasks that can serve to stimulate discussion and reflection. Taken as a whole the

Figure 1. Overview of the student-led modules for students in the ClinEd 711 course

Student-led modules

The student-led modules provide you with a hands-on opportunity to work with one or more assigned colleagues to take the learning objectives for an assigned module (Module 3, 5, or 6) and create an engaging online module that will help your colleagues to achieve the module's objectives.

During Module 1 your instructor will notify you of your assigned colleague/s, and the module you will be preparing and moderating.

The student-led modules provide you with an opportunity to:

- become more familiar with the literature as you conduct your own research to locate suitable readings for your assigned module
- use software tools for collaboration, planning & production of web-based resources
- apply learning theory to the design of an online module
- build a 'teaching presence' into online materials
- set up and moderate online discussion
- reflect on the process of creating and moderating the online learning for your module.

You may wish to use the [module layout](#) used in this course (and the questions included there) to help inform your work.

You and your assigned colleague/s are able to choose which software platform you will use to create and moderate your module. Options include:

- A [wiki](#) or [blog](#) (both of which enable content to be presented and discussion to take place via a 'Comments' function)
- The [eXe eLearning editor](#) (which is able to produce webpages that can be uploaded to the ClinEd 711 course in Cecil), in conjunction with discussion conducted via a wiki or blog, or in the ClinEd 711 Network
- Setting up a Community in the [ClinEd 711 Network](#), which enables files to be uploaded and discussion to occur in the community's blog
- Some other web-based option that will enable you to present your content and links to readings, as well as to facilitate online discussion (if you're unsure, ask your instructor).

We appreciate that this is a challenge! Your instructor will be available to assist.

Assessment

Your collaborative efforts on your student-led module are worth 20% of your total mark for the course. Detailed information and assessment rubrics are set out [here](#). **Make sure you use the detailed rubric for the Collaborative Module to guide your work. Note the weightings for each category, and use the description of ideal performance for each category as your target.** If you do not carry a fair share of the workload you may incur a penalty.

resource provides a sound platform for peers to successfully fulfil the module's learning objectives.

A further 5% was allocated to moderating module tasks and online discussions engaged in by peers as they undertook the module, and the remaining 3% to accurately evaluating the success of the module design, resource, and moderation.

STUDENT RESPONSE TO THE STUDENT-LED MODULES

As noted earlier, we had initiated our redesign for the second iteration of the course (including introduction of the student-led modules) in the hope that students' engagement with the course concepts, with their peers, and with educational technology tools would be enhanced. The student-led modules embodied all of our 6 core learning design principles, but there was a particular focus on the first principle: that learning should be personally meaningful for the learner. Our

hope – indeed our design conjecture (Sandoval, 2004) – was that the challenge of collaboratively creating and moderating a module for peers would lead to positive intermediate outcomes or “observable patterns of behaviour predicted by a model of how an embodied conjecture functions to support learning” (Sandoval, 2004, p. 215). We predicted that these intermediate outcomes would include student research activity in order to offer a variety of resources and perspectives, creative module learning designs, use of a range of technologies, and engaged moderation of tasks and discussion during the modules.

Our predictions were largely fulfilled in the manner in which students engaged with the student-led module task. All three pairs collaborated successfully to produce online modules that were ready on time. The first pair used the open source eXe eLearning editor (<http://exelearning.org>) to produce their module resource, and moderated peer discussions in the ClinEd711 Network social networking environment. The second pair used a wiki (<http://www.wikispaces.com>) to both present

their resource and to facilitate discussion. The final pair used an eLearning development tool (CourseBuilder) created by a web developer at the University of Auckland, and facilitated peer discussions in the ClinEd711 Network. Each pair took a different design approach to achieve their module's learning objectives, and provided a range of readings and resources for their peers to draw on in undertaking module tasks and discussions. One of the modules was exemplary when measured objectively in terms of the marking rubric. Moderation of discussions was inconsistent for one module, but the student pairs were otherwise active in moderating their modules. Students reflected well on their learning designs for the modules that they created, on the moderation that had been effective, and on what they would do differently next time.

At the end of the course, students were asked to complete the revised post-course questionnaire. This included questions regarding the student-led modules. Five out of six students who undertook the course completed the questionnaire. Students were asked:

Was it helpful for your learning to collaborate with a peer to develop and moderate your student-led module? Why or why not?

All respondents answered in the affirmative with three of the respondents referring directly to the benefit of gaining a different perspective on their topic, two students referring to the benefit of sharing the workload and one respondent expressing the view that the task provided an insight into expectations that are placed upon their students. Students were also asked:

Did you learn more from the student-led modules (led by your peers) than from those led by the course coordinator? Why or why not?

Some students answered from the perspective of developing and moderating their own student-

led module whilst others responded in terms of their participation in the modules that were led by the other students. Three of the five respondents indicated that they had learned more from the student-led modules with one respondent referring to the need to actively learn about a module in order to present it effectively and two respondents reporting on the value for their own learning of leading a module.

Finally, in engaging with this research over two years we have shown fidelity to the fifth tenet of design research: intensive collaboration among researchers and practitioners, and learning communities. We have achieved this through working as academic partners in reflecting on and refining teaching approaches and course and research design, working with ClinEd 711 students as academic colleagues who can offer valuable insights into the effectiveness of the course design, and through our informal discussions with other researchers about the project. At the time of writing we are in the final year of our research project and we are committed to carrying out evaluations of the their iteration of the course in order to improve ClinED 711 further.

THE MORE THINGS CHANGE, THE MORE THEY STAY THE SAME

The technologies available today may open up a wider world for information gathering and provide for multiple means of social interaction through, for example, the use of Web 2.0 applications and services such as blogs, wikis and social networking spaces such as FaceBook. However the fundamental model of personalised learning with a social dimension, in which students make use of multiple media sources to work collaboratively on a particular problem, is not new. The issues and challenges faced in previous implementations of what can be considered to be personalised learning – albeit under the different name of student centred learning (Brush & Saye, 2000; Hannafin

& Land, 1997) – need to be borne in mind in the current educational climate.

We are all I suspect familiar with the now somewhat tired notion of the shift from the sage on the stage to the guide on the side and possibly even the meddler in the middle (McWilliam, 2008). However, the question of the changing role of the educator in a personalised learning environment – and by implication the role(s) of the students – is significant. Whilst personalised learning may shift responsibility for learning to the student, it is the educator who is designing the learning environment thereby providing the parameters within which the learning takes place. Thus, whilst learning may be personal, that learning has to be focused on something and that something has to do with course objectives, learning outcomes, provision of content and appropriate forms of assessment. In other words, there must still be careful course and lesson planning. If not, then students may experience a sense of “frustration” and “disorientation” (Brush & Saye, 2000, p. 79 & 88) with some students failing to understand the nature of the task or problem that has been set for them (Brush & Saye, 2000, p. p.90). Whilst it may not be in vogue for educators to transmit knowledge, they are still subject matter experts in their particular field and they need to fulfil the essential roles of advising, guiding, supporting, discussing and critiquing the student’s learning (Salmon, 2001).

Educators need to accept that students who are engaged in personalised learning are going to find resources, develop perspectives and create work that will fundamentally challenge the educator as subject matter expert. In the opinion of one writer, the educator will become “a usefully ignorant co-worker in the thick of the action” (McWilliam, 2008, p. 263). Whilst the notion of the educator as an ignorant co-worker is certainly ill considered hyperbole – a heart surgeon with twenty years experience and a wealth of theoretical knowledge to impart is anything but ignorant – it is true that personalised learning is a very different scenario

from the lecturing scenario in which the lecturer as “guru” (McWilliam, 2008, p. 266) is distanced from the students and transmitting knowledge. In contrast, personalised learning brings proximity – the educator in the midst of the learning – and the concomitant challenges that come with proximity; for example, the educator has much less control over the actual learning process and may find him/herself in unfamiliar territory both in terms of subject matter and technologies. This suggests that educators require support (Brush & Saye, 2000; Hannafin & Land, 1997) in transitioning from a traditional role to a new role in a personal learning environment. This is particularly apparent if we conceive of a student’s personal learning environment (Downes, 2005). In this case, the learner is situated at the heart of the learning environment whilst being connected to communities of interest, learning communities, communities of practice, social spaces, Web 2.0 tools, multiple sources of information and, finally, to multiple forms of media. Amine provides an excellent graphical representation of such a personal learning environment (Amine, 2007).

Teacher management strategies remain important in a student-centred learning environment (Brush & Saye, 2000, p. 92). It cannot be assumed that students will simply work effectively either as individuals (Hannafin & Land, 1997, p. 191) or in groups (Brush & Saye, 2000, p. 88). Educators need to structure activities in terms of, for example, “individual accountability, group goals and rewards, and, most importantly in the case of student-centred learning, methods for providing students with opportunities to learn and practice group management and decision making skills” (Brush & Saye, 2000, p. 81). The educator must also retain the role of ensuring that student interactions are both socially and academically appropriate. For example, maintaining appropriate decorum on message board discussions or, if the learning space is physical, within the classroom (Brush & Saye, 2000, p. 88). However, if the educator is successful in the task of establishing

an environment conducive to personalised learning then s/he can gradually fade into the background as students develop the requisite skills to become self-directed learners (Hannafin & Land, 1997, p. 194). It is at that point that we might describe the learning environment as truly personal. We would note, however, that the tutor still has a role at this stage. That role covers both the affective activities conducive to good teaching – encouragement, support and understanding for example – and the ‘intellectual’ activities that are a part of teaching well. Examples of such activities would include providing students with sources of information, assessing their work at both a formative and Summative level and providing constructive feedback to help students improve.

FUTURE RESEARCH DIRECTIONS

It is time perhaps for a slight confession. We have two issues with our future research direction. The first issue concerns the use of design research as an appropriate research methodology. We are fundamentally questioning the value of this approach to research. Our concerns in this area lie with whether or not the research results warrant the time and effort that has to be spent analysing the quantitative and qualitative data. Despite the fact that student numbers have been low on ClinED 711, we have put considerable time into analysing student coursework, student blog postings and student discussion board postings in order to determine whether the changes that we made to ClinED 711 resulted in an “improved” learning experience for students. Whilst we would say that our changes have led to improvements in the course – particularly in terms of personalising the learning for students – we are of the opinion that reflective teaching practice might have achieved the same results with considerably less work. Reflection can be understood as “learning through questioning to lead to a development of

understanding” (Loughran, 2002, p. 134). This questioning is prompted by something that is common to all reflection; the centrality of a problem in a practice setting (Centre for Support of Teaching and Learning, 2008; Loughran, 2002). Reflection would differ from a more formal research approach in terms of the fact that changes to particular courses would be made in terms of the judgment and experience of the practitioner. Furthermore, reflective practice does not necessarily result in peer reviewed publications of any sort. Whilst we have not focused on research methodology in this paper, the point is an important one in terms of the feasibility of carrying out this sort of research on a larger scale. Just as there would be problems scaling up the pedagogical approach of ClinED 711 in order to offer the course to much larger class sizes, so there would be problems scaling up the research.

Our second issue with our research concerns where to go next. The fact is that ClinEd 711 has been rated very highly by both the external examiner and by students. We have made a number of changes to the course with the result that we have provided a more personalised learning experience for students and our current judgement is that whilst we might make minor revisions to the course, ClinED 711 provides a quality learning experience for students. Furthermore, ethics approval for our research comes to an end this year (2009) and we are not envisaging asking for an extension. It is time to look for a new research direction. We have made mention throughout this chapter of the fact that student numbers on ClinED 711 are relatively low. However, the Learning Technology Unit produces distance postgraduate courses where student numbers are considerably higher. Nursing, for example, regularly offers postgraduate courses with student numbers approaching two hundred. One logical direction for our research would be to consider how we might take the learning principles applied in ClinED 711 and apply them to courses with much larger

class sizes. In essence this would entail considering how we might offer meaningful and authentic learning tasks with students taking responsibility for their own learning whilst also learning according to their preferred learning style. Taking over the pedagogical tactics (Goodyear, 2005) or the specific learning activities from ClinEd 711 is unlikely to work for reasons already cited; the demand on the teacher's time would simply be too great. The challenge will be, therefore, how to apply our pedagogical philosophy (social constructivism) and high level pedagogy (meaningful and authentic learning tasks) whilst changing our teaching tactics (Goodyear, 2005).

If we are to scale up the pedagogical approach that we have taken in ClinED 711 then there are number of key areas that we need to consider. At the level of the learning activities in which students engage we will have to address the issue of monitoring blog entries and discussion board postings. In a course of two hundred students or more the potential workload for the teachers responsible for monitoring discussions and postings is enormous. We would also have to look at the nature of our assessed activities. With large student numbers it would just not be feasible to be marking – for example – two hundred discussion board postings against a detailed marking rubric that required extensive feedback for students. It is interesting that the idea of students taking responsibility for their own learning is one of the key elements of a personalised learning environment. If students really did take responsibility for their own learning – and by extension the learning of others in a social constructivist framework – then the tutor role might be reduced to one of providing guidance throughout the course whilst also providing extensive feedback on two major assessed activities. Taking this direction would make the teacher workload much more manageable. The core research question would then be one of how to increase the intrinsic motivation of students. There is a certain logic

in considering this question since the heart of constructivist learning theory is the notion that student learning is a search for significance or meaning. If this is the case, then one of the key roles of the educator would be to understand the student, particularly in terms of what motivates each student to learn. This would be – in part at least – a question of eliciting already held beliefs from the student. It would also be a question of understanding student attitudes. For example, which students are taking the course simply to progress their careers? Which students are taking the course because they are passionate about learning? Which students prefer to learn individually rather than in a group situation? These seem to be important questions if one adheres to a constructivist teaching philosophy and yet these questions are seldom asked (Holt, Smissen, & Segrave, 2006).

CONCLUSION

In this chapter we have described the process of designing and delivering a personalised learning environment for students. We have acknowledged that the course in question – ClinED 711, EL-learning for Clinical Educators – is a specialised postgraduate course with relatively low enrolments and we have discussed the difficulties of “scaling up” the course design in order to deliver a course based on similar principles to much larger student numbers. Finally, we have recognised that there are two areas that require further research; the first is the implementation of constructivist learning theory and the second is how to offer personalised learning to larger classes. Overall, student feedback together our own experience of teaching ClinED 711 suggests that personalised learning is a valuable approach to teaching that results in a rewarding learning experience for students.

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APPENDIX

Table 4. Course Development Document

Outline the learning tasks students will complete for which you seek LTU development support:						
Module/Topic, Learning Objective and Learning task	Student Role/ Activities (what will students do?)	Delivery Mode(s)	Resources (what materials or information will students draw on to complete the task?)	Tutor Role (how will you support the students as they undertake the task?)		Assessment/Feedback (how will you assess or provide feedback on the students' work?)
				Text-Based Supports	Personal Supports	
e.g. Microbiology module - Small group collaboration (1 week) to produce individual summary of particular disease organism and process	e.g. Students will work in groups of 3; each group will be allocated one of 3 disease organisms; will individually develop summary of organism and disease process and submit to group members for critique; will refine and submit to lecturer for marking	e.g. Online, via LMS small group discussion forums	e.g. Lecturer's PowerPoint summaries of disease organisms Journal articles Weblinks	e.g. Instructions outlining task and student roles Rubric for disease summary Rubric for participation Disease processes template (Word doc) Announcements at start/midpoint/completion to keep students focused	e.g. Facilitate small group discussions online by moderating as required	e.g. Assessment of disease summary based on rubric (12%) Assessment of participation based on rubric (3%)

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Chapter 4.3

Creating Supportive Environments for CALL Teacher Autonomy

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ABSTRACT

This chapter reports on a study undertaken on the impact of pedagogical and technological innovations in language teaching and language learning, with a special focus on creating online institutional environments to support teachers' autonomy in computer assisted language learning (CALL). This study took place at MUELC, a self-funded teaching institution that belongs to a network of Australian universities offering English Language Courses for Overseas Students (ELICOS). Significant expansion in student enrollments has resulted in programs across four locations with all language teachers involved in CALL delivery. Fostering and supporting teacher autonomy became the key premise for the creation of multifaceted in-house CALL support initia-

tives, one of them an online portal containing resources for teaching and learning as well as tools for reflection on practice and opportunities for professional development. Language teachers have been building this intranet portal site using the theoretical frameworks of practitioner-based inquiry and organizational change management. The evaluation of this study reflects the duality of the research aims; namely, the features of the developed product and the learning process of the teachers involved. This may be of value to other language institutions embarking on similar online projects.

INTRODUCTION

The research site is a university English language center established in 1988, initially with about 80 to 100 students. The first CALL classroom was

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fitted in 1992 with a CALL specialist employed to promote the value of computers in language learning. Since then, the center has been offering weekly language sessions in a computerized environment that aims to equip students with computer literacy and lifelong learning skills to assist them in diverse sociolinguistic contexts.

Increased student enrollment resulted in a serious shortage of specialist CALL teachers, ensuing a conscious decision to involve all language teachers in the delivery of CALL. In order to achieve consistency and quality of CALL delivery across programs, language teachers needed to be adequately prepared and supported. This was (and continues to be) achieved by removing barriers to using technology for teaching and, specifically, through organizational efforts supporting teacher autonomy. As a direct result of these activities, teachers' attitudes to CALL have become more positive. CALL in-house training, support programs, and other means of removing barriers to teaching with technology have been a major contributing factor to this change (Chylinski, 2005).

The current study has directly evolved from these organizational initiatives aimed at supporting teachers in CALL delivery and professional development. Due to continuous expansion, the center now operates on four campuses. This necessitated some of the support structures for CALL programs to become independent of their physical locations. The main project aim was thus to create a common space online that would centralize access to CALL materials, ensure consistency of information available to all campuses, and assist with professional development in CALL, thus supplementing current work practices. The other aim was to record all factors that influenced the instructional design process and record thoughts, feelings, actions, and behaviors of the research members. The qualitative, practitioner-based inquiry approach chosen for this study meant all these factors could be meaningfully interpreted.

BACKGROUND

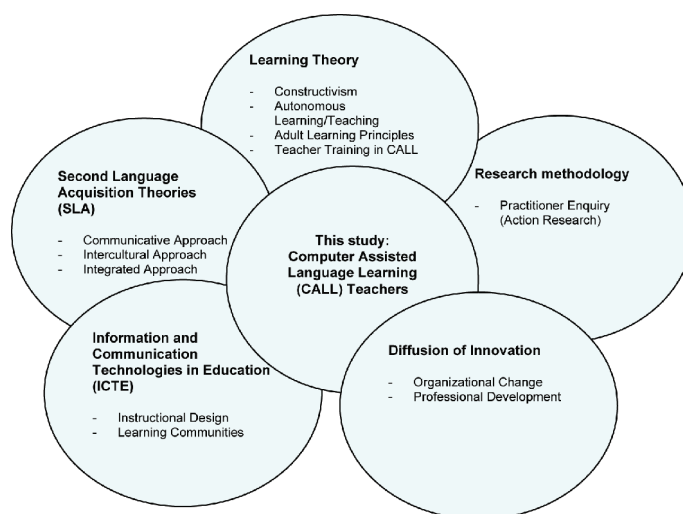
There is a large number of acronyms and terms used to describe teaching and learning with new technologies. For this chapter, the term Computer Assisted Language Learning (CALL) was chosen, as it emphasizes "the whole range of possible roles the computer could play in language learning" (Levy, 1997, p. 82) and because this is the term by which computer-aided instruction is referred to at the language center in question.

The theoretical grounding and literature for this chapter focus on professional development in CALL informed by the fields of second language acquisition, adult learning theories, Information and Communication Technology in Education (ICTE), diffusion of innovation theory, and action research methodology. Figure 1 depicts this chapter's focus, main knowledge fields, subthemes, and how they intertwine.

History of CALL with Some Insights to Teacher Professional Development

Warschauer and Healey (1998) identified three phases of CALL in their overview of the use of computers for language teaching in the last 30 years. They observed gradual but irregular transition from the behavioristic phase of CALL through to the communicative and, most recently, its integrative phase. An alternative and, we would like to argue, more encompassing attempt at the analysis of the history of CALL is provided by Stephen Bax in his paper titled *CALL—Past, Present and Future* (Bax, 2003). Rather than describing phases, Bax provides three approaches to CALL teaching; namely, restricted, open, and integrated. He argues that this helps to alleviate confusion with time periods and methodologies and allows for a better description of teaching and learning practices.

Figure 1. Literature focus, themes, and subthemes and their overlap



Leaving these discussions aside (not because they are unimportant but because analyzing them is beyond the scope of this chapter), the following section will briefly review developments in CALL with particular emphasis on language teachers and their professional relationship with computer technologies.

Initially, CALL was influenced by behaviorist theories of learning in the 1950s, with repetitive language exercises based on *drill and practice* courseware. During the 1960s and 1970s, main-frame computers were used, with computers being seen as a patient tutor able to give instantaneous feedback for repeated vocabulary drills, grammar exercises, and translations. These were relatively easy to program by early CALL software developers, as they utilized set instructional sequences. Each step required a learner response, followed by computer feedback (Ellis, 1997). Professional development for CALL teachers focused on computer operating skills, labeled by Jackson (1971) as the *defect view* because this development focused on helping teachers overcome deficiencies in their computing skills. This remedial type of professional development was mechanical and consisted of a singular event focusing on the use

of the technique, whether it was appropriate from a pedagogical point of view or not.

According to Warschauer and Healey (1998), the introduction of microcomputers and, more importantly, the shift at the theoretical and pedagogical levels toward the communicative approach, allowed for the second phase of CALL to commence. Dissatisfied with behaviorism and realizing that learning was not just a *stimulus-response* reaction, researchers actively investigated other theoretical frameworks. The concept of *individualistic* learning began influencing educational practice and gradually became the dominant learning theory of the time (Jones & Mercer, 1993). This concept had implications for software design and evaluation of computer-based classroom learning and created a problematic relationship between language learning theories and educational computer programs (Jones & Mercer, 1993). This significant pedagogical shift resulted in moving from the paradigm of an instructional approach toward a collaborative and facilitative approach. This move has been reflected in the terminology of the field: *language instruction* was now seen as *language acquisition*, and the term *foreign language teaching and learning* changed to *second language acquisition* (Krashen, 1982).

In CALL, skill practice was provided through courseware that offered language games, paced reading, and text reconstruction. These choices were giving learners numerous options, decision power, and interaction in discovering the correct answers. The previous view on computers as tutors was reconceptualized, with the computer being seen as a stimulus and a tool. Software was used to provoke discussion and critical thinking as well as to teach language aspects through the use of word processors and their features (Warschauer, 1996).

The previous defect approach to professional development of CALL teachers gradually lost its appeal since it emphasized the latest educational fads and prescriptive techniques concentrating on simple or behavioral aspects of teaching. Instead, the *growth approach* (Jackson, 1971) was observed more frequently. This approach recognizes that teachers are continuous learners who desire to solve instructional and organizational problems and wish to be involved in the decision-making processes.

The next historical phase of CALL was facilitated by advances in technological developments; namely, multimedia computers and the Internet. Numerous media (e.g., text, graphics, sound, animation, video) could now be accessed and used by the learner through the keyboard or the mouse, or by listening through headphones or speaking into a microphone. Authentic on-screen environments allowed application of all four macro skills within one activity while giving learners control over the pace and path of their learning. This was achieved through revising or skipping specific parts as desired and by managing the levels of difficulty. The main focus of instruction was not merely on the content and language forms but also increasingly on learning strategies. However, the quality of available programs, combined with technological limitations, prevented hypermedia having a significant effect on language learning (Warschauer & Healey, 1998).

In contrast, the expansion of electronic communication and the World Wide Web (WWW) in

the late 1990s offered a cheaper, easier, and more convenient means for using language across all aspects of the curriculum. Initially, materials on the Internet were textbooks, grammar exercises, and collections of random activities. Using e-mail to share messages, documents, graphics, sounds, and video files offered other meaningful, authentic, and immediate language learning opportunities (Warschauer & Healey, 1998). Currently, the immediate access to authentic materials in the target language on the WWW (i.e., newspapers, radio broadcasts, podcasts) and opportunity for publication of texts and multimedia materials by learners (i.e., blogs, wikis, and digital storytelling) created by the Web 2.0 social software, facilitates an even more communicative approach to using CALL. No longer restrained by difficult and time-consuming authoring shells and the static, self-contained courses on CD-ROMs, language professionals increasingly use these new, user-friendly technologies in their teaching (Godwin-Jones, 2003).

Current technologies have opened up possibilities for creative development of language learning and teaching materials, thus enhancing and also necessitating increased teacher autonomy.

Supporting Teacher Autonomy Through an Online CALL Portal

As previously stated, MUELC is committed to CALL teacher support and provides a range of in-house initiatives in this area. These aim for teacher autonomy through structured professional development opportunities, provision of relevant teaching resources, flexibility in the choice of materials and methods, and opportunities for reflection on practice. In this study, the MUELC research team wanted to test whether providing all these support functions through an online portal was at all possible or desirable, and whether it would aid CALL teachers' autonomy.

Research Aims and Questions

The key axiom, frequenting all practitioner-led inquiries is the identification of a problem emerging from the tension between research and practice (Dick, 1999). Similarly, the context of this research was not purely academic but also pragmatic. The aim was to involve teachers at the language center in creating a Web-based CALL teacher portal that would support teacher autonomy through professional development provisions, transparent access to resources, and reflection on CALL practice.

The overarching research question was “*Can online portal support teacher autonomy in CALL?*” with the following three lines of inquiry:

1. In what ways do teachers feel that the Web-based CALL teacher environment can assist them in their professional development in CALL?
2. Can access to resources, from the teacher’s point of view, be improved with this online environment?
3. Do teachers feel the need for professional discussion and collaboration in CALL ?

Would they reflect on their CALL practice using the new Web-based environment?

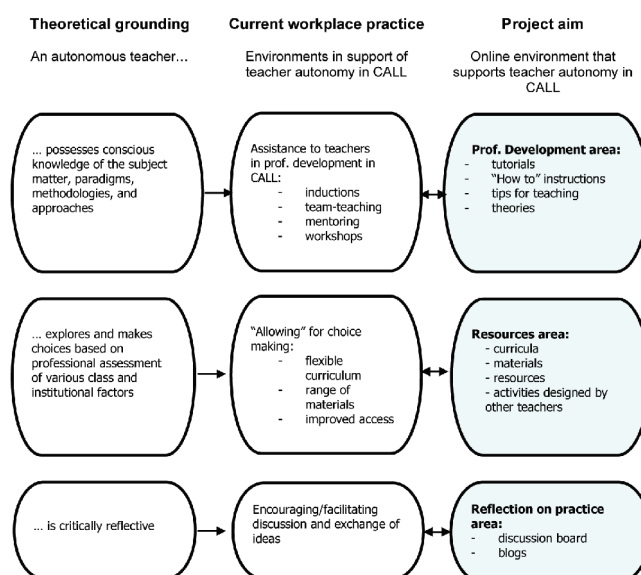
The graphic representation of these aims in Figure 2 demonstrates how they evolved from contemporary CALL support structures at MUELC (Chylinski, 2005) and their placement within the theoretical and pedagogical assumptions of teacher autonomy.

Research Methodology and Supporting Literature

The emphasis of this study was on instigating a process of positive change and on the recording of factors influencing the research and the research subjects. Most fitting for this purpose was action research, defined by Geoffrey Mills as follows:

[A]ny systematic inquiry conducted by teacher researchers to gather information about the ways that their particular school operates, how they teach, and how well their students learn. The information is gathered with the goals of gaining insight, developing reflective practice, effecting

Figure 2. Research aims in relation to current MUELC practice and underpinning theory



positive changes in the school environment and on educational practices in general, and improving student outcomes. (Mills, 2003, p.4)

Action-research, or practitioner-based inquiry, usually assumes participation and is occupationally relevant and responsive (Dick, 1999). Participation of the teaching staff was of significant importance during this project; team members were expected not only to use and evaluate an online environment but also to engage in its design right from the conceptual stage. Their active involvement had better potential to deliver a product that would meet CALL teachers' needs. It was also hoped that a collaborative and collegial exchange of ideas would foster greater understanding of ICT in language education, thus contributing to teachers' professional development. This intention was in line with the views of Moon (2000) on professional reflection as an effective learning tool for practitioners.

The choice of action research for this particular project was further supported by two other bodies of literature; namely, managing organizational change and instructional design.

The literature on managing change at educational institutions stresses the importance of staff involvement in the process of instigating change. Such involvement of colleagues increases the ownership, improves understanding of the process of change, and builds a critical mass of change agents (Eckel & Kezar, 2003).

The literature on instructional design strengthens this view and proves that in order for multimedia projects to be successful, collaboration should occur between experts of the content and experts of multimedia design (Clark & Mayer, 2002; Sinclair, Alfred & Smith, 2002). Researchers also advise against educational technology projects being totally dependent on individuals or a few impassioned professionals. Such projects are usually short-lived because they are not entrenched in the work culture of the place (Sheely, Veness & Rankine, 2001).

The design of the CALL Teacher Portal research was informed by a wide range of literature on Instructional Design Models (IDMs) and specifically by works of Andrews & Goodson (1991), Sims (2000), and Sheely, et al. (2001). Gustafson and Branch (2001) surveyed instructional development models and categorized them according to scope and purpose into Classroom Oriented Models, Product Oriented Models, and Systems Oriented Models. In accordance with their definition, the design of the CALL Portal is likely to fall into the *Systems Oriented Models* focusing on analysis of a large environment and assuming a large scope. The articulation of such a model usually encompasses the process of theoretical conceptualization (Conceptual Stage/Analysis); the process of designing of a platform (Product Design/Prototype); the process of production, dissemination, and adoption (Development, Dissemination/Adoption); and finally, the process of evaluation.

These stages, according to Sims, rarely occur in a chronological manner. His dynamic I³D model (Interactive Instruction Influence Model) describes particularly well project management and quality control practices at MUELC (Sims, 1997).

An important element of the way the design of the CALL Teacher Portal was managed was the context analysis (added as an important ingredient of IDMs to the analysis stage by Tessmer and Richey in 1997). Focusing on context allowed us to analyze learner background, incentives, resources, organizational culture, and available group support.

The CALL Teacher intranet has been designed to provide for, among other functions, teachers' professional development in CALL. Therefore, the quality of the interactivity constructs have been of significant importance to the project. Designing interactivity may seem to belong more to a world of computer games. However, it plays a prominent role in all instructional design environments. There is more to interactivity than just the physical

interaction with software. Sims (2000) seconds Aldrich, Rogers and Scaife (1998) to move “the emphasis away from the level of physical interactivity at the interface (i.e. button pressing and mouse clicking) to a consideration of cognitive interactivity (i.e. learning activities which are supported when interacting with the software)” (p.331). Sims (2000) provides an in-depth analysis of interactivity through taxonomies and levels while defining four dimensions of interactive constructs: interactivity and learners, interactivity and content, interactivity and pedagogy; and interactivity and context. It is within those four dimensions that the interactivity constructs of the CALL Teacher intranet will be discussed later in this chapter. (Table 1)

Account of the Process and Data Summary

The Action Research Team consisted of six teaching English as a second or other language (TESOL) experts with various degrees of CALL experience and proficiency. The selection process was completely voluntary.

Data were gathered in several ways: detailed notes from the team meetings with verbatim quotes from participants, journal entries, questionnaires, and field documents (archived CALL reports and in-house publications). In keeping with action research approaches to data analysis, once data collection was complete, a theoretical framework was used to enable analysis and evaluation. All data were categorized and evaluated according to the conceptualization of the action research process in relation to teaching a language with ICT and teacher autonomy frameworks.

The research took six months in all, with the main part of the project having three distinctive stages: conceptual design, platform design, and project evaluation. On average, team members worked one hour a fortnight over four months on the main research component. There were nine meetings in all. The purpose of these meetings was to set an action plan and decide on priorities, read excerpts of relevant literature and discuss its understanding, explore thoughts and feelings as reflected in the journals, and review the data gathered from previous meetings to clarify accuracy if necessary.

Table 1. Research and action elements at various stages of the project

Project Stages	Research Process → People (as researchers and adopters)	Action Product → Online Portal (as a learning environment)
Stage 1 Conceptualization	Who is involved? How do they work? What paradigm do they associate with? What is their educational context? What are their skills, knowledge, and theoretical framework? What do they want to achieve?	What is its purpose/rationale?
Stage 2 Platform Design	Who are the users? What are their needs? What is their IT context (expertise, access, and support)? What is their CALL context (expertise, access, and support)?	What will the interactivity constructs be? What media should be deployed? What is the publishing model? What are the quality assurance procedures?
Stage 3 Project Evaluation	Do users feel the product meets their needs?	Is the product being used as intended?

The main characteristics of action research are, as its name suggests, *action* and *research* (Dick, 1999). The action aspect of this research was to create an online environment that empowers CALL teachers, while the research aspect was to instigate and evaluate the learning process and to reflect on practice with a view of professional and organizational growth.

During the first stage of the project (Conceptualization), the team engaged in discussion of research background, context, and aims, while reflecting on their reasons for joining the action research group. Responses revealed that all team members regarded this as an opportunity for professional development and wanted to make a contribution and be part of positive change, believing in research as a way of implementing new ideas.

Reading of Patton's *Common Principles Undergirding Qualitative Inquiry and Humanistic Values* ensured common understanding of qualitative methods of action research and, particularly, understanding the idea of *process use* (the process as important as the outcome) as opposed to *findings use*, the former being of a greater learning value to the process participants and to the program being developed (Patton, 2002).

The focus then moved to defining types, or categories, of CALL teachers in the language center and specifying their respective needs in order to become autonomous. The distinction was based on teachers' CALL experience and skills (Novices, In-Transition, Experienced/Confident, Power Users), attitudes to CALL (Luddite or Debutante, Chrysalis, or Explorer), and mode of employment, which intertwined with time and access factors (Sessionals, Contract, Emergency Teachers, Part-Time, and Full-Time).

During Stage 2 of the project, the Platform Design stage, needs for each CALL teachers' category were prioritized and the issue of a model design considered through questions such as "Can or should the online portal meet these particular

needs and how, and what functions should it fulfill? The list of desired functions and items for inclusion was then matched against the aims of the research. Then, the team reflected on the discrepancies between the project aims and the proposed project's design thus far. The exercise revealed that the collaborative and reflective functions of the intranet portal had not been sufficiently addressed by the team. The general discussion that followed aimed to ascertain if teachers regard collaboration in teaching and teaching CALL in particular as important.

Finally, teachers had input into the proposed site structure, learning some basic principles governing Web design and usability issues (Krug, 2000). The team members also took part in a hands-on session on the functions of the discussion board settings and blogs, which for some was the first encounter with online collaborative environments.

During the final, evaluation stage of the project, participants were asked what they judged as measures of success and/or failure in assessing both the product and the professional development benefits of the project. Finally, the future of the CALL intranet portal was contemplated and the recommendation for further evaluation and development discussed.

DISCUSSION

The two-step process of a final evaluation reflected the duality of the research aims; namely, the learning process of the teachers involved and the features of the developed product. The next section of this chapter aims to ascertain whether subjects of this study felt participation in the research developed them professionally as hypothesized and whether the designed product was indeed perceived as supporting teachers' autonomy in CALL.

The Teachers

Providing for CALL teacher autonomy was a principal theoretical concept behind the design of the CALL teacher portal. Team discussions on autonomy during the first stage of the project found teacher autonomy important, though difficult to achieve, and perhaps in some circumstances not entirely desirable:

- “it is essential for teacher satisfaction” (Participant B)
- “essential in our environment, due to variability in course structure and programs” (Participant F)
- “too much autonomy may not be desirable to teachers with no CALL experience” (Participant C)
- “not all teachers want CALL autonomy (in particular novices, those not confident)” (Participant D)

These discussions led to specifying needs of CALL teachers according to their position on the path to full autonomy. Members agreed that the needs of novices and in-transition teachers were quite similar, these needs being immediate, highly specific, and of a survivalist nature. Without trying to patronize, the team felt these teachers needed to be closely guided through lesson plans for technically uncomplicated CALL classes. These lesson plans “should not only explain what to do, but also how to do it” (Participant E) to ensure the greatest possibility for success, thus boosting the confidence of a novice teacher. Providing access to technical information, a ready-made list of logins and passwords, instructions on the use of CD-ROMS and other resources were also seen as paramount. The need for access to CALL theories and research was ranked low on the list of priorities, although the need for explaining differences between CALL and non-CALL language classes was seen as important.

There was also a consensus that meeting the needs of novices and in-transition CALL teachers would simultaneously meet the needs of a much wider group: emergency teachers, teachers with limited access to technology, and those new to the center.

The needs of the Experienced/Confident and Power Users (i.e., professionals specializing in CALL) were not seen as a priority by the team: “It is not relevant to them” (Participant C), “they are already autonomous” (Participant A), “they are power users” (Participant C). This issue was revisited when the Power Users voiced their hope for their needs to also be considered in the project.

When the issue of the missing collaboration and reflective functions in the design of the CALL intranet portal surfaced, we probed into their importance to the research participants. Some observations made on this issue included:

- “it is important especially in technology applications” (Participant A)
- “I believe in collaboration” as it “enriches our teaching but doesn’t preclude individualization and autonomy” (Participant B)
- “is essential to understanding of both relative and absolute values” (Participant C)
- “increases both variety and cohesiveness of teaching” (Participant D)
- “broadens one’s own outlook,” supports “learning from others” (Participant E)
- “reflection on practice brings the biggest benefits” (Participant F)
- collaboration in CALL is “more important than other areas of language teaching because there is more to know and the knowledge base is expanding exponentially” (Participant F)

The *collaboration* function, it was therefore decided, should be an integral part of the portal and would take a form of either an asynchronous discussion board or reflective blogs. After learning more about Web usability principles and in

order to ensure consistency of layout, the team decided to adopt the global university template as the template for the CALL portal.

Finally, issues of quality control and proofreading led to major decisions that all student handouts should be produced using a special template and that an editorial panel for the project should be formed to decide on priorities for further developments, to proofread the texts, and to assist with recordkeeping.

The Product

The process of conceptualizing and analyzing the unique needs and circumstances of CALL teachers at MUELC resulted in a development of a prototype that avoids lock-step and linear progression and allows for the model to be adapted for a variety of CALL programs, to be able to expand as new resources become available, and to be developed further when the context analysis prompts such a necessity.

The CALL teacher intranet model also borrows on the cognitive apprenticeship theme, reflecting situated cognition theory and adhering to a number of its principles (Anderson, 2000). First, it aimed at presenting knowledge in an authentic context; namely, settings and applications that would normally involve that knowledge. Second, it provided modeling and explanation on the *how* and *why* of the learning process. Third, it encouraged learning through social interaction and collaboration. In addition, it was hoped that the environment would gradually reduce assistance in favor of encouraging independent performance (Vygotsky, 1978). Finally, it aimed to provide opportunities for reflection where tacit knowledge becomes more explicit, helping teachers to analyze their performance and making the computer a *cognitive tool* (Lajoie, 2000).

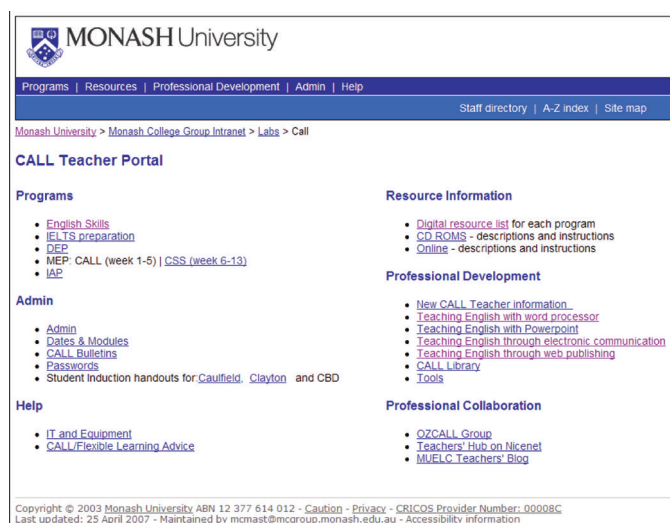
One of the aims of this research was to build an online environment that would enable teacher autonomy in CALL. To facilitate this goal, this online site was to perform three main functions:

provide easier access to resources, professional development opportunities, and reflection on practice. This initial conceptualization of the core intranet portal areas might suggest that they form discrete elements of the site, accessed perhaps through distinctively separate points of entry. However, in the design developed by the team, this is not the case. The intranet portal was created within the learning theory of constructivism, and so it is ultimately its users who determine what role each design element plays in the process of their learning.

The resources area, for example, can be accessed as a separate entity, giving an overview as well as details of digital resources (CD-ROMs and online) available to CALL teachers (see Figure 3). However, it can also be accessed through the *Lesson Bank* area, where specific lesson-related resources are discussed. The Lesson Bank itself can be considered a resource, but it can also function as a professional development tool through the provision of lesson exemplars and models. Similar blurring of function boundaries applies to the *reflection on practice area*, as professional reflection can now occur not in one, but in many ways. Teachers may reflect on their methodology by analyzing lessons submitted to the lesson bank, by reading publications on CALL theories, and by collaborating through internal and external discussion boards.

Sims (2000) defines four dimensions of interactive constructs: learners, content, pedagogy, and context. He advises instructional designers to analyze these interactive constructs in detail in order to ascertain how effective the user-software interactions (and therefore the learning process) might be. Looking at the CALL intranet portal through these lenses provides a number of observations: first, that the platform was designed with the explicit *underlying philosophical and pedagogical concept* (teacher autonomy), and therefore, its *content elements* and the media used were selected to serve that purpose; second, that the underlying pedagogy is based on a constructivist

Figure 3. CALL Teacher Portal home page (© 2008 Monash College Pty Ltd., used with permission)



learner model, and therefore, the resulting design allows for the learning focus to change for different users; and third, we can observe that the design caters to different users because its interactive constructs are a function of the stage at which *teachers* (as *learners*) find themselves (e.g., Novice, Explorer, Power User and/or Emergency, Sessional, Full-Time/Part-Time). This also determines the *when* and *where* of the learning process, the *contextual* elements of the intranet.

If analyzed in the context of diffusion theories (Rogers, 1995; Surry, 1997), the product displays four attributes that increase its likelihood of success. First, it has been designed and trialed on a limited basis, with the opportunity for improvement before the product reaches a wider group of users. Second, it has an advantage over the status quo by providing more flexible access to CALL resources, professional development, and discussion completely independent of time and place. Third, the system is not overly complex and caters to any level of CALL expertise. Finally, it is compatible with existing practices and values; namely, current Second Language Acquisition theories, CALL pedagogy, and CALL professional development practices at the language

center, which greatly enhances its prospects for wider adoption.

The following section should be viewed as a commentary on screen captures of various areas of the intranet CALL portal. The first to be shown there is the *resources area*, which contains a description of in-house digital resources and examples of their applications in CALL classes (see Figures 4 and 5).

The second area, the *professional development area* of the portal, contains tutorials on various aspects of teaching languages with ICT tools such as word processing, animated presentations, electronic publishing, and electronic communication. These tutorials are accompanied by examples of linguistic applications and teacher-developed classwork materials that utilized these tools. Figures 6 and 7 provide sample pages from the professional development area, titled *Teaching English with a Word Processor*, and one of its subtopics, *Dragging*.

To cater to novice CALL teachers, a lesson bank for all programs and levels was established. It is a steadily growing area of the intranet portal, where all contributing teachers are acknowledged. It contains handouts for students with step-by-step

Creating Supportive Environments for CALL Teacher Autonomy

Figure 4. List of resources for one of the language programs on offer (© 2008 Monash College Pty Ltd., used with permission)

Monash University > Monash College Group Intranet > Labs > Call > Resources

Digital Resources

ES Resources IELTS Prep Resources DEP Resources
MEP Resources IAP Resources EIRC Resources

ES Resources

CD ROMs	Online
Click to English (ES4 classwork only)	Nicenet (online discussion board for students)
Interactive Picture Dictionary (ES2 level)	Virtual ILC (Easy SBS News, Business Vocab, Web based activities)
Issues in English (all levels class & self-study)	Monash English Self Access (MESA) (a range of activities for any level both in general English, test preparation and academic purposes)
Tense Buster CD (all levels)	E-news and Vistas (MUELC Student online magazine)
That's Life! (ES2 and ES3 class & self-study)	Web-based ESL Activities (class activities based on authentic websites)
Typing Master (self-study)	Onlearn.biz (language exercises in Academic, Business and IELTS)

[top](#)

ESL Search Engine

ESL Search Engine

Search

Browse: [Teachers](#) or [What's New](#)
Maintained by [The Internet TESL Journal](#)

Figure 5. Example of a resource description (© 2008 Monash College Pty Ltd., used with permission)

EASE CD: Essential Academic Skills in English

How to play:

Note: You cannot play this CD from home

1. Double click on a desktop folder that reads "CD Roms".
2. Double click on the desired CD title.

Overview:

It is a video-based CD-ROM designed to help students whose first language is not English with their studies at English-speaking universities with an emphasis on **Listening to Lectures**. It contains 85 video clips from 40 different lectures in 25 different departments across the humanities, social sciences and sciences. There are more than 300 pages of interactive tasks based around these video clips. These are designed to help students improve their academic listening and language skills. You can view screen shots at this website: <http://www.ease.ac.uk/samples.htm>

There are six units which guide students through the key language skills involved in listening to lectures. These units are:

Unit	Lessons	Suitable for (as discussed and agreed by the MUELC review panel)
Unit 1: Openings of lectures	- opening a lecture - introducing a topic - structure and content - talking about earlier lectures - structure and structural phrases - questions as structure - note-taking - vocabulary	ELBP, ETP 5&6
Unit 2: Structure and organisation of lectures	- opening and closing summaries - structure and structural phrases (signalling) - mainline (forward, backward, identifying) - transitions - note-taking (topic: Indian cinema 1945-1970) - vocabulary (idioms, synonyms, connotations, word analysis)	
Unit 3: Functions (i)	- defining - classifying (topic: economies) - comparing and contrasting (topic: novels)	ELBP, ETP 5&6
	- exemplifying - note-taking (pre-teach or research HIV AIDS) - vocabulary (pre-flags for 'not')	ELBP, ETP 6
Unit 4: Functions (ii)	- Referring to Sources - Evaluating sources - indicating cause and effect - indicating purpose - interacting - Recap - Note-taking	ELBP, ETP 6
Unit 5: Significance and Attitude		ELBP, ETP 6
Unit 6: Argumentation		ELBP, ETP 6

[top](#)

instructions and additional resources for the teacher. The lessons are technically uncomplicated and do not require multitasking (see Figure 8).

The CALL Teacher Portal, as was previously explained, also enables teachers to access both in-house and external communities of practice, and to set up and maintain their own blogs for reflection on practice. Figure 9 depicts an ex-

ample of the page encouraging exploration of an online discussion board (Nicenet.org).

EVALUATION

At the first meeting, members stated that the main reasons for joining the action research team was their willingness to contribute to the process

Figure 6. One example from the “professional development” area: “Teaching English with word processor” (© 2008 Monash College Pty Ltd., used with permission)

Teaching English with Word processor		
Deleting Dragging Cut/Copy/Paste Find&Replace Creating graphs Creating Tables Drawing Tools Columns Formatting Inserting Images Inserting Symbols Flowcharts How I teach with WPP – Benita's tale		
Deleting		
How to do it	Useful for:	Examples of class work:
1. select chosen text (or empty space) 2. hit Delete key	removing parts of text	Compound nouns/numbers
top		
Dragging		
How to do it	Useful for:	Examples of class work:
1. select chosen text (release mouse) 2. click on the selected text and hold the click 3. “drag” the text into its new place	jumping unjumping sequencing	Spare Tyre
top		
Cut/Copy/Paste		
How to do it	Useful for:	Examples of class work:
1. select chosen text (release mouse) 2. click Edit/Cut OR press Ctrl C (together) 3. move cursor to a new place 4. click Edit/Paste OR press Ctrl V (together)	jumping unjumping sequencing	Public Phone
top		
Find&Replace		
How to do it	Useful for:	Examples of class work:
1. click on Edit/Replace 2. type in text you would like to replace in “Find what” 3. type in the text you would like to replace it in “Replace with”	vocabulary building	Guess what I do
top		
Creating graphs		
How to do it	Useful for:	Examples of class work:
1. How to create a column graph 2. How to create a pie graph	interpreting data in a graphical form analysing tables/graphs	Immigration – column
top		
Creating tables		
How to do it	Useful for:	Examples of class work:
1. To insert a table Click “Insert/Tables” 2. Type in the number of columns and rows required 3. To modify a table: Use Tables and Borders toolbar: click on View/Toolbars/Tables and Borders	classifying categorising create questionnaires grammar work	
Explore the tools on this toolbar by following an online tutorial and study the following instructions		
top		

Figure 7. “Teaching with word processor”: Example of a “dragging” exercise supplied (© 2008 Monash College Pty Ltd., used with permission)

Put this story in the right order by dragging the sentences.



She put the spare tyre on. She took off the flat tyre. She stopped the car. Michelle thought she had a flat tyre. She opened the boot and took out the spare. She put the flat tyre in the boot. She closed the boot. Michelle drove away.

of change and willingness to learn more about CALL. Their comments during the final stages of the research confirmed their satisfaction in achieving both of these goals. When asked if the involvement in the action research process met their expectations, they provided comments such as the following:

- “Yes, because (i) I feel I had input into the final prototype, (ii) I learned about how to design/ implement a project in a CALL environment, and (iii) I expanded my theoretical basis of understanding in this field” (Participant A).
- “Insofar as I expected that there would be a tangible outcome—the intranet—and that it would be a collaborative process” (Participant E).
- “Yes, I am aware more about the process and the product” (Participant D).
- “I wasn’t sure of what to expect at first—I thought we were going to ‘put things on the intranet,’ but I was happy to be involved in the ‘how’ rather than the ‘what’” (Participant C).

The participants commented on their increased awareness of the complexities behind developing

Creating Supportive Environments for CALL Teacher Autonomy

Figure 8. Example of a lesson bank for pre-intermediate levels (© 2008 Monash College Pty Ltd., used with permission)

Monash University > Monash College Group Intranet > Labs > Call > Es

ES 3 Pre-Int - Module A

At the end of the 10-week course student should demonstrate the following ICT skills:

- ICT1 Can create and format simple wordprocessed documents using basic tools from the Formatting Toolbar and Picture Toolbar. Can use Spellcheck tool
- ICT2 Can use a search engine to search for images. Inserts and manipulates images in a wordprocessed document
- ICT3 Can reorganise a wordprocessed text using cut/copy or dragging

When creating CALL course teachers have an option of:

- designing own integrated lessons
- creating a 5-week project or using an [existing project](#)
- using lessons from the weekly [lesson bank \(if available\)](#)

Students need to be introduced to the following digital resources

- [That's Life CDROM](#)
- [Interactive Picture Dictionary CDROM](#)
- [Issues in English 2 CDROM](#)
- [Tense Buster Lower Intermediate CDROM](#)
- [Monash English Self Access \(MESA\) website](#)

Lesson bank

Note: raw documents for students are located in: My Computer/Student/ES classes

Weeks	Lessons	Handouts	Related resources
1 Induction: overview of self-study resources	1. Induction Lesson: - Print out and photocopy an induction flyer - Go through all the points on the handout, ensuring that students understand them - Check students' access to drives as per handout. - Take students through checking uni e-mails - Introduce them to the recommended self-study CDROMs	Induction handout	Overview of ES self-study resources
2 Adventure: Narrative: Simple Past vs Continuous	1. When I got lost as a child - reading, writing and speaking (from Renata)	1. N/A	Model text - teacher broadcasts the story and reads it out to the students. Students write about a similar experience of being lost. Then they can record it using the recording tool and send it to their teacher as an e-mail attachment
3 Entertainment: Review: 1st conditional, adjectives and phrasal verbs	1. You Must see it! Victoria's top 20 attractions: reading and speaking, models (from David)	1. You Must see It!	1. Visit Melbourne website: http://www.visitmelbourne.com
4 Childhood and teenage years. Note- taking.	1. Remembering childhood smells (web-based activity) (from Gale and Geraldine)	1. Childhood Smells	1. Childhood Games 2. Mum-isms - things your mum always said
5 Travel: Graphical Information: Prepositions of place.	1. Holiday plans and booking plane tickets. (from Renata)	1. Travel Bookings	That's Life (Free Time/Holiday Plans)

Figure 9. Invitation to join teacher discussion board on Nicenet (© 2008 Monash College Pty Ltd., used with permission)

Monash University > Monash College Group Intranet > Labs > Call > Pcollaboration

Discussion Board (Teacher's Hub on Nicenet)

Teacher's Hub can be used for practice in using an online discussion board (here: Nicenet) and for professional reflection.

Instructions:

- go to [Nicenet](#) homepage
- click "Join a class" (because you are going to join a "class" called the "Teacher's Hub".
- Type in the class key: BZ32442T39 (you only need it once, when you join)
- Fill in your details (your username and password should be the same as the one for MUEL) and click Join the Class

Once inside:

Navigate through/click on various links on the left hand side and see what they do.

Experiment:

- submit a document (plain text),
- submit a link,
- create a conference posting,
- reply to existing postings

a worthwhile instructional design environment, especially one that aims to cater to a range of user types. Some team members found it beneficial to learn about action research methodology and to extend their knowledge of Web design principles.

All teachers found the most rewarding aspects of their involvement to be the team approach to the research and to the portal design process. They appreciated the fact that many points of view were expressed and taken into account, which resulted in a comprehensive needs analysis and, it can be inferred, a superior product. Some comments on this issue were the following:

- “Views and opinions of all people involved at the various stages were represented and responded by the researcher. It was a committee, and the ‘chairperson’ was in charge, but in a good way—kept us on track and took on board design changes, and so forth” (Participant C).
- The strength of this process was “team and the task orientation” (Participant E).
- The strength of this process was “team-work and great direction and super well-structured (i.e., we knew exactly what was required and no pressure given” (Participant D).

The main weakness, as the team repeatedly stated, was the difficulty in arranging team meetings and time allowance:

- “How to ensure team members all had enough exposure prior to each meeting to contribute and how much time was available for team members to experiment between meetings in a class environment” (Participant D).
- “Not everyone is able to put in time commitment as required (time factors)” (Participant E).
- “Time for group meetings” (Participant A).

These findings confirm the common knowledge of time-pressures and their effect on teachers’ professional development. Results highlight the tension between the necessity for thoroughness and adherence to the required stages (analysis, product design, dissemination/adoption, and evaluation) and the need to maintain interest and momentum to deliver tangible outcomes within a reasonable time frame.

The teachers saw this research as a “goal-oriented, cohesive and targeted” process (Participant B), which resulted in a “tangible gain” (Participant D) and was “a rewarding and productive experience” (Participant A). They all believed that the project achieved its aims and catered to their needs as CALL teachers. In relation to the three fundamentals of teacher autonomy (i.e., knowledge, choice, and reflection), they felt that the self-designed intranet portal holds the potential to support them in professional development, in selecting teaching materials and resources, as well as in sharing experiences and on reflecting on CALL practice.

At the time of evaluation, the system had been in place for only a few weeks. Not surprisingly, when asked to establish measures of project success, team members initially thought of an external evaluation; that is, an evaluation achieved through another study and conducted with a group of teachers not involved in the intranet portal design. This was beyond the scope of the research in question and would certainly require another research cycle.

There are at least three other strong indicators suggesting this process was successful in implementing positive organizational change. The first indicator is the product, the intranet portal itself, and its superiority when compared to earlier environments created without teachers’ input and accompanying research. The second is the members’ clear interest in the future developments of the intranet portal and their ongoing willingness to contribute to the process as a means of keeping abreast of its changes, adoption rate, usefulness, and relevance in promoting teacher and

student independence. All members voiced that the action research process should be an integral part of further intranet portal developments, and most expressed their interest in maintaining their involvement, although with a lesser degree of engagement or under a condition of time release. This last caveat is symptomatic of the professional development program's intensity if conducted in the way it was and considering its impact on teachers' busy schedules.

The third indicator of success is the grassroot aspect: the upward direction of this change, the voice and strength it gives to the efforts for improvement. This is no longer the voice of a lonely impassioned individual, but rather the voice of a team of language teachers interested in their professional development with the goal of improving the learning experience of their students.

SUMMARY

The analysis of the evaluation feedback is very encouraging, proving that the intranet portal has fulfilled its professional development aims by providing relevant and immediate, just-in-time training opportunities (McKenzie, 2001).

The research process and the product of this research were equally important, and both achieved or have the potential to achieve tangible professional development outcomes for MUELC teachers. These outcomes include increased awareness of CALL principles; better understanding of teacher autonomy in light of second-language acquisition theories; greater acceptance of action research methodology as a method for professional reflection; and finally, improved appreciation of research processes required for collaborative development of instructional design environments.

This study corroborated the findings of other proponents of action research who have stressed the relevancy, active participation in the learning process, knowledge focus, and collegial support

as most effective for professional development (Borko, 2004).

The project's predicted future developments are collaborative material development, raising teacher awareness, a review, an external evaluation, and adapting the model to other programs at MUELC. The process of evolution, according to the team, should continue for as long as it will be required and for as long as it will serve its purpose.

CONCLUSION AND FUTURE TRENDS

The promise of CALL—the utilization of computers for teaching or enhancing second-language acquisition—remains largely unfulfilled. Barriers are the technical problems and the limited capabilities of computers, which still lag behind the way language teachers and learners would like them to perform, and administrative constraints (Felix, 2003). Issues to do with the role of the teacher in CALL, effects of the technology on the methodology, integration, and evaluation, remain central (Levy 1997).

The previous lack of consensus on second-language acquisition (Nulman, 1996) is bridged by the re-emergence of the eclectic approach (Mellow, 2002) and the incorporation of cultural dimensions (Liddicoat, Papademetre, Scarino & Kohler, 2003). Despite epistemological differences, language specialists agree on the most basic principles or conditions under which language instruction should take place: students should be exposed to rich language and cultural input, have authentic opportunities to interact, and be actively involved. They should be encouraged to reflect on their learning and to take responsibility for their own learning (Liddicoat et al., 2003).

When new and emerging technologies are juxtaposed with these basic conditions for language learning, they do indeed hold great promise. There is no question that the Web and other technolo-

gies provide greater access to authentic and rich intercultural language input, although not all languages are equally well represented. Web 2.0 social software such as blogs, wikis, and voice and text chat lend themselves to interactivity and personal engagement but also to reflection on learning strategies. Human Language Technologies (HLT) such as Natural Language Processing, Machine Translation, Corpus Linguistics, Speech Technology, and artificial intelligence will make a significant impact on CALL (Davies, 2007), as will indeed the developments of virtual worlds and virtual tutors.

However, the majority of language teachers do not feel adequately versed in or prepared for teaching with the use of computers (Hubbard & Levy, 2006). Thus, the vision of normalized CALL (Bax, 2003), where computers in language learning and teaching are used with the same normality as books and pens, is still seen as a distant and future goal for the profession.

This is an issue of concern because many argue that the most significant impact on the effectiveness of CALL in the future will be the ability of teachers to create appropriate learning contexts and learning, to allow students to create, and to share their own content through discovery and experimentation within cyber-communities. Such fostering of learner growth and language development will generate even greater necessity for teacher and learner autonomy, and it is thus of paramount importance that learning organizations not only allow for teacher autonomy but also *actively* support its three fundamentals: access, knowledge, and reflection. The research described in this chapter is an example of how such support might be provided. It signifies how adherence to proven methodologies of action research informed by instructional model development theories can bring tangible results and desired improvements.

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KEY TERMS AND DEFINITIONS

Adult Learning Principles: The field of adult learning was pioneered by Malcom Knowles (1913–1997), who theorized that self-concept and motivation to learn, previous experience, readiness to learn, and a problem-centered approach to learning are the main principles.

Computer-Assisted Language Learning (CALL): An approach to language acquisition that utilizes computer technology to assist with the teaching and assessing of material, often including various interactive elements.

Communicative Method/Approach: A way to teach and learn language(s) with the goal of communicative competence. It stemmed from dissatisfaction with previous grammar-based and audiolingual approaches, and focuses on the processes of communication in various sociolinguistic contexts.

Constructivism: Jean Piaget (1896–1980) is credited with the development of this theory whereby learners construct new knowledge from their experiences through processes of accommodation and assimilation. Constructivism describes how learning should happen, and it is often associated with “learning by doing.”

English as a Second Language/English as a Foreign Language (ESL/EFL): These abbreviations are often used interchangeably to describe the science of teaching English to non-native speakers. ESL denotes teaching English to Non-English Speaking Background (NESB) persons in countries where English is dominant, such as Australia, Canada, the UK, or the USA. EFL

denotes teaching English to NESBs in countries where English is not the official language.

Teachers of English to speakers of other Languages/Teaching English as a Second or other Language (TESOL): Both interpretations are used for the abbreviation, causing significant confusion. The first refers to the professional associations and their members, whereas the second construct is often used as the umbrella term for ESL and EFL.

Instructional Design Models: Robert Mills Gagné (1916–2002) is one of the leading theorists in models of instructional design. Models offer structure and meaning to Instructional Design problems by helping negotiate the design task through sequenced components. The context of use determines the value of a particular Instructional Design Model.

Diffusion of Innovations Theory: Everett Rogers (1931–2004) suggested a five-stage model for the diffusion of innovation (Knowledge, Persuasion, Decision, Implementation, Confirmation) and five types of adopters (innovators, early adopt-

ers, early majority, late majority, and laggards) in his 1962 book titled *Diffusion of Innovation*.

Practitioner-Based Inquiry (PBE): Small-scale, applied educational research activity by practitioners in fields such as school teaching, nurse education, and social work to address professional concerns.

Second Language Acquisition (SLA): The process by which learners acquire an additional language, often termed the target language. SLA focuses on the language system and learning processes of naturalistic acquisition of language. Stephen Krashen used the term “language acquisition” to differentiate from formal language learning.

Teacher Autonomy: Involvement in and ownership of the change process. It encompasses professional freedom, self-directed professional development, transformation through dialogue, critical reflection, and analysis of the teaching process.

APPENDIX

Description of Participants in Relation to Their (Self-Perceived) CALL Experience and Training

Participant A. Usually teaches CALL in a few five-week courses a year and considers herself a teacher who had some limited experience in CALL and only through her work at MUELC. She did not study CALL as a university subject or as a short course. Her only training was received through MUELC's Professional Development workshops.

Participant B. He teaches CALL at least once a week in a few five-week courses a year and believes he possesses practical knowledge of CALL with some past experience, which he considers "very out of date," gained by choosing CALL as a unit at a postgraduate level. He also attended short courses in CALL.

Participant C. Teaches CALL at least once a week in almost every course, seeing it as good fun for students as well as an opportunity to be creative in learning English and increase their computer skills in a nonthreatening way. She did not study CALL at a tertiary level and did not attend any short courses in CALL.

Participant D. The fourth member of the team is involved in teaching a few CALL courses a year and thinks he has a practical knowledge of CALL, which was also a subject he has done at a tertiary level.

Participant E. He teaches mainly CALL and has a sound theoretical and practical knowledge of CALL gained through his Master's degree course.

Participant F. He teaches CALL regularly, one or two classes in almost every course in the year. He sees himself as a teacher with sound theoretical and practical knowledge of CALL. He completed a semester unit in CALL at a university level, which was quite in-depth, and though some years have passed, this knowledge is still functional.

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Chapter 4.4

Learning Object Based Instruction

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INTRODUCTION

Imagine a vast repository of digital materials that includes an unlimited supply of instructional videos, interactive multimedia exercises, links to Web sites, reading exercises, recorded interviews with experts, interactive graphs, charts, diagrams, photographs and maps—and nearly any other form of digital instruction—all organized according to academic standards, instructional objectives, and specific topics addressed. Teachers could log in to the repository via the Internet, type a simple search string and instantly access hundreds of pertinent instructional sequences that they could use to enhance their teaching practices in both the classroom and in the virtual learning environment.

This vision has been the driving force behind a form of instructional technology called learning objects (LOs), and it is becoming an increasingly relevant topic within the field of instructional technology today.

The idea that instructional content can be systematically encapsulated, retrieved, transmitted to others, and then reused is the driving force behind the LO movement. In the face of such enormous potential, the field of instructional technology has made little progress since 2002 when it comes to defining a practical method for populating LOs with meaningful instructional content and research that addresses the pedagogical effectiveness of using LOs in the K-12 learning environment is scarce. As yet, no practicable model for implementing this technology in a “real world” setting exists.

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BACKGROUND

Perhaps the most widely accepted definition of the term learning object comes from David Wiley (2002). Wiley (2002) states that a learning object is any digital resource that can be reused to support learning (p.7). While Wiley's definition and other attempts to define the true nature and function of learning objects are important efforts, varying views regarding the true nature and function of learning objects have caused a great deal of confusion within the field of instructional technology concerning this technology (Sosteric, 2002; Welsch, 2000). In any event, the fundamental theme that ties every perspective together is the basic idea that digital instructional content can be encapsulated, stored, and reused in the appropriate context. To put it more succinctly, learning objects are reusable and interoperable. These core attributes make learning objects both appealing and controversial.

The term "learning object" appears in the vernacular sometime around 1994 and is often attributed to the work of Wayne Hodgins (Wiley, 2002, p. 4), but the basic concept of reusing digital resources to streamline computing practices for programmers and to introduce uniformity of experience for end-users can be traced back to the work of Ole-Johan Dahl and Kristen Nygaard from the Norwegian Computing Center, Oslo, Norway, in the mid 1960s with their work on a programming language called SIMULA. This work led to a form of computing called object oriented programming that has had a profound impact upon the field of computer science and information technology. Object oriented programming gained momentum in the 1970s with the work of Alan Kay and became increasingly popular as a result of the work conducted in the 1970s and in the early 1980s by Bjorn Stroustrup with his efforts to apply the basic concepts of object oriented programming to the C computer language to create the commercially successful and widely accepted C++ computer language. Soon after that, a group at Sun led by

James Gosling introduced a derivative of C++ called Java that has gained increasing popularity with the expansion of the Internet.

While the effective implementation of learning objects (LOs) will undoubtedly continue to require formative input from the field of computer science, the fields of instructional technology and education will need to add more formative input to the conversation if LOs and learning object based instruction (LOBI) are to reach their full potential. To date, the majority of work concerning LOs has been focused upon establishing metadata referencing and retrieval schemes that can be used to quickly access LOs. In the 1980s and early 1990s, several metadata referencing initiatives began to address the need to categorize and quickly retrieve digital content and various tagging schemes began to emerge. In the fall of 1997, the U.S. Department of Defense, the White House Office of Science and Technology, the Department of Labor, and others, kicked off the Advanced Distributed Learning (ADL) initiative that established the metadata referencing standard called the Sharable Content Object Referencing Model (SCORM). Since it was introduced, SCORM has come to be the most prominent metadata referencing standard in the United States, but other metadata standardization efforts—like the IEEE's LOM project—also address the same need.

The introduction of, and further refinements to metadata referencing standards like SCORM and LOM are a critical step that must be taken to allow different content publishers to create learning objects that can interoperate within different learning management systems (LMS), but these efforts have little or nothing to do with pedagogical effectiveness of the LOs themselves. These efforts were an important first step because they addressed the need to ensure that LOs are retrievable and interoperable, but they do not address exactly what instructional materials a LO should contain to be instructionally effective (Welsh, 2002, p.2).

The first attempts to address the need for LO content standards are typically attributed to the

work of M. David Merrill from Utah State University in his work in the 1990s. Other early pioneers in the effort to devise a content model for LOs include L'Allier (1997) and his efforts with the NETg Learning Object Model and Barritt (1999) and others from CISCO who introduced the RLO/RIO content models. Verbert and Duval (2004) present a thorough overview of such efforts.

In 2002, Macromedia released a white paper that clearly identifies SCORM as a referencing standard only and acknowledges the fact that

the intent of SCORM is not to promote uniform content, but to enable conformant content to work better in a technical level. What content goes into the Learning Object (LO) is determined by the learning designer and not governed by SCORM. (p. 4)

Other efforts at around the same time, like The Masie Center's white paper (Masie, 2002), the Learnativity content model (Duval & Hodgins, 2003), and the SCORM content aggregation model (Dodds, 2001) all attempted to meet the demand for a content model that addresses the actual instructional media contained within an LO. Despite these early efforts, the confusion between the function of SCORM and how it does (or more appropriately, does NOT) affect the content of a LO remained—and it is still present today. Soon after this flurry of activity, the collective attention of the field of instructional technology moved toward the formation of LO repositories and the issue of how best to populate LOs with instructional content still needs to be addressed in a practicable way.

Much of the recent activity in the LO community has been devoted to building LO repositories like MERLOT, Wisc-Online, EduSource in Canada, CELIBRATE in Europe, and the newly introduced commercial product from Discovery Learning, Inc. called Cosmeo; but, there has been surprisingly little research and discussion surrounding the use of learning objects within the

learning environment (Haughey, 2005). While these repositories represent a great deal of progress and they are, indeed, a critical accomplishment; they are only a first step toward widespread implementation of LOBI in the K-12 environment, and ultimately into every day learning and teaching practices in public schools across America. Table 1 Includes some of the more prominent learning object repositories that are available today.

Each of these projects has made significant contributions to the advancement of LOBI. They are, however, only a first step toward implementing LOs into the main stream of the field of instructional technology and, ultimately, into every day teaching practices.

The Need for a Widely Accepted Content Model

SCORM imposes few restrictions upon the content to which it refers and the position that SCORM is a referencing model only (Brown, 2002) is an important one because it underlines a need to somehow define the parameters of the instructional content contained within the learning objects to which it refers. Just like the Dewey Decimal System refers to all kinds of different media in your local library ranging from microfiche, to encyclopedias, magazines, and classic novels, and so forth, the SCORM metadata referencing model is concerned with brief descriptions and access—it has little-to-nothing to do with the quality and/or the quantity of media to which it refers. Friesen (2001, p. 2) acknowledges the dichotomy between function (metadata) and form (content) by noting that metadata standardization efforts are a start, but there remains a need to answer the basic question “What is the relation between learning object metadata and content?”

The responsibility to practically answer this question and provide some guidelines for populating LOs with meaningful instructional content falls upon the shoulders of the field of instructional technology. The questions remain, however, ex-

Table 1. Partial list of existing LO repositories

Organization	LO Repository Name	URL
California State University	Merlot	http://www.merlot.org/Home.po
Discovery Education	Cosmeo	http://www.cosmeo.com
EduSource Canada	Canadian Network of LO Repositories	http://www.edusource.ca/
European SchoolNet	Celebrate	http://www.eun.org/eun.org2/eun/fr/Celebrate_LearningObjects/entry_page.cfm?id_area=1008
The Remediation Training Institute, Inc.	ExtraLearning	http://www.extralearning.net
The Monterey Institute for Technology and Education	The National Repository of Online Courses Hippo Campus	http://www.montereyinstitute.org/nroc/nrocworking.html http://hippocampus.org/
Utah State University	Instructional Architect	http://ia.usu.edu/
Wisconsin Technical College System	Wisconsin-Online	http://www.wisc-online.com/

actly how that content model will be formulated and how it will be embraced by the educational community as a whole.

A Suggestion for Meeting the Need for a Content Model

Hodgins and Connor (2000, p. 1) claim that revolutionary changes do not take place without widespread adoption of common standards, but, ultimately, those standardization efforts have to address a common need in a delivery environment. The fact that resources currently exist (LO repositories) and that there is a growing demand within the K-12 learning environment for a practicable model for teaching K-12 online learners underlines the need for such an environment that accommodates the natural evolution of this LOBI.

Consider how various forms of recorded media are interwoven into our daily lives. It can be argued

that stored digital media like movies, songs, and television shows adhere to at least three types of guidelines that make them meaningful for us. First, they meet the technical requirements of the delivery mechanism—they must be recorded in a way that can be broadcast so we can experience them. Second, they fit within the publishing norms for their respective medium, and third, they must meet an intrinsic need in the target audience. First, there is typically an elaborate process that ultimately results in the creation of a physical artifact that is compatible with projectors, CD players, and/or TV broadcast equipment. Second, the content of that particular production adheres to established standards for publishing content in that particular medium (it is rare to come across a 12 hour movie, a song that is so high-pitched that only your dog could hear it, or a TV production without characters or a plot line), and finally, each of these forms of recorded media meets an

intrinsic need within the target audience. They fit into our lives in such a way that they have value for us—they are *used*.

In each of these examples, guidelines, or standards, have emerged that drive distribution, content production, and adoption. Ultimately, it is the iterative interplay between content production and adoption within a target delivery environment that refines the adoption of the particular form of recorded media—and the content publishing standards themselves. To date, the field of instructional technology has (perhaps necessarily) focused its attention upon the interplay between distribution (or retrieval) standards and content production standards. But like any other form of recorded media, it will be the interplay between content production efforts and adoption in the delivery environment that will have the greatest impact upon the development of standards that will guide the widespread implementation and acceptance of LOs. To facilitate this formative process, a theoretical framework that accommodates the interplay between published artifacts (LOs) and the intrinsic needs of learners in the target delivery environment must emerge.

Rather than continuing to rely upon rigid and abstract theoretical perspectives to guide the development of learning objects and the implementation of LOBI, the field of instructional technology has evolved to the point where more pragmatic approaches to instructional design (Visccher-Voerman, 2004) can be employed. Shank (2002, p. 4) suggests that a good opportunity for semiotic research in education will be to create an a-priori set of meaningful concepts that can serve as the basis for a new model for educating in a particular setting. Rather than a “one size fits all” approach to creating a content model for LOs, several types of native interactions will be identified and then specific types of LOs that accommodate those interactions will be developed. The specific methodology that will be employed to transform and translate these different types of native interactions into LOs that are woven into

the proposed theoretical framework is what C.S. Peirce calls abduction, or the creative process of reasoning to a satisfactory explanation, of creating a structure in which our observation makes sense (Buchler, 1955).

Curriculum Directors: The Missing Link

Every lesson that uses learning objects needs to be assembled. Just like any other well designed lesson, someone has to analyze instructional goals and learning objectives and then create a strategy for conveying information to the learners that will help them meet those objectives. The fact that LOs are self-contained, meaning that the instructional message is already inherently part of each learning object greatly streamlines the process of creating a lesson and, as search techniques become more and more refined and repositories become more and more standardized, it may be possible for classroom teachers piece learning objects together to make online lessons, but this is not presently a practical reality.

In the meantime, LOBI will be implemented by a select few curriculum directors who work with classroom teachers to “hunt and gather” pertinent learning objects from existing repositories and deliver them online in a learning management system. This development process is an extension upon Wiley’s (2002) manual assembly techniques and has come to be known as *the collaborative model for distance education*. This process effectively enables classroom teachers to “broadcast” lessons online that mirror the instruction that they present in their classrooms. Ultimately, this simple assembly process opens the door to many exciting possibilities for students who are absent from the classroom for any number of reasons because it effectively blends virtual instruction with traditional classroom instruction in such a way that effectively accommodates the existing infrastructure of public schools and utilizes stored

media as a performance support tool for classroom instructors.

By analyzing native instructional design documents like lesson plans as a guide, curriculum directors can employ rapid prototyping techniques (Tripp & Bichelmeyer, 1990) and situated instructional design methods (Wilson, 1995) to quickly assemble online learning object based lessons that mirror the instruction presented in the traditional classroom environment. More recent advocates of this approach include Suhonen and Sutinen (2005) with their work on formative methods in sparse learning environments. Other instructional technology visionaries like Hodgins (2000, p. 14) agree that the best way to arrive at a future that embraces LOBI, it is most practical to adopt a backward approach, and more mainstream instructional designers like Wiggins and McTighe (2005) advocate this approach as a practicable way to achieve results in a learning space.

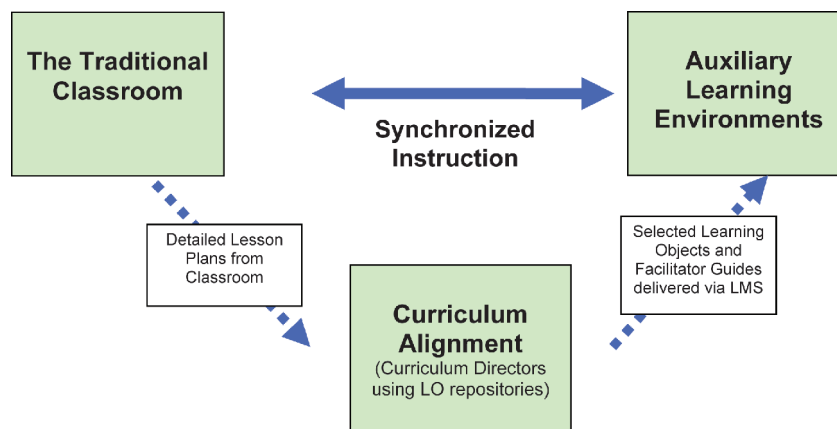
FUTURE TRENDS

The apparent benefits of decoupling stored, reusable, and self contained digital instructional content and retrieval and delivery mechanisms is a fundamental aspect of LOBI and computer mediated

instruction that opens the door to many exciting opportunities for educating K-12 students, but also poses fundamental challenges to paradigms that guide existing classroom practices. More specifically, if facilitators in a computer mediated learning space that accommodates LOBI can rely upon stored and reusable instructional content to convey the instructional message to their students, it becomes possible for them to devote their energies to other critical aspects of the teaching and learning process (like behavior support and more individualized instruction). This interplay between stored media and facilitated learning is one of the great strengths of LOBI that makes it more suitable for the K-12 audience than other forms of distance education because children often need more guidance in learning activities than adults.

Haughley and Muirhead (2005, p. 2) suggest that “learning objects do not have value or utility outside of instructional contexts and that their value is in their application to classroom settings and to online learning environments where teachers may or may not be present.” Currently, teachers in the traditional classroom setting follow a model for presenting information that simply does not accommodate the use of LOBI. The very nature of how information is presented in the ideal delivery environment differs so dramatically from

Figure 1. Using the collaborative model for distance education to refine a content model for LOs in the K-12 online learning environment



traditional classroom practices (lecture-based instruction vs. inquiry-based facilitated learning), that introducing LOBI into a traditional classroom setting requires a complete rethinking of the role of the teacher and the way that information should be presented in the target delivery environment.

In a sense, learning objects are an anachronism—they are artifacts that are available in an environment that does not yet know how to use them. While LOs themselves will undoubtedly be transformed and refined as the educational community develops learning environments and practical pedagogical principles that accommodate LOBI, the majority of the evolutionary change will happen within the learning environments themselves. As may be expected, sociocultural approaches to learning and teaching that view LOs as semiotic tools and/or social resources that can mediate the link between the social and the individual construction of meaning (Hung, 2002, p. 175) will play a formative role in the adoption and development of LOBI. Ultimately, LOBI will be defined by the environment in which it is delivered and, like any other form of instruction, its efficacy must be determined by the effect it has upon learners themselves.

CONCLUSION

Since the introduction of learning objects in the 1990s, the field of instructional technology has struggled to develop implementation models that fully take advantage of the vast potential that this form of instructional technology affords. While nearly all instructional designers and technologists currently acknowledge the nearly endless possibilities associated with LOs, several obstacles remain that make practical implementation of LOBI difficult. At this point in the evolution of computer assisted instruction, LOs and LOBI are being under utilized and only when these barriers are isolated and addressed (and/or eliminated), will learners and teacher reap the benefits that LOs can provide.

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KEY TERMS AND DEFINITIONS

Collaborative Model for Distance Education: The term used to describe the process formative and iterative of using native resources to guide the translation of classroom instruction into learning object based instruction so it can be delivered online.

Content Model: A commonly accepted set of specifications that developers can use to guide their efforts when they create media. Commonly used interchangeably with the term *publishing standard*.

Curriculum Director: In the collaborative model for distance education, the curriculum director is the person who is responsible for analyzing classroom instruction, searching through a repository to collect learning objects that address the same topics, and then delivering those learning object to end users in a learning management system.

Learning Object: Any digital resource that can be reused to support learning.

Learning Object Based Instruction (LOBI):

The process of utilizing assembled learning objects to teach in a learning environment. LOBI is a form of facilitated instruction, or performance support, as opposed to direct instruction and/or lecture based models for presenting information to learners.

Metadata: The standardized information that is used to describe learning objects. Typically metadata comes in the form of completed form fields that describe the formative characteristics of a learning object.

Metadata Referencing Scheme: A shared, syntactical approach to the use of metadata that programmers can use to ensure that learning objects are retrievable and interoperable.

Publishing Standard: A commonly accepted set of specifications that developers can use to guide their efforts when they create media. Commonly used interchangeably with the term *content model*.

Pragmatic Paradigm: An instructional design approach that emphasizes environmental factors like adoption and use in the test when evaluating the validity and efficacy of learning materials.

Rapid Prototyping: The process of quickly analyzing instructional needs in a learning environment and selecting relevant instructional materials that meet those needs.

Shareable Content Object Reference Model (SCORM): A set of guidelines that The Learning Technology Standards Committee of the IEEE began their efforts to come up with one set of metadata guidelines that can be used to systematically categorize digital content. Currently, this effort is being refined by the U.S. Department of Defense's Advanced Distributed Learning Division (ADL).

Situated Instructional Design: Brent Wilson's theory for instructional design that posits that implementation and design are ultimately inseparable.

ENDNOTE

* www.vlnpartners.com

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Chapter 4.5

Teaching Technology to Digital Immigrants: Strategies for Success

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ABSTRACT

Someone has to prepare faculty who are in need of technology skills. For example, in Louisiana, in response to Hurricanes Katrina and Rita, every faculty member at the university level has to have a Blackboard presence and a disaster plan so that classes can continue in the event of a catastrophe. Those faculty called upon to assist their peers in complying with the directives are often chosen only because they are more comfortable than others with technology. Often, trainees are uncomfortable in such training, and senior faculty, often later “digital immigrants,” can be resentful. The researchers and authors of this paper have garnered \$443,658 in grants involving training faculty in instructional technology. Through

their experiences, the authors and researchers have isolated seven key practices that make such training successful. This article describes those practices and supports the findings of the primary research with secondary research on andragogy and Marc Prensky’s ideas of the literacy divide that exists between “digital natives” and “digital immigrants.” By considering the basic tenets of adult education, we can be better facilitators of valuable training sessions that will bridge the digital divide.

INTRODUCTION

John Dewey was a pioneer in the field of education, namely with his contribution to educational theory. One of the basic tenets of Dewey’s 1938 publication *Experience and Education* is the idea

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of a democratic educational experience, also known as the progressive movement. Dewey believed that education should be both “accessible and [enjoyable]” (p. 34) rather than the traditional authoritative experience in which the teacher is the holder of all relevant knowledge and the student is an empty vessel to be filled with that knowledge. Like Freire (1977) decades later, Dewey valued the prior individual experiences of the learner and claimed that “all genuine education comes about through experience” (Freire 1977: p. 25).

In 1973, another educational pioneer, Malcolm Knowles, introduced us to his theories of education. While Knowles’ predecessors theorized about learners in a more general way, Knowles himself focused on the adult learner. With Dewey’s progressive theories in mind, Knowles established the “groundbreaking” idea of “andragogy and the concept that adults and children learn differently” (Knowles, et al, 2005, p. 1). Knowles and his co-authors define andragogy, in part, as “an honest attempt to focus on the learner” (p. 1). Whereas Knowles pioneered the actual theory of andragogy, Galbraith (1990) and others have made significant contributions where actual teaching methods are concerned. In Galbraith’s *Adult Learning Methods* text, eight chapters focus on foundational perspectives of adult education, a few center on instructional design, and this text, currently in its third edition, clearly has college instructors in mind, which is the focus of our research in this article. Specifically, we will examine, in part, the literacy divide that exists between “digital natives” and “digital immigrants,” terms coined by Marc Prensky (Prensky 2001). Then we will use that information to support and explain what we have found to be best practices in educating digital immigrants in instructional technology. Our best practices are derived from over ten years of educating high school and college-level faculty in instructional technology. This training was funded by \$443,658, total, in grant funds from Louisiana Systemic Initiatives Program (LaSip) (\$222,741), Louisiana Board of Regents Traditional Enhance-

ment Grant Program (\$120,159), Louisiana Board of Regents SELECT Grant Program (\$89,258), and Louisiana Tech University Research (\$11,500). The result of our primary and secondary research is a list of seven key “do’s” when training faculty in instructional technology.

BACKGROUND

When the term “digital divide” was first mentioned in a 1995 report from the National Telecommunications and Information Administration (NTIA), physical access was the primary topic of discussion. The subtitle alone, “A Survey of the ‘Have Nots’ in Rural and Urban America” attests to the goals of this report on the digital divide (*Falling*, 1995). But since the publication of this report, researchers (Warschauer, 2002, 2003; Cooper & Weaver, 2003; Solomon, et al, 2003; van Dijk & Hacker, 2003; Enoch, Y. & Soker, 2006) have noticed other trends—cultural ones rather than physical ones—that prevent certain people from reaping the benefits that technology has to offer. Some of these barriers include gender, social class, urban versus rural community, and age. In US society, as some researchers (van Dijk & Hacker, 2003; Warschauer, 2003) have discussed, physical access to technology is widespread; therefore, “the key issue is not unequal access to computers but rather the unequal ways that computers are used” (Warschauer, p. 46). Indeed, there exists a clear gap between digital natives and digital immigrants in terms of how these groups utilize available technology.

In Prensky’s words, “Today’s students—K through college—represent the first generations to grow up with this new [digital] technology” (2001, p. 1). So if we think about this fact from the perspective of established faculty members, it is apparent that many of us are the immigrants whereas our students are the digital natives. This potential dilemma places faculty members in the interesting position of being behind the learning curve when it comes to our students and technology.

Educational theorists such as Dewey and Knowles have already established that we as educators do not really know as much as we might think. Rogers goes so far as to say that the role of the teacher is “vastly over-rated” (Rogers, 1969, p. 103) and that we should view ourselves as mere “[facilitators] of learning” (pp. 164 – 166). But what happens when university instructors, perhaps because of the age factor of the digital divide (because they might be “digital immigrants”), are unable or unwilling to try and bridge the gap between them and their students in terms of technological literacy? The problem here is not that the instructors are merely behind their students when it comes to digital literacy; the problem is that these instructors may be missing out on the potential benefits that technology in the classroom can afford them.

BENEFITS OF TECHNOLOGY

Knowles, et al, (2005) “see technology as a force that presents great opportunities for andragogical adult learning” (p. 236). According to the authors, enhancing classroom instruction with technology “directly caters to adults’ desire to be self-directed in their learning;” it allows students opportunities “to tailor the learning experience to fit [both] their prior experiences” as well as “their real-world problems;” and “it often allows them to access ‘just enough’ to solve the problems that led them to the learning in the first place” (p. 237). Building on and valuing prior experience might be key when it comes to engaging digital immigrants in technology workshops (Knowles 2005).

In terms of experience, Journet (2007) suggests that to engage digital immigrants in learning new technologies, we (the facilitators) should “recognize the expertise senior faculty bring and make connections between their interests and yours” (Journet 2007:117). In other words, the prior experiences of the trainees must be valued. While she discusses digital literacy in terms of senior

faculty members specifically—or those faculty who have “settled in until retirement in terms of career, institution, rank, and work responsibilities (in Sorcinelli, 1999, p. 63)—Journet’s ideas easily carry over to digital immigrants in general, whether they are new faculty, mid-career, or senior faculty. Of course, newer faculty members are less likely to fall into the category of “digital immigrants” than are their more seasoned colleagues.

It is important to remember that learning new technologies benefits not only us as faculty but our students as well. If the instructor is well-versed in digital literacy, then he or she can act more efficiently as a facilitator to help prepare students to make the most of the available technology in the classroom environment. However, if the instructors themselves are not using available technology, then it is not possible to facilitate this type of learning; moreover, these digital immigrants may not even have the very basic technological skills that are becoming more and more commonplace, such as use of Blackboard, email, and presentation software. Hence, the remainder of this paper will focus on the importance of training university faculty (at least those of us who fall into the “digital immigrants” category) to be more skilled in various areas of digital/technological literacy, not only so they can become better facilitators within the classroom, but also so that they can gain the more basic digital knowledge that will keep them on par with new (and probably younger) faculty.

One might wonder how teaching technology relates to college writing—that is, perhaps one might if one did not actually teach college writing. Writing is no longer the province of the pen and typewriter. For students to be successful writers in the college classroom, they must be able to use the tools of the college classroom—often the computer. Research happens as often in cyberspace as it does in a library. And dictionaries are often accessed via computer. Not all composition instructors are fresh out of an electronically-saturated graduate school environment. Someone has to prepare college instructors who are in need

of technology skills, for example, in response to the Blackboard initiative in Louisiana (every faculty member at the university level has to have a Blackboard presence and a disaster plan) instituted as a result of Hurricanes Katrina and Rita.

Many of us as university faculty who are more comfortable with technology than our peers might be have been called upon offer faculty development workshops on a variety of topics, including

- Blackboard
- email basics
- PowerPoint
- webpage creation using html coding and various html editors such as Adobe Go Live and Dreamweaver
- Hot Potatoes
- MS Word's comment feature
- Adobe Photoshop
- Tegrity
- Taskstream
- Inspiration
- Camtasia

Obviously, as university faculty members, we appreciate the extra time and effort faculty are giving to gain new skills to better instruct students. In addition, we also know that they want the shortest, most efficient, and most effective training they can conceive of—nothing dissolves a faculty development's session participant's patient goodwill more quickly than a general feeling that the participant's time is being wasted.

TRAINING FACULTY: A BASIC LIST OF "DO'S"

When we began training faculty to use instructional technology, we drew upon the closest resource we had for do's and don't's—our own experiences as participants in instructional technology workshops. One first don't was clear—don't run an instructional technology workshop without al-

lowing participants access to the technology. This "don't" came from one researcher's experiences: the first instructional technology workshop she attended as an instructor was a lecture on various types of technology—with no demonstration, and certainly no hands-on activities. We felt that sort of training was a waste of time and were sure that others would, too. Our list of "do's" became

- Do tell participants to bring some type of storage device—floppy, jump drive, etc. If possible provide participants with such devices as a prize for attending the session.
- Before the training session, contact participants or potential participants and tell them what the software can do for them and give them ideas to come to the session with. Tell participants to come with some sort of project in mind to work on. Plan for participants to have a "take away"—either a completed project, or a project under construction for a class they are working on or currently teaching.

The preceding two "do's" are in line with Thorndike's notion of "teaching as the control of learning by the management of reward" (in Knowles, et al, 2005, p. 76). In other words, providing participants with a storage device as a prize, albeit a useful one, could prove to be a good incentive for participation in the first place. Of course, if participants are not "interested, problem-oriented, and attentive" (p. 76) to begin with, then our task as trainer may be daunting. Nonetheless, with a practical topic such as learning new technology, perhaps we can, as Knowles, et al, suggest, "manipulate the learning situation so that the learner accepts the problem posed because of the rewards involved" (p. 76). Sorcinelli, in discussing "measures of reward and recognition" for faculty development workshops, suggests that recognition in campus publications, plaques, or some other form of acknowledgement might be good incentives for the amount of time

faculty put into these kinds of training workshops (1999, p. 69).

Of course, a physical reward, such as a storage device or a plaque, is only part of the actual prize; the practical knowledge gained is as much of an incentive, even if we have to convince the trainees of this fact. But the topic of incentives is certainly worthy of consideration. To engage digital immigrants in learning new technologies, we might need to specifically address the question of “What’s in it for me?”

It is interesting to point out that certain colleagues might be less inclined to attend training sessions. In terms of faculty development, studies “indicate that senior faculty are somewhat less likely than junior faculty to seek out individual consultation or partake in teaching development workshops on their own (in Sorcinelli, 1999, p. 67). Therefore, as facilitators of technology workshops, we must provide an answer to the above question. Journet suggests offering digital immigrants “chances to engage in both the production *and* the analysis of their own multimodal compositions so that they can get a sense, for themselves, of the powerful affordances of different modalities” (2007, p. 117). In other words, we must help them to see firsthand how digital literacy can benefit them.

- Do allow participants access to the technology being presented, and make sure they will have access to the technology for their own use later (either give them the software at the presentation or let them know how to download it or access the computer lab with the software when they need to use it).
- Do present the schedule of activities and session goals at the beginning of the training session—a hard-copy detailed schedule is not too much to give adult learners. It’s also useful if they have to write a report on the training later (in case they are being reimbursed, for example).

The preceding “do” will, in part, satisfy one of the typical challenges of training or teaching adults: “to discover the problematic element that will arouse and maintain the interest of adult learners regardless of their global or specific motives for learning” (Long, 2005, p. 28). If the trainees can actually see in advance what they will learn in the session, then they will be more likely to participate actively in the session. So it would be wise to include not only a schedule of events, but also some clearly stated ways that the training will benefit the learner.

- Do limit training to two hours, and whenever possible, try to make the second hour a voluntary workshop targeting participants who need more help or who just want to keep working on projects with the availability of assistance.

The preceding “do” is partially in line with Long’s (2005) list of physiological variables that must be considered when teaching adults. These variables apply mostly to older faculty members, or senior faculty, but these physical characteristics are nonetheless important to consider, even if only a portion of our trainees fall into this category.

However, it is these senior faculty who often fall into the category of digital immigrants; therefore, we should consider the possibility that many of the learners in technology workshops will be senior faculty who may exhibit one or more of the characteristics Long discusses, such as “diminished auditory and visual acuity, reduced energy levels, and increasing frequency of health problems” (pp. 28-29). So the point here is that we should not expect all of our learners to be physically comfortable sitting through an all-day workshop, and if participants are not comfortable, then they will not learn efficiently. But regardless of the preceding physiological concerns, it is important to “Offer professional development opportunities that meet the needs of senior faculty” (Journet, 2007, p. 117) or of any

faculty members who are in need of technology training. One simple way to do this is to consider “scheduling between terms or in the summer months” (Journet, 2007, p. 117).

- Do make yourself available to participants after the training in case they have questions, run into difficulties, or just want more information. The training doesn’t end when the session ends.
- Do encourage participants to veer off course and play or move ahead in the training. Participants will learn more and have more fun if they are in charge of their experiences.

The preceding “do” is in line with some theories of self-directed learning (Brookfield, 1986; Candy, 1991; Knowles, 1975; Knowles, et al, 2005). Here, we will use Knowles, et al’s definition of self-directed learning, which “is seen as self-teaching, whereby learners are capable of taking control of the mechanics and techniques of teaching themselves a particular subject” (Knowles, et al, p. 185). Citing Candy’s (1991) ideas of autodexterity, Knowles, et al (2005) state that when learners take ownership over their learning, it “leads to an internal change of consciousness in which the learner sees knowledge as contextual and freely questions what is learned” (p. 186). So in these technology training sessions, we would encourage faculty to work at their own pace and to practice self-teaching as much as possible. Another benefit of this “do” comes from Journet’s own experiences, which suggest that “the allure of pleasure or creativity” (2007, p. 117) when engaging learners in new technologies should not be underestimated. In other words, if we allow trainees the opportunity to play with the technology and to see that it might actually be fun, then they might be more likely to learn it.

DIGITAL IMMIGRANTS VS. DIGITAL NATIVES

At the 2006 Beyond Boundaries: Integrating Technology into Teaching and Learning conference at the University of North Dakota, we heard Marc Prensky, CEO of games2train in New York and author of *Don’t Bother Me Mom—I’m Learning!* presented two sessions, one entitled “Engage Me Or Enrage Me: Educating Today’s ‘Digital Native’ Learners.” While we actually disagree with a lot of what Prensky says about students and student needs today—for example, none of us are going to consider letting our students use their cell phones to call their friends during exams—we think everyone was struck with the accuracy of his example of digital immigrants vs. digital natives. Just as natives are born in a country and speak the native language and are comfortable with the native customs, digital natives are the generation born in the digital age, the students who grew up never knowing a world without computers. They are comfortable with technology and have handled and used it all their lives. And just as persons who immigrate to another country at a young age may adapt very well to the new environment, they are still immigrants. They may still have accents and still think along the lines of the native country and not the new country. It has been commented that digital natives use their cell phones to tell time, while early digital immigrants may be very technologically savvy with the latest cell phone gizmos, but will still wear watches to tell time. Another test to tell the digital native from the early digital immigrant and later digital immigrant involves handing the test subject a digital camera and asking the subject to perform a desired function. A digital native, understanding that the technology should be intuitive, would begin to play with the camera. The early digital immigrant may also begin to play with the camera, or may Google the instructions for the function on the Internet. The later digital immigrant may likely look for

the box the camera came in to attempt to find the instructions. Those who immigrated at a young age can be contrasted to recent immigrants who have thick accents and a hard time figuring out the ways of the new country. We think many instructors at this point in time are digital immigrants in some form—even though we may have very slight accents. After all, when we want to know what time it is, we look at our watches, not our cell phones. We know our cell phones display the time, but we are still used to the ways of the “old” country. We want watches.

The problem encountered throughout the research into best practices in teaching faculty instructional technology was that those who are tapped to lead such faculty development workshops are often tapped because they are “good” with technology. Their first reaction is to play with the technology in an unstructured way, and since instructors often create teaching materials to meet their own learning styles, early faculty development workshops in the research were unstructured to cater to the early digital immigrants. The result was frustration on the part of learners because they were generally not early digital immigrants, but later digital immigrants. The learning materials did not match the intended audience, and this problem led to the research and resulting key “do’s” that we found.

As stated previously, many of the faculty who fall into the later digital immigrants category are considered senior faculty. We all have heard the clichés which suggest that we as humans tend to become set in our habits, that we often fear change. Such is the case for senior faculty members (and even some faculty who are mid-career) who avoid technology of any kind. We all know our colleagues who are recent, and perhaps unwilling immigrants into the digital country, who never think about “Googling” to find out the weather for tomorrow. One of our digital immigrant colleagues recently received an Adobe file as an attachment and could not get it open. When he returned it to the sender with a message that the file would not work, he

was informed that it was an Adobe file. He called a colleague into his office to ask about the situation and asked, “Do I know Dr. Adobe? Is that a new dean?” Those of us who “immigrated” at an earlier age, when presented with an unknown file form, would probably turn to the web to help us access the information needed to solve the problem. We can function in the old country, but we are usually comfortable in our chosen digital home.

The digital natives, however, our students (with some exceptions), are fluent with the new and ever-changing technologies in a way that the immigrants can never be. It’s a different way of thinking and functioning, and it has some bearing on different types of adult learners in instructional technology workshops because those of us running the workshops—the earlier digital immigrants—can make assumptions that are frustrating to the faculty who have the most to gain from the instructional technology workshops—the later digital immigrants.

The key difference in the two types of faculty stems from the last “do.” Earlier digital immigrants are like digital natives in that when we receive a new piece of technology or software, we “play” with it until it works. It’s not uncommon for a colleague to hand one of us a digital camera or cell phone and ask us to make it perform a function. We can do it—usually in a few minutes—but we have great difficulty telling the owner how we made the technology perform the desired task. Why? We understand that the road to achieve the goal is not linear. The technology has been programmed to be intuitive. We’re comfortable with looking for the logical buttons to push until the goal is achieved. And we are having so much fun in solving the problem, that we forget that this knowledge needs to be translated into a series of linear steps for our more recently immigrated colleagues. In other words, those of us who are more akin to digital natives tend to forget the very theories of adult education that we have studied, the methods that will better ensure assimilation into the digital society that is upon us. Fortunately,

we have put aside this forgetful tendency because we realized the potential benefits that technology can afford to all faculty members.

FUTURE TRENDS

Faculty will likely always need professional development in instructional technology because instructional technology constantly grows, changes, and improves. For example, operating systems upgrade, and with those upgrades come new interfaces on old software standbys or even new features and functions. Old programs are phased out and new programs are phased in. Another training opportunity arises when an expensive favorite piece of software becomes available for free in a similar form via open source software. Training is here to stay. However, face to face training such as the type advocated here for later digital immigrants is becoming a thing of the past. Many companies and universities have already made widespread use of Just in Time (JiT) or desktop training, where employees access the technological training they need from the desktop. As this trend grows, the seven key “do’s” could be adapted thus:

- Provide participants with portable storage devices such as jump drives or flash drives as incentives for completing desktop training.
- Provide participants with a real person behind the desktop training. Before the training session, that person should contact participants or potential participants and tell them what the software can do for them. If possible, design the training to assist participants with projects they are currently working on.
- Do allow participants access to the technology being presented, and make sure they will have access to the technology for their own use later.

- Do present the schedule of activities and session goals at the beginning of the training session. Make it printable so the participant can make a hard copy and refer to it throughout the training, if desired.
- Do limit training time and make desktop training in easily accessible segments tailored to suit the immediate needs of the participants. Ten minutes is a good time limit for a desktop training session.
- Do make a real person available to participants after the training in case they have questions, run into difficulties, or just want more information. The training doesn’t end when the session ends.
- Do encourage participants to veer off course and play or move ahead in the training. Participants will learn more and have more fun if they are in charge of their experiences.

CONCLUSION

Journet (2007), who considers herself to be senior faculty, “[came] to digital media later in [her] career,” (p. 107), and she has discovered, as no doubt many faculty members have, the multiple benefits of learning digital media. Journet, a composition teacher, lists a few concerns typical of digital immigrants when it comes to learning new technologies:

- How do new media mesh with what many of us have traditionally (and over a lifetime) considered our responsibilities as composition teachers?
- How do we negotiate difficulties attendant on becoming a learner in areas where we are accustomed to being experts?
- How can we find appropriate opportunities for professional development? (p. 108).

If we consider the basic tenets of adult education, then perhaps we can become better facilitators of training sessions that will help bridge the gap between digital immigrants and digital natives. A digital divide does exist in terms of age, and often mid-career and senior faculty fall into this gap, becoming what has been termed “digital immigrants.” It is important to remember that becoming more technologically literate will benefit not only the faculty members themselves, but also their students. If we can bridge the gap, even partially, between digital immigrants and digital natives, then all of us will be better off. Therefore, it is crucial to address the concerns of our colleagues, and by adhering to the preceding list of “do’s,” we hope to do address the above concerns (and any other concerns that arise) as well as possible.

The most successful method of directing instructional technology workshops with faculty requires that the facilitators provide printed out, step-by-step instructions relevant to exactly what the faculty will be learning. In addition, faculty should be advised to arrive at the workshop with a storage device, a syllabus, a textbook, and a specific goal—and the facilitators should suggest specific goals to help the instructors best prepare. Whenever possible, faculty should be provided with “prizes” or incentives such as software, thumb drives, or other desirable items as a “thank you” for attending training.

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Chapter 4.6

Internet Citizenship: Course Design and Delivery Using ICT

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INTRODUCTION

This article presents the design of an undergraduate course that focused on how the Internet¹ may be used as a medium for discovering information about citizenship, in general, and for advocating and practicing citizenly conduct, in particular. The goal is to share with the reader a set of guidelines to specify course objectives and requirements, to select relevant materials, to engage students in self-directed learning, and to appreciate the process of working with the students over a semester. Applications of information and communication technology (ICT) were integrated into the course management and delivery, and they also formed the basis of the topic for the course content.

The title of the course was “The Voice of an Engaged Citizen: Vote, Advocate, Volunteer, Respond, Act...How?” This course was one of 14 first-year seminars² (FYS) intended to be taken by high-achieving freshman at the University of Maryland–Baltimore County (UMBC).³ These seminars, which are limited to 20 students, are intended to create an active learning environment. The students’ development of effective oral and written communication skills and the mastery of techniques to seek and evaluate information are the cornerstones of these seminars. This particular course was intended to explore the ways that ICT could foster the practice of citizenship. The course also had the objective of teaching students to use the Internet to search for reputable evidence in support of the Internet’s use in such an application area.

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COURSE DESCRIPTION

First, the students taking part in this course should use the Internet to learn what citizenship is. From there, they can look for ways that the Internet can be used to practice citizenship. Practicing citizenship via the Internet may include, but is not limited to, finding and evaluating Web sites that provide information about important issues and that provide the opportunity to communicate with our representatives. Likewise, students are also encouraged (1) to look for research that has been done to see if and how citizens are using the Internet to participate in democracy, (2) to seek information about political activist groups on the Internet, and (3) to determine how effective those groups are in attracting members and influencing decision making. Students should then attempt to find out if the Internet has information about character development and the learning of moral values.

The overall objectives for the coursework are formulated as the class progresses. This way, the class will allow itself the flexibility to pursue an avenue it finds interesting. The format of the work should include group discussions and seeking out information on the Internet. During some of the classes, students present their findings for discussion, ensuring that the students learn how to prepare and deliver PowerPoint presentations and how to write evaluative essays of journal articles and other material.

COURSE MANAGEMENT AND DELIVERY

A Blackboard site was available in support of this course where material, such as readings and Web site links, were posted for the class to review. It should be noted that the “syllabus” of this course evolved in the form of an “Assignments Log” posted on the Blackboard site that specified the requirements for each particular class. This log

evolved because there was flexibility in the pacing and type of assignments required from the students; typically, the due dates for written essays and presentations were posted two weeks in advance.

However, the most important use of Blackboard was its function as a forum for students to provide immediate written comments on class events, whether led by the instructor or by the students themselves. Furthermore, Blackboard was also used for students to post their PowerPoint presentations, their review essays of journal articles, and their evaluations of Web sites so they could be reviewed by the instructor as well as other members of the class.

COURSE CONTENT AND STRUCTURE

This particular seminar course met twice each week for 75 minutes over a 14-week semester. Class time was devoted to the following types of activities.

First, the instructor (HHE) posted on Blackboard a collection of journal articles (Evans & Yen, 2005; Froomkin, 2002; Thomas & Streib, 2005), related reports (Best & Wade, 2005; Clift, 2002; Emurian, 2004; Noveck, 2004; Vance, 2000), and surveys (Horrigan, 2004). This material was used for reading and discussion in class. The preferred style for engaging this material was found to be a type of “round robin” where each student would lead and read several paragraphs, later passing that role to another student. The student leader and reader was free to make comments and ask questions as he or she engaged the material, and other class members were encouraged to present their own questions and comments. At the conclusion of a reading and discussion, each student posted his or her own thoughts on the reading on a designated Blackboard discussion forum. Students were encouraged to give an evaluation of the material read and discussed in relationship to the overall objectives of the course. These class

exercises, which were interspersed throughout the semester, provided the occasion for open discussion and the rehearsal of tools of analysis that were applicable to the students' written reviews of journal articles that they themselves selected.

Second, as briefly mentioned above, each student reviewed six journal or other reputable articles throughout the semester (Coleman & Norris, 2005; Gil-Garcia, 2005; LaVigne, Simon, Dawes, Pardo, & Berlin, 2001; Lourenço & Costa, 2006). Each review was based upon a set of guidelines⁴ for evaluating an article, ultimately resulting in a two-to-three page, single-spaced essay. The articles selected by the students were posted on the Blackboard site for approval, and the review served as a basis for a PowerPoint presentation to the class. The set of guidelines was discussed in class, and anonymous examples of reviews written by students in similar seminars were also presented and discussed. For the first review, the instructor met with each student individually to provide feedback on a draft of the review. This meeting ensured that both the students and the instructor were in agreement with regard to what was expected from the review; consequently, both the instructor and students found this initial feedback session to be invaluable to the production of subsequent quality essays.

Third, several classes were devoted to examination and open discussion of various Internet portals and Web sites thought to be relevant to the course topic of Internet citizenship. This activity was made feasible since the class was able to meet in a PC lab or in a seminar room, depending upon the needs for each particular class. Based upon the feedback from the students during these open discussions, it was decided that PowerPoint presentations would be delivered by each student to evaluate a Web site. Consequently, each student shared his or her findings with the class. The pace of this course allowed each student to make three of these PowerPoint presentations. Among the cornerstone sites investigated, in open discussion or by student presentations, were the following:

1. <http://www.advocacyguru.com/>
This site contains a wealth of Web sites organized into the categories below. From among the many sites presented within a category, one example is presented for each category.

- a. Advocacy Resources

CITIZENOUTREACH

(www.citizenoutreach.com)

- b. E-Government General

E-DEMOCRACY

(www.e-democracy.org)

- c. Communicating with Elected Officials

YOUR CONGRESS

(<http://www.yourcongress.com/>)

- d. Nonprofit Resources

NONPROFIT BASICS

(www.nonprofitbasics.org)

- e. Online Political Networks and Conversations

E-THE PEOPLE

(<http://www.e-thepeople.com/>)

2. <http://first.gov/>
 - This is the U.S. Government's official Web portal.
3. <http://www.regulations.gov/fdmspublic/component/main>
 - On this U.S. Government Web site, you can find, view, and comment on regulations for all federal agencies.
4. <http://www.nifi.org/>
 - The National Issues Forums help people of diverse views find common

- ground for action on issues that concern them deeply.
5. <http://www.studycircles.org/en/index.aspx>
 - The Study Circles Research Center helps communities develop their own ability to solve problems by exploring ways for all kinds of people to think, talk, and work together to create change.
 6. <http://h2oproject.law.harvard.edu>
 - The stated vision is to encourage the growth of a more open set of intellectual communities than those spawned by the traditional university system.
 7. <http://www.americaspeaks.org/>
 - AmericaSpeaks is developing a national infrastructure for democratic deliberation that institutionalizes the links between decision-makers and citizens in determining public policy.

An initial attempt was made for the student presentations of the Web sites to be a demonstration; that is, the student would show the features of the Web site by navigating through it in front of the class. This approach turned out to be awkward and unsupportive of communicating the evaluation

of a site. Therefore, embodying the student led nature of the class, the students decided that the presentations of the Web site should follow the PowerPoint presentation format similar to that used for presenting the review essays. By using this format, screen shots of the features of the Web site were able to be included into the presentations, and it became easier to point out the strengths and weaknesses of a site. Figure 1 presents an example of a screen shot used for a student presentation. The screen shot was more beneficial than an open navigation Web site presentation because it allowed the student to focus on a specific aspect of a given Web page. In this example, the student chose to focus on the types of study circles offered in the state of Maryland.

In addition, classes that were scheduled between assigned deliverables consisted of such exercises as the investigation of Web sites that occurred during the third class of the semester.

1. Overview in class

a. Congress.org

(<http://www.congress.org/congressorg/home/>)

b. U.S. Senate Portal

(<http://senate.gov/>)

Figure 1. Slide from a Web site PowerPoint presentation on StudyCircles.org

How Study Circles Help:

Issues
Using study circles to work on:

- Racism
- Education and Achievement
- Neighborhoods and Families
- Health and Spirit
- Youth Issues
- Poverty
- Diversity
- Immigration
- Police/Community Relations
- Criminal Justice
- Civil Liberties and Security
- Facing the Future after 9/11

Related Pages

- How-To Guides
- Discussion Guides
- Videos
- Story Booklets
- Agenda
- Research
- Focus Newsletter
- Study Circles E-Letter
- Find a Study Circle Program**
- Events
- 2005 National Conference

Find a Study Circle Program

You may browse active study circle programs by state and/or by issue. Please contact us if you would like to get in touch with one of these programs.

State	Maryland	
Issues	All Issues	

Clear Search

Search results: 6 programs

- Baltimore Education Network**
 Baltimore, Maryland
 Issue(s): Education and Achievement
- Baltimore Education Network**
 Baltimore, Maryland
 Issue(s): Education and Achievement
- Calvert County Public School**
 Calvert County, Maryland
 Issue(s): Education and Achievement
No Longer Active
- Harford County**
 Harford County, Maryland
 Issue(s): Education and Achievement
No Longer Active
- Montgomery County Schools**
 Montgomery County Schools, Maryland
 Issue(s): Education and Achievement
 Program website
- Riverside Elementary**
 Riverside Elementary, Maryland
 Issue(s): Education and Achievement

- c. **U.S. House of Representatives Portal**
(<http://www.house.gov/>)
- d. **The White House Portal**
(<http://www.whitehouse.gov/>)

These portals were investigated and discussed in class and the students used them to express an opinion, anonymously to the other students and instructor, on a topic of interest.

STUDENT MILESTONES, CONTRIBUTIONS, AND FEEDBACK

In administering the course, there were several milestone instructional events that provided the occasion for the students' acquisition of background skills and knowledge that became instrumental to the successful deployment of this seminar to undergraduates.

One such instructional event was posted on the Blackboard site on the date of the second class, and it was due on the date of the fourth class:

This assignment is to prepare a PowerPoint presentation covering the below three topics. Find sources on the Web for this exercise.

- a. Give a definition of citizenship,
- b. Give core values needed for the practice of citizenship, and
- c. Give specific behaviors regarded as exhibiting the practice of citizenship.

Give your opinion on the quality of the sources of information and defend your opinion. What makes a resource of information have high quality? Give the links on your PowerPoint presentation.

This was the first major assignment for the students in this class, providing the occasion for each student to express his or her opinions on the course's content while challenging each one of them to provide reputable support for those opinions.

Another one of these instructional events occurred during the second class of the seminar. It consisted of a lecture by a reference librarian⁵ who taught the students how to search for information using the library's various databases, research portals, and search engines. The importance of this lecture cannot be overemphasized. Students were familiarized with access to electronically available journal articles and other material that were essential to their success in seeking information related to the topic of this course. Although most students were highly experienced in using Internet search engines, the library offered additional and secure paths to information that many students had yet to explore. Other instructors would be well advised to offer this type of lecture early in the academic careers of students, to include graduate students where necessary.

One very important class milestone occurred during the fourth class, as given in the Assignments Log:

1. Founding Documents
 - a. <http://www.constitution.org>
 - b. We will read in class the Declaration of Independence and parts of the Constitution, to include the Bill of Rights.
 - c. Assignment: *Post your comments* today about your reaction to reading these formative documents.

The instructor and students shared the reading of these documents, accessed via the Web site above. As it turned out, the Declaration of Independence and the entire Constitution were read during the 75-minute class. This class event turned out to be a vital as well as inspirational milestone for the students and the instructor.

Last, the final milestone, which, as the schedule would have it, occurred during the last class, consisted of student presentations of "Reflections on Internet Citizenship." These presentations were summative evaluations of the course by the

students in terms of what was accomplished by each learner. Through these presentations, students were given the opportunity to share lessons they learned while taking this seminar as well as express their opinions about how they believed the course could be improved for future classes. The strengths and weaknesses addressed in those presentations even served to aid the writing of this instructional article. A collection of observations made by several students is given below:

- The Future of E-Government:
 - Overall, E-Government seems to have a bright future
 - People are “getting out of line and getting online”
 - “E-the-People”
- Article Reviews:
 - One of the best parts about this class
 - Very unique activity for a FYS class
 - One activity provided tons of knowledge for future reference
 - Learned a new writing format
 - Improved critical thinking skills
 - Preparation for graduate school
 - Really enjoyed the fact that this activity will be of use to me in furthering my education—kind of like a “heads up”
 - Excellent “plan-as-we-go” class that developed us as writers, presenters, and analysts of academic writing.
 - All assignments had a purpose and we achieved the goals together.
 - I also learned how to critique.
 - Finding trustworthy articles and sites
 - Determining methodology
 - Finding strengths and weaknesses
 - Enjoyed going over articles in class.
 - I liked the course.

- The ability we had to discover such a variety of information in such detail through the presentations of topics we each went out and chose on our own was really neat.

CONCLUSION

This article presented an effective design for structuring and implementing an undergraduate seminar course on the topic of Internet citizenship through the applications of ICT.

It is very important to note that the evolution of this course from a flexible “Assignments Log” allowed the students to undertake a wide variety of activities, from writing those aforementioned journal article reviews to giving Web site presentations using PowerPoint technology. Furthermore, the types of activities pursued in this seminar class (as well as in most other seminar courses) served to strengthen the students’ overall writing and presenting skills, which will continue to be of use to them as they proceed with their education. In the same sense, the student-led nature of the course allowed the class to pursue topics within the concept of Internet citizenship that they saw as particularly intriguing, ensuring that the students remained actively involved in the course content throughout the entire semester. This was easily accomplished, as much of the coursework was designed for the individual student (e.g., allowing each student to select his or her own journal articles to review). As a result, while one student may have chosen to investigate the security concerns surrounding Internet citizenship, another student could have decided to research the technology needed to further the practice of Internet citizenship. Such material variety kept the coursework fresh and interesting as the semester progressed.

Overall, student feedback indicated that the approach described here regarding the instruction of an undergraduate seminar course on Internet citizenship was highly effective. Both the stu-

dents and instructor gained valuable insights on the course content through the interactive group activities that became one of the cornerstones of this class. Similarly, having the opportunity to make several presentations clearly had a positive impact on the students' skill level as it was observed that students' presentations increased in length and quality over the semester. Therefore, it is the hope of the authors that, after reading this article, the reader will have gained a better understanding of the undergraduate seminar program offered at the University of Maryland–Baltimore County and will also be able to execute successfully the methods previously described to create an Internet citizenship seminar of his or her own in the future.

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KEY TERMS AND DEFINITIONS

Citizenship: Although the typical definition of citizenship refers to the rights and privileges of those designated legally to be citizens, the concept was extended in this article to include motivation to participate in shared governance.

First Year Seminar: At UMBC, outstanding freshman are allowed to enroll in a course that has a seminar format similar to what graduate students might experience.

ICT: Information and communication technology was used as the medium studied for political engagement and for course delivery and management with Blackboard.

Internet: The term “Internet” includes the World Wide Web because that is a common way to refer to the media for electronic communications and exchanges of information.

Internet Citizenship: This reflected the use of the Internet for political engagement and empowerment, from local, state, and national perspectives.

Instructional Design: In the present context, this refers to the techniques that were adopted to encourage the students to seek and evaluate information and to provide written and oral reports to the instructor and to the class.

ENDNOTES

- ¹ Internet is used here to include the World Wide Web because that is a common way to refer to the media for electronic communications and exchanges of information.
- ² http://www.umbc.edu/undergrad_ed/fys/index.html
- ³ The junior author (MMC) was a student in this seminar. The senior author (HHE) was the instructor and is an associate professor of information systems.
- ⁴ <http://nasa1.ifsm.umbc.edu/courses/ReviewGuidelines/ReviewGuidelines.html>
- ⁵ The authors appreciate the lecture by Drew F. Alfgren to this and other classes and his ongoing support of our students’ development of research skills.

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Chapter 4.7

The Real World Buffalo*: Reality TV Comes to a Charter School

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ABSTRACT

Videoconferencing is one form of distance learning that can enhance teacher-education programs by linking students in higher education with Pre-K–12 schools. As part of a Preparing Tomorrow's Teachers to use Technology grant (PT3), a teacher-education program utilized distance learning to link college classes with an urban school. Mediated observations of specific literacy practices were integrated into a traditional introductory literacy course. Preservice teachers observed urban teachers teaching literacy. Immediately following these observations, the preservice teachers were granted the opportunity to reflect on the lesson by conversing with the teachers via distance learning. Initial

findings suggest that students acquired positive attitudes toward teaching in urban classrooms and preferred this virtual field experience to a traditional in-school placement.

INTRODUCTION

Two children collide and tussle over some props in the dramatic play area of a kindergarten classroom. Tempers flare and arms begin to flail. Twenty teacher-education students are sitting in a campus distance learning room miles away from the classroom. Their eyes are fixed on TV monitors watching for the teacher's response to the children's struggle. The teacher calmly intervenes and mediates the struggle. The college instructor "voices over" the ongoing scene, describing to

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the students the importance of body position and eye contact, and explains the conflict resolution strategy of active listening and validating feelings, which the students are observing. She prompts them to listen to the teacher's language and to watch the children's faces for signs of what they might be thinking and feeling. The college instructor briefly connects what the teacher is doing with points made in the chapter on guidance and discipline from the course textbook. Ten minutes later, the kindergarten teacher, on site at the school, enters a distance learning room (the collaboratory) and spends fifteen minutes answering questions and commenting on the 30-minute lesson. Students question the teacher about the conflict, and the teacher provides answers interspersed with her own reflections, a critical component in understanding teacher behavior. She returns to her classroom, and the live video session concludes. The college instructor urges the students to think more about the conflict scenario. She queries them: "In your experiences, what are some of the ways you have seen teachers resolve conflicts among children? What did this teacher do that worked? What did she say? What else might she have done? How do you think the children felt at the end? What will you need to know and be able to do to resolve a conflict with children?"

The setting above describes an ongoing transformation in teacher preparation programs. Research suggests that the more classroom experience that preservice teachers have, the better it is for their expanded repertoire of teaching strategies, by providing for more thoughtful decision-making when responding to children (Darling-Hammond, 1998). Experiences over time are needed for preservice teachers to acquire teaching confidence, make connections from theory to practice, and engage in reflection on teaching; however, time constraints, lack of access to classrooms, school safety issues, and liability concerns are some of the issues prompting teacher-education programs to find alternative ways to design and structure early field experiences (Adcock & Austin, 2002).

Though the nature and frequency of early field experiences is changing and expanding, the diversity, quality, and consistency of the experiences can be greatly enhanced (from what existed in the past) by using the technology available to students and faculty in teacher-preparation programs. The videoconferencing technology described in the opening scenario is just one means of using telecommunications. The range of technologies and their use in teacher-education programs is growing and expanding to include both videoconferencing and Internet protocol videoconferencing.

This chapter describes the collaboration between a teacher-education program and a unique urban charter school equipped with the technology to broadcast live teaching episodes from four primary classrooms. The project began using videoconferencing technology with preservice teachers to conduct guided observations of children and teachers working and learning in an inner-city charter school. Encouraged by positive feedback from students and faculty who used the technology, a pilot program was implemented examining the potential of the technology to mediate reflection with preservice teachers. Two different Preparing Tomorrows Teachers to Use Technology grants (PT3) from the U.S. Department of Education funded the work. The first grant, Project Access¹, enabled the development of the consortium between higher education and a high-need urban school, and provided the technology for real-time video linkages with four primary classrooms. The second PT3 grant, Reflective Mediation Through the Use of Technology², continued the work of the first with the development of a research-based set of best practices for supporting reflection with technology.

CHANGING FIELD EXPERIENCES AND THE ROLE OF TECHNOLOGY

Teacher-preparation programs in the sixties and seventies often had the luxury of a laboratory

school on campus (usually attended by the children of faculty and staff). Eager, inexperienced preservice teachers were able to observe and occasionally participate at the lab school for short field experiences, testing their “teaching wings” prior to the student teaching year. Many of these schools had rooms equipped with one-way mirrors and microphones allowing guided observations to occur for a whole college class. The sixties version of “high-tech” classrooms enabled students to unobtrusively see and hear the culture of a classroom under the interpretation and mediation of an instructor. If time permitted, the teacher might join the college class to talk about their teaching and answer any questions. This provided a less intrusive way for an entire class to watch teaching in action.

Evidence suggests that labs schools have been in a steady decline since the 1970’s. In 1964, a survey had responses from 186 schools, while in 1980 there were around 100 lab school respondents (Levin, 1990). As college budgets tightened, lab schools became financial burdens and less of a priority. Faculty began seeking natural settings for fieldwork more representative of the increasing diversity of modern classrooms. Laboratory schools were converted into child development centers, office, and classroom space, and teacher educators turned to the schools in the community to provide classrooms and teachers for early field experiences in addition to the capstone semester of student teaching.

MacNaughton and Johns (1993) suggest that the professional development schools (PDS) movement was the next step in the evolution to improve connections between university-based and field-based teacher-preparation components. College faculty began negotiating with schools interested in forming collaborations for the purpose of mentoring preservice teachers by providing early field experiences, methods classes, and student teaching on-site in school buildings.

Professional development schools made sense because they involved multiple players (college

instructors, preservice and in-service teachers, and the students and their families) in helping to reduce disconnect between theory and practice. Darling-Hammond (1992) identified professional development schools as positioned to provide accountability “by ensuring that they (preservice teachers) have the tools to apply theory in practice and by socializing them to professional norms and ethics” (p. 91). Others (Levine, 1992) argued that typical schools are ill-suited to provide the right environment and support for professionalization, and that the cooperating teacher/student clinical practice model implemented in most teacher-education programs does not support the “reflection in action” necessary for the preparation of quality teachers.

In the movement for professionalization of teaching, teacher-education programs seek accreditation to improve outcomes for teacher-education candidates and to distinguish their programs. In the past, teacher-education programs could become accredited if they could demonstrate their curriculums provided the appropriate experiences for candidates to become knowledgeable in both content and pedagogy. There was little emphasis on early field experiences before the student teaching year. Current standards from accreditation organizations like the National Council for Accreditation of Teacher Education (NCATE) call for field experiences that are clearly defined by individual teacher-education programs. Candidates should have “diverse, well-planned, and sequenced experiences in P-12 Schools” (NCATE, 2002, p. 4). The PDS Standards Project of NCATE has identified 28 highly-developed PDS sites, which in a survey described their practices, goals, and funding sources. These data, along with a literature review and other commissioned papers, were used to develop a set of standards for PDS endorsed by the Unit Accreditation Board Standards Committee in March, 2001 (Teitel, 1999). Work of the PDS movement, along with more clearly-defined statements from accreditation councils and state boards of education, seems

to suggest that preservice field experiences are equally as important for preservice teachers as the student teaching year and should be given careful attention. Teacher education programs are encouraged to give consideration to the quality of the setting, number of hours, and how the placements are supervised.

With the challenge to meet high standards, teacher-education programs have been pushed to improve in many areas simultaneously. Technology, diversity, and quality field experiences are three areas that have been targeted as needing improvement (Cochran-Smith, 1995; Irving, 2000; NCATE, 1997). Research has documented the value of using technology in teacher-education programs, and teacher educators are asked to model the integration of technology to ensure that future teachers will include technology in their own classrooms (Strudler & Wetzel, 1999). Many have documented the effectiveness of early, ample, and well-supported field experiences and focused observations in urban schools in order to facilitate confidence, commitment, and readiness to succeed in teaching in urban schools (Groulx, 2001). Classroom observations are enhanced when preservice teachers are able to engage in collaborative reflection with urban teachers and college faculty (Fountain, 1994).

With increased emphasis on enriching the number, quality, and diversity of preservice school experiences, and preparing preservice teachers to utilize technology, the following questions could be posed to assess the effectiveness of any changes as to how teacher education programs implement and structure field experiences:

1. How have technology innovations been able to reproduce and improve the experience of the guided observation (allowing students to observe a common teaching episode) as it unfolds live and unedited?
2. Can the quality of students' reflections be changed and enhanced by the opportunity to

watch a common teaching episode while an instructor mediates what is being observed?

3. Can students be encouraged to use a higher level of reflection if the field experience is technologically-mediated instead of actively participating in a randomly-assigned classroom?
4. How have technology-mediated observations reduced students' stereotypes of working in an urban classroom?

These are some of the questions under investigation in a project using technology to mediate reflection involving teacher-education students and the teachers and children at one charter school.

A UNIQUE URBAN SCHOOL: THE KING CENTER CHARTER SCHOOL

In the mid 1980's, a 100-year-old church scheduled for demolition in inner-city Buffalo was given "historic landmark" status, thus saving it from destruction. A committee was commissioned to study possible adaptive reuses for the building. It was agreed, since the hope for reviving this community would reside in ensuring the education and well-being of its children, that the facility would be used to provide the highest quality of education for this predominantly African-American community's youngest children. Support from local colleges and universities would be essential to the project.

After years of fund raising and planning, a Pre-K through Grade 2 program, designed to model a high-quality, research-based, holistic education opened as the King Center, and was housed in an early childhood center in a public school until the church was renovated and ready for occupancy.

In 1993, Yale University's Bush Center in Child Development and Social Policy designated the King Center as New York State's first "School of the 21st Century" (Hoot, Massey, Barnett, Henry,

& Ernest, 2001). As New York State joined other states in passing a charter school law, the King Center submitted a proposal to the SUNY board of trustees for a charter. The King Center School's application to begin a K–3 school for 80 children was approved, and the school opened in August, 2000. Grade 4 was added in 2002.

Phase I: Videoconferencing Technology and Guided Observations at the King Center Charter School

The school's virtual learning collaboratory (distance learning room) has the capability to bring professors from area colleges/universities and their students together with teachers and children for the purpose of observing "real-time teaching" using a distance learning environment. Four classrooms (K-3) are equipped with corner-mounted cameras. The teacher is provided with a microphone and camera remote pack. A laser-tracking device follows the teacher's movements in a limited range within the classroom. The microphone picks up conversations between the teacher and children. Typically the children know when the camera is on for an observation, but within minutes they are usually absorbed in their work, easily ignoring the presence of the camera.

The school utilizes the technology for many projects. For example, the director of the school has asked each teacher to videotape several lessons and decide on one to use for performance evaluation and assessment of teaching skills. From the initial installation of the cameras, however, the school was primarily interested in linking with higher-education institutions for consultation and to serve as a virtual urban lab school. Buffalo State College responded to the invitation to partner and subsequently included King Center Charter School in two PT3 grants acquired in 2001 and 2003.

Teacher Participation

The PT3 grant project relied on teachers from the school to volunteer. In the beginning, all classrooms were equipped with cameras, but only two teachers agreed to participate. After several guided observations, the two teachers shared their enthusiasm with the rest of the staff at the school. All were continually encouraged and invited to join *when they felt ready*. Within two years, all teachers were hosting guided observations for students in teacher-education programs.

The four participating teachers have two to fourteen years of teaching experience. One was designated as a "master" teacher when she was employed in the public school system. Two of the teachers have been with the school since it opened in 2000. The school enrolls 100 children in five classrooms, with the same building leader since inception. There is cohesiveness in the philosophy, teaching strategies, and behavior management that preservice students see during each virtual observation.

Participating teachers comment that they get nervous before each session begins and are constantly aware that twenty to twenty-five preservice teachers are watching every move and hanging on their words. Every teacher expressed the realistic worry that a child might have a "meltdown" while the camera was on. On the positive side, teachers state that participating in the guided observations makes them conscious of teacher language, lesson materials, and student feedback.

I try to model appropriate and logical consequences for students' misbehavior. I try to make sure that I model various strategies for motivating and engaging students in a lesson.

I find that I try to stress positive teacher language and consistency when the college students are watching me teach. I try to be explicit with logical consequences.

I try to model using a quiet voice and redirecting in a neutral tone. I try not to become emotionally charged when students make poor choices regarding behavior/conduct. I try to model a deep sense of respect and reverence for the individual humanness of each student. I model my relationship as a nurturer/caretaker.

In spite of the pressures and responsibilities of normal classroom teaching, the added complications of scheduling videoconferencing sessions, and the need to leave the classroom and their children to talk with the college students, the teachers continued to volunteer because they believed in professional development and giving back to teacher-education programs by sharing their experiences and expertise, even at a beginning or emerging level. Their continued willing participation highlights the critical importance of trust in relationships between partners. This seemed key to sustaining the work. For the teachers in this project, knowing that a person who knew both their work and them professionally and personally was stationed in the college distance learning room, interpreting and moderating the videoconference for the college students, kept them volunteering and participating in the program.

Technologically-Mediated Guided Observations

Buffalo State College education faculty were invited to schedule a session (during their regular class time) in the distance learning room on campus and participate in a “guided observation” of an unedited, live teaching episode. Initially there was concern that the project might be overwhelmed with requests. If so, it would not be possible to burden the four participating teachers and the children at the charter school with too many interruptions in one week. However, as Boccia, Fontaine, and Lucas (2002) found in their “Looking into Classrooms Project”, the college faculty seemed reluctant to take time out of scheduled

class meetings to have students participate in this unique new format for guided observations. After a campus-wide mailing, posting flyers, scheduling a demonstration seminar, describing the project, and inviting people to sign up, the project has sustained a small group of regular participants who typically requested one observation each semester. Once instructors had a direct experience using the technology, they were eager to repeat the process with students each semester.

The teacher education classes that participated came from several departments, including Elementary Education, Early Childhood, and Art Education. The students enrolled in the classes were in the first three years of their teacher-education program. For most students, the guided observation experience represented only one piece in a collage of early clinical field experiences prior to student teaching. The college instructor of the class and the project liaison mediated every distance learning session. As is the case with all college/school collaborations, the project was possible because a level of trust had been established between the teachers at the charter school, their director, and the higher education project director, prior to the implementation of the first grant. Teachers were more comfortable being observed knowing that a person that they knew and trusted (the project director) was on-site and available to clarify for students what they were observing.

The guided observations were structured for different purposes, depending on the request of the college professor. For example, an Introduction to Education class asked to observe 15 minutes in each of the kindergarten through third-grade rooms. The instructor wanted students to look at room arrangement, transition techniques, activity level across grade levels, and behavior management techniques. A reading methods instructor requested an observation of a guided reading lesson. A literacy methods professor wanted to observe the kindergarten teacher model interactive writing or sharing the pen (something which had been difficult for students to observe in their live field

placements). With prior planning, requests were easily accommodated in the classroom teacher's normal daily schedule. Teachers e-mailed the lesson plan prior to the scheduled observation. Students were encouraged to follow the plan and match what they observed with what had been planned. Detours taken from the original lesson plan were frequently a source of questions and reflection in the debriefing talks following each observation.

Immediately following the 20- to 30-minute observation, the classroom teacher moved to the school's collaboratory and held an interactive session with the college students, including questions and answers. Initially, students seemed quiet during the question-and-answer period. In spite of this generation's increased use of technology, seeing themselves on TV and being asked to speak into a microphone as the camera focused on them was novel and unsettling for them. Almost all students who participated reported that they had never been in the distance learning room prior to the guided observation. The students seemed to need encouragement and prompts for asking questions. It appeared that they felt uncomfortable voicing a question to the classroom teacher in front of peers while the camera focused on them. Students were encouraged to write down a question or thoughts that occurred during the observation, with the intent of asking the teacher during the debriefing. Additionally, the project leader and the instructor would pose questions (during the observation) about what the teacher appeared to be doing and saying, and suggested that students should ask the teacher to clarify these points during the debriefing. Questions commonly asked by the students centered around specific aspects of a lesson plan, the reaction of the children to the lesson, and what the teacher planned to do in a follow-up lesson. Students asked about teaching strategies, the children's behavior, curriculum requirements, discipline, family involvement, and differences between charter and public schools. Students frequently queried the teacher about a

specific child's behavior and the teacher's use of different behavior management strategies. Another common question was how the teacher acquired ideas for a particular lesson, and how long it took to prepare and plan the entire lesson.

Students' Reactions

From surveys collected during the initial phase of the guided observations, students reported a positive reaction to this virtual field experience and an increased understanding of the realities of teaching and urban schools. It was revealing to read some of their misunderstandings and sobering to realize the work still needing to be done in teacher-education programs to uncover and discuss misperceptions and biases.

The obvious strength of this experience is being able to look over the shoulder of a skilled professional as she demonstrates the concepts we have read and talked about. Nothing (short of actually doing it) makes a concept clearer than seeing it actively and accurately portrayed in real-world settings.

This experience gave us an unedited picture of a teacher and students in action. It was great to see what we've learned about in every education class in an actual setting, not just words in some text.

I have gained more confidence. It is easy to read information in a textbook or watch videos, but to actually see everything implemented live by a teacher who is unable to go back and redo or erase mistakes...This was so inspiring and gave me a realistic view that everything is not always going to be perfect and that it does not have to be either.

I expected a bunch of wild, out of control children. What I saw was a group of bright, well-behaved children with just as much potential as other children.

I was much more afraid of urban schools before this experience. There are a lot more similarities to suburban schools than I previously thought.

REFLECTIVE MEDIATION-IN-ACTION

Mediated reflection using a virtual field experience evolved and changed over several semesters. After three semesters of scheduling guided observations and receiving positive student feedback, the project added additional open observation times and invited all students enrolled in any section (usually six or seven) of Introduction to Literacy, an early course in the teacher-education program, to take advantage of the opportunity to watch good teachers teach literacy.

A graduate student was hired to monitor the open sessions, but the teachers at the school were unable to leave their classrooms for the question-and-answer period due to the frequency of the open observation times (three mornings a week for one-and-a-half hours).

The open observation model proved problematic for many reasons. Few students were able to come to the distance learning room in the mornings because of other course commitments. Instructors had other teaching responsibilities and could not be there to observe alongside the students. The classroom teachers at the school felt burdened by having to “go live” so many hours in one week.

Reflecting on the data collected, we found that the students reported experiences of using video-conferencing to conduct the guided observations as valuable. The guided observations, though valuable and positive, were still disconnected and needed to be included in the content of individual courses if faculty were to become convinced to use class time to fulfill the field experience requirement. Following one semester of combining some scheduled guided observations including student/teacher debriefing sessions, and adding open observation times which proved ineffective, we decided to develop a model using

a class-embedded virtual field experience. One course section of the Introduction to Literacy class served as the pilot for the project.

After assessing feedback from preservice teachers, instructors, and the classroom teachers, it seemed that the true value of observation for preservice teachers lay in the opportunity to hear classroom teachers reflect on their teaching immediately after a lesson, to have their instructor mediate discussion, and to integrate the virtual observation into college classroom conversations and activities. This led to reconceptualizing and implementing phase two of the virtual field experiences.

Phase II: Using Technology to Mediate Reflection in a Course-Linked Virtual Field Experience

Reflection is a complex, abstract concept. Though most educators state that it is an important trait for teachers to possess, it has become a difficult term to concretely define and even more difficult to determine how to prepare teachers to be reflective practitioners, especially in unfamiliar cultural contexts. The preservice teachers quoted in the Instructor’s Vignette show how traditional field experience conditions perpetuate limited opportunity for reflection. Frequently, instructors send class participants to different schools for short periods of time with no opportunity to integrate what they observe in schools to course content or class conversations. In essence, students are left to observe and participate in individual field placements with limited opportunities for any meaningful discussion or reflection with an instructor or mentor.

To complicate matters further, reflection is not generally associated with teachers. Teaching is seen as immediate action, whereas reflection is perceived as a more academic action (Hatton & Smith, 1995). Additionally, it has been suggested that preservice teachers tend to revert to traditional notions of teaching and learning during student teaching.

These assumptions may be further reinforced in a traditional teaching environment. If these beliefs are firmly held, teacher candidates are resistant to reflection and change (Yost, Sentner, & Forlenza-Bailey, 2000). Furthermore, it is often difficult for teacher candidates to even know what to reflect about (Dieker & Monda-Amaya, 1997). It is important, then, for teacher educators to facilitate this reflection before the teacher candidate reaches the point of student teaching. In the course-embedded virtual field experience, preservice teachers were engaged in mediated reflection on teaching from three different viewpoints. Preservice teachers were watching and reflecting on the classroom teacher's teaching. Simultaneously, the college instructor was watching, reflecting, and talking with them about the classroom teacher's teaching, and finally they were hearing the classroom teacher reflect on their own teaching during the question-and-answer period. Contrasted to the traditional field experience, where the preservice teacher is alone in a classroom watching and observing and returns to campus without time for debriefing with a classroom teacher, the virtual field experience can simultaneously provide four two-way communication opportunities: students and classroom teacher, instructor and students, instructor and classroom teacher, and student to student.

The teacher educator must "induce disequilibrium and cognitive conflict" in the learner to prepare him/her for critical reflection (Yost et al., 2000, p. 42). As the instructor's reflections in the vignette suggests, the instructor can mediate reflection through a common virtual field experience. The instructor can facilitate reflection by posing questions before, during, and after the observation (Appendix B). Preservice teachers can observe the classroom teacher's thought processes while she/he responds to questions posed following each observation.

Reflective teachers and teacher candidates develop a *habit* of continually learning from experience. According to Whipp (2003), reflective teacher candidates have the ability to stand back

from their own assumptions and biases to notice problems in their practice. They can then reframe problems in light of multiple perspectives and take action that is informed by reframing. As shown in the students' comments, preservice teachers were forced to confront their biases and assumptions of urban schools and children by having the opportunity to observe, reflect on what they were seeing, and then speak directly with the classroom teachers following each observation.

Reflectivity appears to develop in stages. Researchers have found that teachers who are reflective move from a singular focus on technical issues surrounding the delivery of lessons when they first enter the teaching field, to critical reflection, where master teachers regularly examine the technical, practical, social, and moral issues inherent in their design of the learning environment in their classroom from multiple perspectives. Master teachers are also able to make changes to their teaching that improve student learning based on a variety of sometimes competing factors. These teachers take responsibility for their own learning and that of their students (Giovannelli, 2003; Hatton & Smith, 1995; Truesdell, 2004; Yost, Sentner, & Forlenza-Bailey, 2000).

Videoconferencing, as described in this project, provides a unique forum for preservice teachers to be in a field experience environment where reflection dominated the conversations with the college instructor and the classroom teachers. For example, they might (and did) question teachers about the details of their lesson plans by asking how long something took to plan or prepare (singular focus), yet have the opportunity to hear a response from the teacher who would speak with them about how that lesson looked in the first year that she taught it and the changes that had been made based on her own reflection on practice.

Our attempt in both phases of this project was to move preservice teachers from reporting what they observed, which is evidenced in early iterations of the traditional field experience, to more critical reflection based on a common mediated experience.

Box 1. Instructor's vignette

Instructor's Reflection

The first semester, I taught the Introduction to Literacy class using a traditional field experience model. Throughout the fifteen-week semester, students went to various schools to observe in the classroom for a total of ten hours. The students kept observation logs and wrote a culminating paper describing their experience. This field experience was problematic in a number of ways. Because many of the preservice teachers were non-traditional students and local schools are at capacity with teacher education students (there are nine institutions preparing teachers within a fifty mile radius), placing students for observations was always difficult.

A second difficulty with traditional observations was students were watching one 45 minute to one hour lesson with no context of what happened prior to or what would happen in the future. There was no way to control for good, bad or indifferent teaching, and I was unsure whether the students would even recognize the quality of the teaching they observed. The students were very quick to judge the teachers and the children's behaviors without reflecting on what they were seeing. They just reacted. Compounding that, students all observed different classes at different times, so it was impossible to have class conversations regarding the observations. Often what they observed in their separate schools was disconnected to the conversations, readings and activities taking place in class.

These issues led to a discussion with the project director about other possible formats for observation. The following semester we decided to have students utilize an open observation plan at the distance-learning laboratory. The teachers agreed to take turns being observed for three mornings a week for one and a half hours at a time. After the observations occurred, the preservice teachers were excited to talk about what they observed. Again though, only two to three students of a class of twenty-four observed the same lesson, and I, as the instructor, was unable to observe any of the lessons. A major complaint of the preservice teachers was that the open observation times were not convenient for them since the school taught literacy in the morning and most college students had a full schedule of classes in the morning. There were issues with the technology not working on several occasions further frustrating the preservice teachers.

Once again, with the help of the project liaison, we re-conceptualized the field experience. This time, we decided to utilize class time to facilitate and mediate the field experience observations. Because this is a critical course, prior to the field-based literacy methods classes held in professional development schools, agreeing to give up class time were very difficult. One stipulation was that the observations had to be integrated with the content of our college course. The project liaison and I met with the teachers from the school. The teachers were each given a copy of the syllabus with topics, assignments, and dates (Appendix A). We discussed which topics would be best for observation and which teacher's style was best suited to that topic. We determined that, after the lesson, the teacher would go into the collaborative and reflect on her teaching and answer the preservice teachers' questions. We agreed on six observations and determined the dates to correspond with course content. After each observation, I posted one question on a collaborative Web-based discussion group site (Appendix B). All students were required to respond. They were encouraged to respond to others' postings.

My misgivings about relinquishing precious class time for the observations were eliminated about ten minutes into the first observation. The students (and I) were mesmerized by the classroom teaching. The discussions on Blackboard and in class were far richer than the old "field experience paper" that was required during previous semesters. Because we all had a common observation experience connected to our classroom readings and discussions, we could dialogue based on our personal interpretations. This allowed us to debate, break down stereotypes, and change some of our notions of teaching. After the final observation, I posed the following questions:

On a scale of 1 (poor) to 10 (great), how would you rate the usefulness and the relevance of our observations in the distance-learning lab? How did these observations enhance your learning? What did you get in the observations that would not have been possible by observing in person? Do you feel you missed out on anything by not observing in person? What might it have been? Every student rated the experience an 8, 9 or 10. Comments from students included:

...one of the great things about observing in the lab was that you were able to communicate with the teachers and have them do plans on what we were learning about in class...

We didn't have to get into a car and drive somewhere and only spend 30 minutes in the classroom. Then the students are not going to behave normally because someone is new and they will act up for the time that I am there.

We did not interrupt their learning process and got to see how the kids really do act during a typical day.

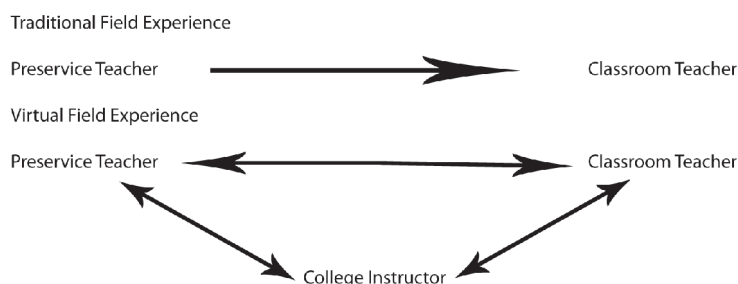
...we could talk about the events from the observation as a class and we had the opportunity to observe the things that we were learning about.

I did like that we did this as a class, so that all of us were on the same page and could discuss some of the effective as well as ineffective practices that some of the teachers were taking. If we would have all went to different schools, and seen different exercises being implemented in the classroom, our discussions would not have gone very far as none of our classmates would have known what we were talking about. Also, we cannot be guaranteed that what we would have observed would have reinforced the concepts that we were learning about in the classroom.

In my opinion, one of the best things that came out of these observations is the knowledge that we gained as a result of talking with the co-operating teachers. When doing observations in classrooms, it is rare that we are able to talk with the teacher after we have seen her in action. Talking with the teachers after observing them allowed us to grasp a true understanding of what they did and why, and allowed us to ask them questions if we were unclear about any of the exercises that they did with their students.

It seems clear the mediated field experiences were more meaningful to the preservice teachers and enhanced the classroom readings, discussions and activities. Final evidence of the success of the virtual field experience came from the department evaluation which all students are required to fill out at the end of the semester. In response to the question "What aspects of the course were most beneficial to you?" eleven students out of twenty, unprompted, mentioned the distance learning lab observations. Clearly I'm encouraged to continue to use this model. The evolution of planning for and thinking about this integrated field experience has enabled me to reflect on my own teaching. I find myself more intentional about including what we see in the observations into class activities and conversations. On one occasion we observed a vocabulary lesson. Following this, the students were required to present, with a group, a vocabulary mini-lesson. The students incorporated several strategies they observed the teacher from the charter school model during her vocabulary lesson into their mini-lessons. Rather than feeling students missed out on instructional time, I think the students have been enriched and their professional development supported by the video-conferencing experience.

Figure 1. Opportunities for mediated reflection in traditional and virtual field experiences



NEW TECHNOLOGIES BRING BOTH CHALLENGES AND PROMISE

Distance learning via interactive television (programmable two-way audio and video signals for communication using television monitors as a display) began at Buffalo State College in 1995 when the campus was granted funds to purchase equipment to create two distance learning classrooms and join the Western New York Fiber Network. At its peak, the network included over 100 classrooms in K-12 schools throughout the western eight counties in New York State. Buffalo State College built two of the original distance learning classrooms for two consortia within the network, Buffalo CityNet and Project Connect.

Over the past 11 years, the network was quietly phased out by nearly all of the original schools. The initial contracts with Verizon for access to the network were for ten years; for many school districts in Western New York, this contract period has ended. Using E-Rate funds, the original local BOCES centers have entered contract discussions with local cable companies to create a Gigabit Ether Network (Gig-E), which will continue to provide high-speed connections not only into specially-equipped classrooms but, via videoconferencing technologies, having the potential to make any classroom, any laboratory, or any media center into a distance learning facility.

The distance learning classrooms at Buffalo State College were built with a diffusion fund and

grants via Buffalo's local telephone company, Verizon (formerly Nynex). Each classroom in the network contained the same equipment: eight 32-inch SONY television monitors; one teacher station that included a touch panel to control the equipment; a computer with Internet access; an Elmo document camera to display items; a telephone/fax machine; and two VCRs, one to play videotapes and the other to record class sessions to tape. Each classroom had a multifaceted sound system, student area and teacher station microphones, and separate student view and teacher cameras. Students and teachers in each classroom were able to see and hear each other at television broadcast quality audio and video.

Despite the successes, there have been challenges which discouraged the use of the present model for more preservice field experiences in teacher education. Access to high-quality schools with distance-learning facilities is unique and not commonly found. The consortia fees enabling the college to connect to King Center Charter School and belong to both Project Connect network the CityNet were \$40,000 annually. Scheduled sessions are sometimes abruptly cancelled (due to unforeseen occurrences at the charter school), or the technology at one of the sites fails.

Many factors contributed to the decline in use of the original distance learning classrooms. Maintenance and repair of the equipment was costly and required trained technicians. All of the classrooms were built with grant or diffusion funds and, at the

conclusion of the grant, there were districts that could not continue with the expensive consortia fees (approximately \$16,000 yearly).

Given all of the changes to the original Fiber Network, the college and the charter school have continued their involvement due in part to the successful relationship of this project involving the education department and the charter school. The college will leave CityNet consortium this year, having recently purchased a videoconferencing unit that will allow expanding virtual field observations and offering college courses to other locations in Western New York and around the world.

The new videoconferencing unit, a Tandberg 6000 codec, costing \$19,000, will be integrated into the old Fiber Network classroom. The classroom will be redesigned with upgrades to accommodate the change from fiber to Internet protocol (IP) video conferencing. The eight SONY television monitors will be removed and replaced with two movie-sized projection screens. Two projectors will be mounted to the ceiling of the classroom, one to display the teacher view and one to display the student's view of the other distance sites. A new teacher station will be incorporated, one that is consistent with other teacher stations in smart classrooms on campus, in order to facilitate faculty use. New furniture will be added along with wireless microphones, new cameras, and, with an eye to the future, an expandable option that will allow the college to add on video capture software and other emerging technologies.

Transferring from the current system will be expensive for both partners, but, in the long run, will potentially save thousands of dollars each year. The old system relied on a local phone company with fees and a network manager with additional fees. The new system will allow for an organization to manage the site internally. While even more cost-effective solutions (such as using the Internet with cameras positioned at both locations) are a possibility, closely monitoring these

less-expensive solutions for quality of the virtual field experience is important.

While the use of interactive videoconferencing continues at educational institutions worldwide, there are other emerging technologies that will impact teaching and learning. As the cost of videoconferencing equipment and broadband connections continue to decline, and the quality of the audio and video increases, more schools may have the opportunity to become involved in virtual field experiences and other technology-supported preservice-education activities.

FUTURE TRENDS

This model suggests potential for addressing key issues in teacher preparation. Since the literature states that students tend to default to the model that they experience in student teaching, it seems important for teacher-education programs to search for ways to increase the quality, diversity, and number of early field experiences which preservice teachers encounter. Observing and reflecting on many different teaching behaviors in a mediated environment prior to student teaching, preservice teachers have the opportunity to internalize multiple responses and, rather than defaulting to what they experienced as children in school or to their one student-teaching model, are prepared to respond more appropriately to individual children.

Feedback from the guided observations conducted in phase one of the project suggested the power of a single virtual observation in helping students alter their perceptions and attitudes about urban classrooms and teaching. With repeated mediated observations, students saw numerous respectful student/teacher interactions, more examples of positive behavior management and culturally-responsive teaching, and many targeted literacy strategies. Students could begin to rethink their notion of teaching and learning and move further along the continuum of internalizing reflec-

tive teaching rather than relying on a singular reactive response applied uniformly for all children. This leads us to speculate that repeated selective observations in different classroom settings (rural, exceptional education, culturally-responsive, and linguistically-diverse classrooms) would enable preservice teachers to have a repertoire of responses, strategies, and behaviors to bring to the first years of teaching in any setting.

Additional work by Garrett and Dudt (1998) suggests that videoconferencing can be effectively used to supervise student teachers. In a project using three wired sites and 24 student teachers, preliminary findings suggest that videoconferencing for student teaching supervision works across settings and disciplines with minimal preparation. Students, cooperating teachers, and supervisors can effectively collaborate in the supervisory process. Similar to the participants of the charter school project described in this chapter, Garrett and Dudt (1998) found that the human aspects of the planning, scheduling, and conferencing were more important to the quality of using distant supervision than the technical aspects (problems and quality) of using videoconferencing equip-

ment. Initial findings from the project described in this chapter suggest some benefits for all stakeholders (see Figure 3). Unique to this project is the opportunity for preservice teachers, college instructors, and classroom teachers to engage in observations and conversations simultaneously reflecting on the process of teaching and learning.

CONCLUSION

While the use of interactive videoconferencing continues at educational institutions worldwide, there are other emerging technologies that will impact teaching and learning. As the cost of videoconferencing equipment and broadband connections continue to decline, and the quality of the audio and video improves, more schools may have the opportunity to become involved in virtual field experiences and other technology-supported preservice-education activities. While we cannot prepare preservice teachers for every situation that they will encounter, we can do a better job of diversifying their teacher-preparation experiences by using opportunities like technology-mediated virtual field experiences.

Table 1. Benefits for stakeholders

Preservice teachers can... • Observe one teacher and classroom at the same time • Eliminate travel time and transportation issues • Concentrate without being distracted by being inside the classroom environment • Gain more opportunities for mediated reflection with an instructor • Ask questions about what is happening immediately and in later class sessions Talk simultaneously with college instructors and classroom teachers about teaching and learning
College faculty can.... • Request and plan specific lessons related to course readings and assignments • Supervise all students in their virtual field placement simultaneously • Have the opportunity for “in-the-moment” reflection on teaching practice and refer back to scenarios that the whole class observed • Ask questions of the classroom teacher in the presence of the preservice teachers to raise teachable moments, thus intentionally connecting theory to practice Talk simultaneously with classroom teachers and preservice teachers about teaching and learning
Classroom teachers can... • Eliminate the distraction of too many adults in the classroom • Model good practices and think more intentionally about their teaching and student learning • Influence the curriculum of teacher-education preparation • Participate in research influencing teaching and learning • Learn more about current theory and practice in teacher-education programs • Share “practical experiences” gained from classroom teaching • Talk simultaneously with college instructors and preservice teachers about teaching and learning

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ENDNOTES

- * The name “The Real World” is copyrighted by MTV.
- ¹ Preparing Tomorrow’s Teachers to Use Technology (2001-2004). Title: Technology = Access: Teaching Future Urban Teachers Project, U.S. Department of Education, P342A010061
- ² Preparing Tomorrow’s Teachers to Use Technology (2004-2007). Title: Reflective Mediation Through the Use of Technology, U.S. Department of Education, P342A030088

APPENDIX A

Sample Schedule of Mediated

Observations in Literacy Instruction

September 13: Community building—Kindergarten

September 22: Emergent reading/writing—1st Grade

September 29: Phonics Lesson—1st Grade

October 27: Vocabulary—2nd Grade

November 10: Poetry—2nd Grade

November 17: Reader's workshop—3rd Grade

December 1: Assessment—Reading support instructor

APPENDIX B

Discussion Board Questions Posted Following Classroom Observations

Observation 1: How did Ms. Lockhart model reading, writing, listening, and speaking? How did it enhance the children's learning?

Observation 2: What dispositions did Miss Ortiz display that are important for teachers of young children? Why are these important? How do these dispositions enhance learning?

Observation 3: So far in our observations, we observed lessons in kindergarten and first grade. This week, we observed a 3rd grade classroom. What did you notice about the comparison in pacing and length of activity, conversations between teacher and child, and behavior management strategies? Thinking about the text reading, activities/discussions in class, and the observation, were the teacher's vocabulary strategies effective? Explain. What was one strength? What would you have done differently?

Observation 4: What were your thoughts and feelings about the content of today's lesson (poetry in 2nd grade), what the children brought to the lesson (and how they responded), how the teacher handled the interactions, and anything else you reflect on what you observed.

Observation 5: Ms. Schwartz discussed early on that she was going to do assessment rather than testing with the students. How does this correlate to our discussion in class on assessment versus evaluation? How can this type of assessment be useful to you as a teacher?

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Chapter 4.8

Research on the Effects of Media and Pedagogy in Distance Education

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INTRODUCTION

Do media influence learning? This is a historical debate in the field of educational technology, which started when Clark (1983, 1994) argued that media are “mere vehicles” and it is the content and pedagogical methods that are the “active ingredients” influencing student learning. Others (e.g., Kozma, 1994; Cobb, 1997) disagreed and argued that special media attributes can make certain types of learning more effective or cognitively efficient. In this chapter, I will first review the key arguments for and against media effects in distance education (DE). I will then review several meta-analyses that attempted to analyze the effects of media and pedagogy based on quantitative syntheses of the empirical research in DE. Finally, I will discuss directions for future research.

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BACKGROUND

Arguments for and against Media Effects in Distance Education

The media effects debate has continued in the context of distance education (DE), especially regarding the need for comparative studies. Clark (2000) believes that comparing media-supported DE versus classroom instruction is similar to the old studies on computer-based instruction and that the research on the effects of DE has the same problem of media and method confound. Therefore, he calls for conducting multi-level evaluation studies on student perceptions of motivation using both quantitative and qualitative data such as questionnaires and cost-effective issues of DE programs instead of experimental studies.

Smith and Dillon (1999) argue for the continued need of comparative studies. They feel that the

way to solve the media and method confounding problem is to describe not only the physical characteristics of delivery media but also how media attributes are used to support student learning in the studies. Such features may include bandwidth of a delivery system, whether the communication is one-way or two-way, synchronous or asynchronous, and interface design. A media attribute associated with bandwidth is realism, which may be used to support the learning of concrete versus abstract symbols. Media attributes associated with one-way/two-way communication are interactivity and feedback, which can facilitate active engagement and adaptation to learners. A media attribute associated with interface is branching, which may support learner control and self-directed navigation. They believe that by describing these media attributes and how they are used to support student learning in DE should help researchers un-entangle the media and method confound, thereby, providing theory-based research evidence to direct effective design of distance education.

Early Synthesis Effort

Regardless of Clark's argument and repeated call against media and DE comparative research (1983, 1994, 2001), a considerable number of DE comparative studies have been and continue to be conducted, esp., after each wave of an emerging information communication technology. As is the case in most educational research, some studies found positive effects favoring DE, some found no significant or negative effects.

Russell (1999) compiled and annotated 335 studies published from 1928 to 1998 that reported no significant difference between mediated DE and classroom instruction. The collection does not include any studies that report significant findings, either positive or negative. Russell's rationale for compiling no significant difference studies only was that these studies considerably outnumbered those that reported significant findings. Based on

his collection, Russell concluded that the results support Clark's theory of no media effects on student learning. Although the study was widely cited, the selective vote-counting approach has been most criticized for its lack of rigor and incomplete picture of DE effects (Bernard et al., 2004; Layton, 1999).

Meta-Analysis

Meta-analysis was first developed by Glass and his colleagues (Glass, McGaw, & Smith, 1981). It employs effect size as a standardized mean difference between an experimental and a control condition so that findings across studies can be statistically combined to estimate an overall average effect size. It also allows researchers to explore variability in the findings to identify potential moderating factors based on study features.

Hedges and Olkins (1985) further developed the meta-analysis techniques. The weighting by the inverse of a sampling variance procedure further reduces bias from studies of different sample sizes. The homogeneity analysis tests if the aggregated findings are consistent or heterogeneous.

MAIN FOCUS OF THE CHAPTER

A total of 12 meta-analyses have been conducted and published from 2000 to 2007, attempting to synthesize the empirical DE research findings using a variety of different meta-analytic procedures (see Table 1). Some focused on one type of DE and others were more inclusive.

Video Conferencing or Telecourses

Two meta-analyses focused on video-conferencing or tele-courses only. Machtmes and Asher (2000) synthesized 19 studies published in 1943-1997 comparing the effects of live and pre-produced telecourses with classroom instruction at the adult and high education levels. They found an overall

Table 1. Meta-analyses on the effects of DE

Author	N of studies	Education Level	Outcomes	Effect Size
<i>Videoconferencing or Tele Courses</i>				
Machtmes & Asher (2000)	19	Adult and high education	achievement	-0.0093 heterogeneous
Cavanaugh (2001)	19	K-12	achievement	0.15 heterogeneous
<i>Online courses</i>				
Ungerleider & Burns (2003)	8 4	Secondary and university	achievement satisfaction	0.000 -0.509* Homogeneity not analyzed
Cavanaugh et al. (2004)	14	K-12	achievement	-0.028 homogeneous
Williams (2006)	25	Undergrad. and graduate applied health science	achievement	0.15* Homogeneity not analyzed
Jahng et al (2007)	20	Undergrad. and graduate	achievement	0.023 heterogeneous 0.0259 homogeneous after removal of 4 studies
<i>Synchronous and Asynchronous DE</i>				
Allen et al., (2002)	25	Not described	Satisfaction	-.031 ¹ heterogeneous; -.090 ¹ homogeneous after removal of 3 outliers
Shachar & Newmann (2003)	86	High education	achievement	0.37* heterogeneous 66% favor DE
Allen et al (2004)	54	Not described	achievement	.048 heterogeneous
Zhao et al. (2004)	51	K-20, military, adult	Mixed	.10 Heterogeneous 2/3 favor DE
Bernard et al. (2004)	232	K-20, adults	achievement attitude retention	0.013 heterogeneous -0.081* heterogeneous - 0.057* heterogeneous
Lou et al. (2006)	103	Undergrad.	achievement	0.016 heterogeneous

mean effect size of -0.0093 and that the findings were significantly heterogeneous. Through univariate study features analyses, they found that studies that were published in the last decade had significantly more positive effect sizes favoring DE ($ES = +0.23, p < .05$) than earlier studies. They also found that studies where two-way interaction between students and instructor were available via either video or audio during live instruction produced significantly more positive effect sizes than one-way pre-produced telecourses.

Cavanaugh (2001) synthesized 19 studies published in 1980-1998 on the effects of telecommunication courses at k-12 levels on student achievement. The overall mean effect size was +0.15 favoring DE but not statistically significant.

The findings across studies were significantly heterogeneous. Although Cavanaugh coded and analyzed a number of study features including use of delivery system, duration, frequency, and mode of DE, grade level, year of publication, outcome measure, test sequence, sample size, grade level, subject areas, and study sources, no significant moderators were identified.

Online Courses

Four meta-analyses were conducted synthesizing studies on the effects of online learning compared with classroom instruction. Ungerleider and Burns (2003) synthesized a total of 12 studies published in 2000-2003 on the effects of online and networked

learning (not exactly distance learning) on student achievement and satisfaction at the secondary schools and universities. The overall mean effect size was 0.000 (N=8) on achievement and -0.509 (N=4) on student satisfaction. The latter is significantly negative favoring classroom learning. Neither homogeneity analyses nor study features analyses were performed on either dataset.

Cavanaugh, Gillan, Kromrey, Hess, and Bloemeyer (2004) synthesized 14 studies published in 1999-2004 that compared the effects of online courses at k-12 virtual schools with classroom instruction. The overall weighted mean effect size was -0.028, which is not significantly different from zero. The findings across studies were significantly heterogeneous. Similar to Cavanaugh (2001), they coded and analyzed a number of study features including grade level, content area, duration and frequency of the distance learning experience, instructional role of the distance education, pacing of the instruction, role of the instructor, timing of the interactions, and types of interactions, as well as various study quality and invalidity factors, but failed to identify any moderating features that account for the significant variability in the findings.

Williams (2006) synthesized 25 studies published in 1990-2003 that compared online courses with classroom instruction in applied health science at the undergraduate and graduate levels. The overall mean effect size was +0.15, which is significantly positive. Although the homogeneity analysis was not conducted, Williams found that effect sizes were significantly more positive for students who were working professionals (ES = +0.74) than traditional students (ES not significantly different from zero). The researcher also classified DE into three categories (p.129):

- *A distributed classroom:* Synchronous learning in which students receive instruction at a set time in a satellite classroom off campus.

- *An independent classroom:* Asynchronous learning in which students complete course content at home on their own time.
- *An open classroom:* Synchronous and asynchronous learning in which students complete course content independently gathering collectively throughout the course to discuss content.

He found that the effect sizes were significantly more positive in distributed synchronous classrooms (ES = +0.24, $p < .05$) and open classrooms (ES = +0.25, $p < .05$) than in asynchronous independent classrooms (ES = -.06). Williams also analyzed several instructional design features based on Olcott's (1999) distance education ID components (p.129-130):

- *Interaction* included the technical delivery methods for communication between instructor and student as well as student and student such as e-mail, audio/video conferencing, fax, telephone, and instant messaging.
- *Introspection* included instructional activities such as use of examples, simulations, laboratory exercises, demonstrations, group discussions, small-group projects, student presentations, guided imagery, outlines, journals, and reflective writings.
- *Innovation* included instructional activities with two or more learning styles targeted, coded according to the type of learning being examined such as visual learning (i.e., textbooks, in-class videos/slides/overheads), auditory learning (i.e., lecture), and/or tactile learning (i.e., computer-assisted instructional programs).
- *Integration* included instructional activities such as case studies, role playing, skill-building techniques, and handouts.
- *Information* included instructional activities such as quizzes, comprehension checks, and other assessment measures to

determine whether the student was gaining the knowledge and/or skills necessary for advancement.

He found that effect sizes were significantly more positive when instructional design components were present: innovation ($ES = +0.18$, $p < .05$), introspection ($ES = +0.26$, $p < .05$), information ($ES = +0.39$, $p < .05$), and interaction ($ES = +0.29$, $p < .05$) than when they were absent and that there was a positive relationship between the number of ID components present and achievement.

Jahng, Krug, and Zhang (2007) synthesized 20 studies published in 1995-2004 on the effects of online courses over classroom instruction on student achievement at the graduate and undergraduate levels. The overall mean effect size was $+0.023$, which is not significantly different from zero. The effect sizes across studies were significantly heterogeneous. After removal of 4 studies, the mean effect size was $+0.0259$ and homogeneity was achieved. One significant methodology study feature was identified: the studies where students received a pre-test and a posttest had significantly more positive mean effect size than studies where students received a posttest only. It is not clear, though, whether the pre-test scores were subtracted from posttest scores in the effect size calculations.

Synchronous and Asynchronous DE

The other six meta-analyses are more comprehensive, including studies on the effects of all types of DE. Shacher (2003) synthesized 86 studies published in 1990-2002 that compared the effects of DE and classroom instruction at all levels of high education. The mean effect size was $+0.37$, which is statistically significant favoring DE students. Similar to most other meta-analyses, the integrated effect sizes were significantly heterogeneous with two thirds positive favoring DE. Based on a fail-safe analysis, Shacher concluded

that it would need 3,062 additional unreported studies with average non-significant findings to refute the conclusion. Shacher did not code or analyze any study features.

Allen, Bourhis, Burrell, and Mabry (2002) synthesized 25 studies published in 1988-1997 on student satisfaction in traditional classrooms over distance education. The overall mean effect size was 0.031 and significantly heterogeneous. Homogeneity was reached after removal of 3 outliers. Two study features, type of media used for conveying information (video, audio, and written) and presence of interaction (full two-way video, limited audio or email feedback, and none during instruction), were coded and analyzed. Student satisfaction appears to differ for different types of delivery media. When video was used in DE, students had similar satisfaction level as students in traditional classrooms; when only written communication (fax or emails) was used in the DE condition, students reported significantly lower satisfaction level than traditional classroom students ($r = 0.247$, $N = 4$).

Allen, Mabry, Mattrey, Bourhis, Titsworth, and Burrell (2004) synthesized 54 studies published in 1962-2001 comparing the performance of students in DE versus traditional classes. Similar to their earlier meta-analysis on student satisfaction, each study was coded for type of media used for conveying information and presence of interactions. No significant differences were found for either of the two coded study features.

Zhao, Lei, Yan, Tan & Zhao (2004) synthesized 51 studies published in 1982-2002 comparing the effects of distance courses versus classroom instruction on a variety of outcomes. The overall mean effect size was $+0.10$. The findings were significantly heterogeneous with 2/3 favoring DE. Nineteen study features were coded and a few were identified as significant moderators including publication year, researcher as instructor bias, instructor involvement, synchronicity of student-instructor interaction, and media involvement. However, because the study features analyses

used the whole dataset with different types of outcomes, the results may be confusing and not easily interpretable.

A common problem with analyzing individual study features separately is that some study features may correlate with each other. This is especially misleading when study quality is not controlled, impacting on the validity of the findings on significant moderating factors. Two recent comprehensive meta-analyses (Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset, & Huang, 2004; Lou, Bernard, & Abrami, 2006) employed multiple regression analyses to control for the quality of research methodology and correlation among study features.

Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset, and Huang (2004) quantitatively synthesized a total of 232 DE comparative studies published in 1985-2002. In addition to estimating the average effect size of DE effects on student achievement (+0.013, $p > .05$), attitudes (-0.081, $p < .05$) and drop-out rates (-0.057, $p < .05$), they first analyzed the difference between synchronous DE (e.g., online courses) and asynchronous DE (e.g., video-based telecourses) and then analyzed the relative importance of media, pedagogy, and research methodology quality through multiple regression analyses of 51 coded study features for each of the three outcomes. The results indicate that on average, effect sizes were more positive for asynchronous DE than synchronous DE. Methodological Quality explained a significant amount of variance in both synchronous and asynchronous DE outcomes (49% and 12%, respectively, for achievement). Pedagogy explained a significant 10%-13% of variance after controlling for methodology quality. Media were only significant when entered at step 1. These results show that pedagogy appears to explain a larger amount of variance in the findings and that media and research quality study features are highly correlated.

Lou, Bernard, and Abrami (2006) synthesized 103 DE comparative studies on student achievement conducted at the undergraduate

level. They further examined how media were used to support different types of DE pedagogy: instructor-directed, independent, or collaborative. The specific codings are (p. 151-152):

- *Instructor-Directed DE*: Synchronous videoconferencing, one-way satellite TV broadcast with two-way synchronous audio, or audiographics were used to deliver teacher-directed instruction and there was no report of discussion among students or group activities.
- *Independent DE*: Only asynchronous one-way TV, video tapes, and/or Web-based resources were used and there was no report of discussion among students or group activities.
- *Collaborative DE*: Discussion board, email, listserv, audio-conferencing, telephone, or chat was used for collaborative discussion among students.

The results showed significantly more positive effect sizes for Collaborative DE than either Instructor-Directed DE or Independent DE (see Table 2). While students in Collaborative DE achieved significantly higher than those in traditional classrooms ($ES = +0.11$, $p < .05$), no significant difference was found in student achievements between remote and host sites in synchronous instructor-directed DE ($ES = -0.04$). Similarly, no significant difference was found in student achievement between students in Independent DE and in traditional classrooms ($ES = -0.04$). Homogeneity analyses indicate that the effect sizes for instructor-directed DE were consistent across the 49 independent findings integrated.

Since the effect sizes for Independent DE and Collaborative DE were both significantly heterogeneous, further analyses were conducted to examine how media and pedagogy were used to support three types of student interactions: student-content, student-instructor, and student-student (Moore, 1989) and their relative impact on student

Table 2. Weighted mean effect sizes for three types of DE pedagogy in undergraduate studies. (Source: Lou, Y., Bernard, R. M. & Abrami, P. C., 2006)

DE Pedagogy	<i>k</i>	<i>G</i> +	95% CI	<i>Q_w</i>
Instructor-directed	49	-0.038	-0.108/+0.032	53.48
Independent	41	-0.038	-0.086/+0.011	223.143*
Discussion among students	30	+0.109	+0.030/+0.188	165.278*

* $p < .05$

achievement using multiple regression analyses. The study features included in the analyses for each of the three interactions and the results of the regression analyses are summarized in Table 3. The non-significant features in each type of interaction appear to be significantly correlated with those that are significant. These results indicate that the best practices of DE that produce higher student learning than traditional classrooms are instructional design and learning activities that enhance: 1) student-content interaction through multimedia and interactive CBI, and 2) student-instructor and student-student interactions through opportunities and learning activities that encourage such interactions.

FUTURE TRENDS

The quality of DE primary studies, as in educational technology research in general, has been repeatedly

criticized by a number of researchers and is often cited as a problem for media and method confound (e.g., Clark, 1983, 1994, 2000). One way to ensure best evidence syntheses is to select only best quality studies such as randomized experiments as advocated by Slavin (1987). This is often problematic due to the limited number of randomized studies in education (Slavin, 2008), especially in DE. Coding and analyzing methodology study features as is done in several of the DE meta-analyses can help identify potential influence from research methodology quality. However, simply identifying significant methodology factors by analyzing each study feature separately without controlling for them is not enough. Bernard, Abrami, Lou, Borokhovski, Wade, Wozney, Wallet, Fiset, and Huang (2004) and Lou, Bernard, and Abrami's (2006) multiple regression approach provides a feasible way in controlling for methodology quality and thereby identifying the unique variance due to media and pedagogy features.

Table 3. Results of multiple regression analyses of the interaction study features after controlling for research methodology quality. (After source Lou, Y., Bernard, R. M. & Abrami, P. C., 2006)

<i>Student-content interaction</i>	• Systematic instructional design (ID) • Use of one-way broadcast TV or videotape* • Use of computer-based instruction (CBI)* • Use of Web-based course materials
<i>Student-instructor interaction</i>	• Opportunity for face-to-face meetings with instructor* • Provision for synchronous technology-mediated communication with instructor • Use of asynchronous CMC with students • Activities that encourage student-instructor interactions*
<i>Student-student interaction</i>	• Opportunity for face-to-face contact with other students* • Provision for synchronous technology-mediated communication with other students • Use of asynchronous CMC with other students • Activities that encourage student-student interactions*

* $p < .05$

As technology-mediated DE is becoming increasingly popular for meeting a variety of education needs, it is time to go beyond simply comparing DE with classroom instruction. Future DE primary research should focus on directly examining the media and pedagogy factors in DE. More research is needed to investigate how different media can be effectively used to support a variety of sound instructional strategies for more effective student-content, student-student, and student-instructor interaction and more effective learning. For example, up to now, two-way communication such as video conferencing has been used mainly to support instructor-directed lecture presentation. An interesting line of future research would be to investigate how synchronous video, such as desktop or portable video conferencing, chat, and Instant Messenger may be used to support student-student interactions (e.g., group projects, peer tutoring) and student-instructor interactions (e.g., project advising and providing interactive feedback).

Future primary studies should also provide more complete descriptions of instructional conditions including media attribute uses, instructional strategies, and methodological procedures, not only of the experimental conditions but also of the control conditions, so as to build a better understanding of the media and pedagogy effects in DE.

CONCLUSION

The DE meta-analyses reviewed in this paper have provided a considerable amount of cumulative evidence on the effects of DE versus classroom instruction as well as a variety of media and pedagogy factors that significantly moderated the effectiveness of DE. While the overall effect size of DE versus traditional classroom instruction ranged from a moderate positive effect favoring DE to no significant difference or negative effects, significant heterogeneity in the findings indicate that the overall means are not representative of all the findings integrated.

Study features analyses in several meta-analyses indicate that both media and pedagogical strategies are important in facilitating student learning in DE. Media and pedagogy that support interaction with the instructor and other students are as important as media and pedagogy used to establish individual student interactions with content only. These results support Keegan's (1996) differentiation between "distance teaching" and "distance learning". The traditional reference of media as "delivery media" may not be sufficient. In effective DE, media should not only be used for delivering instructional materials and teacher directed instruction and feedback but also for facilitating student-student collaboration.

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KEY TERMS AND DEFINITIONS

Asynchronous Communication: Delayed time communication between the instructor and students or among students using discussion board, emails, and etc.

Computer-Based Instruction: Instruction such as tutorials, drill-and-practice, and simulations that are provided through a computer.

Effect Size: A measure of standardized mean difference between the experimental and control conditions.

Media: Delivery media such as television, Internet, and video used in teaching and learning.

Meta-Analysis: A literature review method that quantitatively synthesizes the effects of an experimental treatment.

Method: Instructional and pedagogical strategies used in instruction.

Synchronous Communication: Real time communication between the instructor and students or among students using two-way communication media such as telephone, video or audio conferencing, and chat, etc.

Systematic Instructional Design: Conventional instructional design practices and principles used in developing the course and course materials.

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Chapter 4.9

Application of E-Learning in Teaching: Learning and Research in East African Universities

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ABSTRACT

The challenges of an increasingly borderless world, as seen in the advancements in information technology, have brought reform in universities and re-conceptualized what constitutes learning, teaching, and research. E-learning is often implemented as a response to increasing educational demand and an increasingly networked community. E-learning is considered as an interactive means to provide an alternative environment that stimulates practical learning and equips learners with the skills to manage technological change and innovations. This chapter evaluates the initial phase of e-learning, the importance of a rightful attitude, context, and instructional design in digital learning environments in Makerere University, Uganda, University of Nairobi, Kenya and Uni-

versity of Dar es Salaam, Tanzania. The increase in enrollment in these universities brings in many challenges in service provision, negatively affecting instruction, learning, assessment and research services. A crisis-solving approach is presented as stimulating a creative context for the meaningful introduction of e-learning. It is also discussed whether the environment created so far through computer-mediated learning motivates institutions to integrate e-learning further. The sample involved instructors and learners from three universities in three different countries of Eastern Africa. Findings conclude that an e-learning environment must be introduced by creating relevant awareness to change attitude and empower users with an authentic approach without too much technological complexity. Review of curriculum, assessment and training around e-learning environments are also imperative as these interrelated factors form part of the e-learning process.

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ORGANIZATION BACKGROUND

Some of the problems in higher education of countries of Eastern Africa are the huge numbers of learners and fewer instructors that eventually affect the quality of teaching, learning and research. There have been attempts to tackle some of these major problems by the introduction of e-learning through integration of information and communication technology (ICT) into teaching, learning and research situations. E-learning, begun with the use of radios and television sets in instruction followed by the instructor led systems (audio) where cassettes were recorded for learners to use independently with minimum help of the teachers. In all these phases, there was support of printed media to enable independent and self-paced learning on the side of the learner. In East African universities, e-learning is a recent technological initiative, which started with few computers and basic networks. Makerere University, Universities of Nairobi and Dar es Salaam were connected to an internet service provider (ISP) that enabled them to periodically download e-mails. These Universities, with little knowledge of the potential of e-mail in instruction and limited networks left internet service to the wits of a few individuals, who later abandoned it (Tusubira, 2002).

The three universities share a common context of location in Eastern Africa and have a common challenge of increasing education demands amidst limited resources. During colonial days, these three were constituent colleges of the University of London, specialized in some programs. For instance, students who wanted to do law in East Africa would go to the University of Dar es Salaam as it was not offered in either of the two. In 1963, the three universities became constituent colleges of the University of East Africa: Makerere University College in Uganda, University of Dar es salaam in Tanzania and Nairobi University College in Kenya. Since then, these Universities have grown in terms of student intake, academic units and academic programs. Naturally, the numbers

were manageable then, and quality training was guaranteed. Makerere University, which had less than 5,000 students in 1990, had increased this enrolment to 30, 000 students by 2005. There were equivalent increments in student enrolment at universities of Nairobi and Dar es Salaam to 20,000 and 16,000 respectively. With the large number of students, traditional modes of teaching became quite limiting, compelling the universities into innovations to ensure quality service. From analogue file management system of large box files with immense papers, there was a dig through the digital world of computing and networking as innovations. In these universities, using ICT is so popular now that it has a Swahili language name, TEHEMA: “*technologia, ehabari mawasiliano*”

SETTING THE STAGE

Computers, multimedia (mm), interactive data-banks and communication platforms in e-learning stirs expectation of the potential of ICT in education. Institutions of learning embarked on connections to the internet, formulation of ICT policy master plans and acquisition of learning management systems (LMS) sometimes called learning platforms. Meanwhile, there was demarcation of e-learning centers and intensive set up of other appropriate facilities for e-learning. It was felt that ICT in education have the potential to increase not only the effectiveness of the educational process but also its overall efficiency whether in terms of classroom activities or administration (Omwenga, 2003). Jonassen (2001) asserts that e-learning conforms to constructivism- a teaching and learning paradigm that allows one to learn what they want, at their own pace and to construct knowledge in a social environment. Jonassen describes a constructivist-learning situation as:

Active: where students are able to meaningfully process their own information into valuable personal and social knowledge.

Cumulative: where new learning bases and builds on prior learning; why personal experiences are a good basis for instruction.

Integrative: where learners elaborate on new knowledge and inter relate it with their current knowledge, just to suit the knowledge into prior knowledge.

Reflective: where learners consciously reflect on what they know and need to learn. This is a basis for transfer of learning and situational or practical learning.

Goal directed and intentional: where learners subscribe to goals of learning; enabling focus on ideas that fascinate learners most.

Deriving from constructivism, Omwenga (2003) presents five modes of using ICT in technology enhanced learning environment (TEL) as:

Support mode: This is aimed at increased accuracy and enhancing presentation of work. Tools for use in this mode include word processing, PowerPoint, computer aided design and desktop publishing among others.

Exploration and control: Learners are able to explore, examine, experiment with and build situations. Simulations, expert systems and statistical packages are mostly used for this purpose in TEL.

Tutorial mode: Information is presented at an appropriate level and pace giving learners an opportunity for feedback on progress.

Resource mode: Technology is used to access information and other resources whether online through internet or offline through CDs and other software.

Link mode: Communication between individual learners and instructors, examples of e-mails, net meetings and video conferencing.

Notably however, these modes are not exclusive of each other, they tend to be blended for effectiveness.

Constructivism is a teaching and learning paradigm in which people are assumed to act interactively and socially to create knowledge. Methodologies of instruction are being recast to leverage new learning media and honor multiple e-learning styles to fit learning situations. Ravenscroft (2001), in a study, remarks that most TEL initiatives have been technology-led rather than theory-led. Leading thinkers from both within and outside academia are exploring radically different approaches to teaching and learning based on theory; e-learning, among them.

In Africa, information and communication technology use in educational environment is far from being fully realized as in many incidences, there are a number of encumbrances. In a research done by Karen (2008), in several African primary schools, there was an interesting finding about information and communication use. Most of the schools surveyed reported no functioning computers, and no internet. Interestingly, the report indicates that contacts between African and United Kingdom schools were by e-mails mostly. This study though done in primary schools has an implication on higher education as it is the products of primary schools that end up in Universities. But it is interesting to say on this basis that the will to use ICT is there though with limitations.

Curran (2004) makes interesting conclusions that indicates that universities adopted a strategy of e-learning due to their inherent characteristic of adaptability in use and flexibility in application. Though Curran's study was done in European environment, it informs this study that the major reason why a strategy for e-learning is taken is because of flexibility, if things don't work, there is a lot of freedom to do something else. There is no use clinging on a strategy that is failing in a given context just because it worked in another context. In certain situations, the integration of ICT in teaching and learning has failed because of the implementers attempting the "Everest syndrome".

Application of E-Learning in Teaching

Table 1. E-Learning tools used in teaching and learning

TEL "tool"	Uses and advantaged	Principle for good teaching
COMMUNICATION		
Homepage	Good way of introducing instructors to students, last minute changes can be made, other resources.	Student-instructor contact
Bulletin board or discussion tool (asynchronous)	One-to-many communication moderated discussions, anonymous interaction, debate, peer assessment, group work, searches, introvert students get involved, more writing by students, attachments can be posted	Student-instructor contact, cooperation among students.
Chat rooms (synchronous)	One-to-many communication, brainstorm, virtual office hours, immediate feed back	Cooperative learning, gives prompt feed back
Calendar	Posting of target dates, reminders, last minute changes, full calendar available with dates of activities	Emphasizes time on task, communicates high expectations.
E-mail	One-to-one and one-to-many communication, private communication, reminders of specific dates, personal motivation, groupwork, searchable medium, documents can be sent as attachments	Student-Lecturer contact, cooperation among students
TOOLS FOR AVAILABILITY AND ENRICHMENT OF CONTENT		
Content module: linked pages	Gives the feeling of flow, easier navigation, can add video, audio, graphics	Encourage active meaning
Self assessments	Students asses their own knowledge of the subject, instructors can include detailed feedback, tests can be repeated until students are sure that they mastered it, drilling is good for memory.	Encourages active learning, gives prompt feedback
Hyperlinks and references	Gives links to other pages which can be interactive and credit to referred to material	Encourages active learning, respects diverse ways of learning
Syllabus (course content folders)	Gives a description of the module content, lecturer information, outcomes, textbooks and expectations	Emphasizes time on task, student-lecturer contact
STUDENT ACTIVITY AND STUDY TOOLS		
Search facility	Students can find material electronically	Encourages active learning, respects diverse talents.
Grade tool	Students get their marks rapidly and can determine if they have to put in more effort for a module	Gives prompt feedback (depends on what and how much is made available), high expectations
Help files	Explains to students what is necessary to be successful	Encourages active learning, gives prompt feedback
ASSESSMENT TOOLS		
Quizzes: Timed, Randomized and multiple	Formative / summative assessment, immediate feedback. Students must have mastered the work to complete it in the set time. Students get different sets of questions, generated randomly from the database	Encourages active learning, Expectations, emphasizes time on task, gives prompt feedback, Diverse learning.
Assignment tools	Students can submit assignments electronically, grade assignments and the grades and feedback are immediate	Emphasizes time on task, gives prompt feedback
Group projects	Gives students the opportunity to help each other as they become aware of each other's strengths and weakness, prepares students for future jobs, in which group work is becoming vital.	Cooperative learning

Adapted from Van Der Merwe (2004) Evaluating the integration of ICT into teaching and learning activities at a South African higher education institution, p. 124-126.

In a study in an African context, Van Der Merwe (2004) describes the salient issues in a

technology enhanced learning environment summarized on Table 1.

Multimedia refers to text, sound, graphics, animations, imaging, and spatial modeling into computer systems. Multimedia involves the integration of more than one medium into a form of communication. E-learning and communication theory combines for effectiveness. With the surfacing of computers into education, multimedia has been strengthened and is popular. Multimedia holds a special place in technology enhanced learning because as Jonassen (2001) argues, it attracts and holds attention. A multimedia computer is able to capture sound and video. High-resolution monitors, sound cards and increase in random access memory (RAM) and processing speed of personal computers, can be exploited to transform teaching and learning environments. Multimedia may be very useful where learners use multitasking, but not every learner can be able to do this.

Jonassen (2001) further states that past research has proved that multiple-channel and complimentary channels improve e-learning situations while information from different channels which are inconsistent worsens a learning situation. This compares with the position of Mayer (2001), Clarke and Mayer (2003) as cited in Merrill (2005) who contends that when a presentation contains three elements: graphics audio and visual, there is a decrease in learning. Nevertheless, the integration of multimedia as a tool in e-learning is very vital to enhance instruction and learning situations as long as it is carefully used, given the fact that it goes far beyond what could be possible in a normal face-to-face lecture room situation.

However, Merrill (2005) is critical of designed e-learning materials, saying most so called e-learning materials are merely information transferred to the Internet without appropriate demonstration, practice, feedback, and learner guidance. This is what I call using ICT to give learners *electronic notes*, instead of enabling them to learn at ease. He hastens to add that the letter 'e' in e-learning has to be replaced with *enervative, endless* or *empty* learning meaning that many of the designed

e-learning materials available weakens or destroy the capacity of learning. Merrill is critical of e-learning material because they are designed badly. Though Merrill makes this comment, it should be noted that the beginning phase of e-learning in is characterized by this, so no university should despair that their materials are in this start at the beginning. This is a very big leap forward.

CASE DESCRIPTION

The initial days of the use of ICT in instruction were filled with excitement and prophecies about the great potential and improvement in education (Alessi and Trollip 2001). The same was felt at the three universities under this study. This projection has not been realized, many years down the road and one wonders why. Challenges as understanding, change of attitude and training are still prevalent (Omwenga, Waema and Wagacha, 2004). The persistence of these challenges and ignorance about ICT in education hinders any real utilization of e-learning as a resource that facilitates educational environments (Fonseca, 2001). These issues made this research inevitable. The three universities have heavily invested in e-learning infrastructure in the initial phases; this case study looks into the benefits being realized, if not then why?

The Study

The present study in an attempt to evaluate e-learning for teaching, learning and research in three universities was conducted with the following objectives:

1. To identify the features of e-learning in the universities;
2. To describe the utilization of features of e-learning; and
3. To outline the attitude towards the use of e-learning in teaching and learning.

Evaluation approach as a research design was used because the aim of this research was to study the practice of e-learning in its natural setting in order to interpret it in terms of the meaning people accord to it. The required data mainly concerned actions and feelings about the practice, usage and attitude to a digital learning environment (DLE). The data required was for evaluating practice that made a qualitative design suitable. Data relating to e-learning was collected from Makerere, Nairobi and Dar es Salaam universities. The universities are chosen purposively, to enable a baseline for Makerere University's e-learning project and make the study a comparative one. Additionally, all the three universities were engaged in piloting e-learning at different levels, introduction, implementation and evaluation. The target population was faculty students and instructors (under-graduate and post-graduate).

Purposive sampling was considered because e-learning is a pilot project thus few students and instructors are deeply involved and the characteristics of e-learning practice and indicators needed to be studied intensively. The respondents needed to be reached by discussion groups, observation, and interviews that required a small sample size as the purposive research required only those respondents with relevant data.

The collection of data was done using instruments: observation checklists, structured interviews and focus group discussion guides. Observation enabled the researcher to get first hand information through personal experience. Focused group discussions enabled the researcher to participate in live discussions while noting attitudes and opinions of the respondents. Interviews enabled in-depth examination the practice of e-learning in Makerere, Dar es Salaam and Nairobi universities. The discussions were held because it was vital to facilitate informants' interaction and therefore generate a wider response, while directly observing group reactions and feelings. Focused group discussions consisted of 20 students each, 5 focus group discussions from Makerere, and

two for each of the universities of Dar es Salaam and Nairobi respectively. This technique helped in getting data faster by way of brainstorming.

Structured interviews and focus group discussions involved intensive probing questions using a structured guide to reinforce group discussions and get information from instructors. Participant observation and checklists helped the researcher get and record rightful data from the practical ground. The researcher made observation tours of Nairobi and Dar es Salaam universities and e-learning centers during data collection. Observation checked inter-rater agreement and inter-rater reliability because of poor observation sometimes.

Secondary data was used as universities had extensive documents, some of them posted on the university websites and e-learning platforms. Many other publications from textbooks, journals, magazines and compact disc read only memory (CD-ROM) were studied and analysis of the same done (Jansen and Vithal, 2005).

The findings of the study are summarized below under broad headings of Features of e-learning, Utilization of e-learning, and Attitudes towards use of e-learning.

Features of E-Learning

Computing history of learners and instructors in all the three selected institutions is average. Most of the respondents had used computers for more than two years. The instructors had used computers in daily work while the students used them while being taught, most of them during high school. This has made the introduction of technology enhanced a little easy as the struggle to train in basic computer may be sidelined. Computer literacy is high, with the highest literacy noted at the University of Nairobi. There were therefore not many courses organized as induction into e-learning for students. For instructors, there are several induction and refresher courses in e-learning. Sometimes, it is easy for both students and instructors to find their own way into e-learning. Most of the users said

that they learnt how to use the electronic platforms by themselves, but sometimes only after a very limited induction. In fact some of the students access internet from mostly other places outside the university internet cafes.

There is use of various computer applications in the design of e-content with macromediaTM and Microsoft officeTM often being used in all the institutions. Macromedia is software that is used to design e-content in hypertext markup language (HTML). This enables instructors to create hyperlinks to content outside the designed content to enable further self discovery and learning. Microsoft officeTM is used very frequently though respondents were not conscious that they were using the software in almost all the daily routines. For instance, you would find an instructor with several presentations in power point, or students with a number of typed course works, but when you ask them of the software they use in their digital learning environments, they would say, they have none.

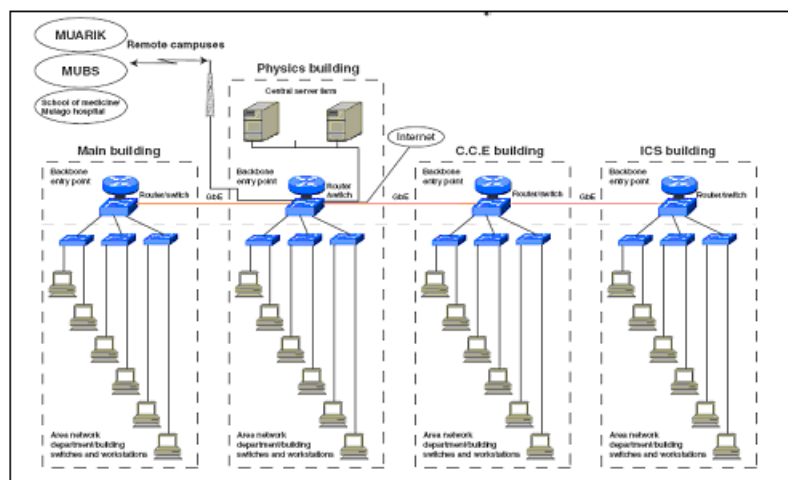
E-learning platforms exist in all the universities, Moodle for Makerere, BlackboardTM and WebCTTM for Dar es Salaam and WedusoftTM for Nairobi with the internet as electronic learning platforms in the institutions. Makerere, had

KewlTM and BlackboardTM at the beginning but has now opted for Moodle which is open source. Most of the features as described in the Table 1 given earlier are existent on the platforms. The features make the learning environment highly engaging and interactive both in synchronous and asynchronous ways.

Internet connection exists with the intranets though the access points and facilities are still inadequate. Nonetheless, these universities have tried their best to increase access points. In Makerere University for example, there is wireless in several places and in many lecturer rooms and offices, there are access points. Network plans like the one given in the Figure 1 have been a very salient feature in the introduction of e-learning. None of the universities could have gone any step without such plans.

In all the universities, there has been a complete digitization of libraries. Students can research online as the universities have been able to get journals, books and other literature, which they have subscribed to and can be accessed by students. The University of Nairobi had been able to do this with support of AVIOR, a Belgian support organization. By the time of this write up, the University of Nairobi had over 20,000, Dar es

Figure 1. Network plans at Makerere University



Salaam 25,000 and Makerere had 19,000 journals they could access. Research literature is more up to date and global compared to the earlier times.

Utilization of E-Learning

Findings on the utilization of e-learning in the three universities relate to technology concerns, technology components, management and organization. To design e-content materials instructors utilize the features of e-learning existent in the universities in e-learning. The design skills are provided in the several e-learning workshops. At the University of Nairobi, all courses on the electronic learning platform are a property of the university. The University of Nairobi, among the three universities had the best (as rated by the researcher) management of the technology they had, where the University of Dar es salaam had the best organization of the technology. At the University of Dar es salaam, there was a very well organized e-learning unit under the University computing center, but Makerere was only trying to put in place such a unit.

Instructors need enough time to concentrate on the design of e-content though this time is hard to be availed to them by the institutions. The conventional teaching methodologies are equally demanding for the time that would have been used to design e-content. Even if there was enough time, the change is so fast in technology. The trap has always been to change with the technological change and pay little attention to the real pedagogic issues and needs required in using technology in education. The management of time to engage in e-learning and to teach is clashing. E-learning at this level is used as a supplement to traditional methods of instruction best described as blended learning approaches. Makerere University learning platforms had more e-content courses than the other institutions though the quality of these courses was still low with little or no interactivity in most of them being electronic lecture notes and Microsoft PowerPoint™ slide shows. The courses

at the universities of Nairobi and Dar es Salaam were better compared to those of Makerere. This variation may be because of the deliberate e-content design workshops at these universities. Naturally, Makerere has a lesson to learn from this as it had no deliberate e-content design workshops. Though the institutions evidently had some e-learning equipment that could produce quality multimedia e-content, multimedia content was not common, because they require more time and technicality to make. The quality of technology to produce and deliver quality multimedia is limited. Currently broadband that has increased the internet bandwidth all over East Africa has come and universities are attempting to increase on their bandwidth. Before, to download only a small image would take too long or sometimes, it would time out because of the bandwidth. This had been a major bottleneck for the universities to effectively implement e-learning.

Effective administration and support enhances the use of technology enhanced learning. There was some evidence of effective administration and support. At Makerere, the support team did not ably handle the e-learning user demands. As stated before, Makerere was at the beginning phase of piloting e-learning. However, many things have drastically changed for the better and now there is an established e-learning unit only awaiting senate to discuss and pass a policy for its total implementation. There are student internet kiosk attendants for the effective management and delivery of e-learning. Though, more is needed for the efficiency of this system.

E-learning takes place through effective communication where an instructor is at one end and the student at another; able to interact in a virtual way just like they were more or less face-to-face. Instructors need time wherever they are to communicate to their students in both, asynchronous and synchronous ways. Instructors did not report effective communication and its use in e-learning because on many occasion, they did not create enough time to communicate with their students.

Students on the other hand were more enthusiastic in communication as they would chat with each other, send emails, and join discussion forums, activities that they instructors had created for them. This comes about because in Makerere for instance, though wiring has done up to offices, very little attempts have been made to put computers in them. In most occasions, staffs who are interested in e-learning have had to buy their own computers. This has been detrimental to the pace of e-learning. On all the main university intranets of Nairobi, Dar es Salaam and Makerere nonetheless, there are a number of issues related to announcements, jobs and other important announcements. Related to this communication, of later, some of the faculties at Makerere University have established state of art video conferencing facilities that will facilitate real time technology enhanced learning.

Attitude towards Use of E-Learning

It was rather difficult to get a general attitude towards the operation of e-learning in all the three institutions, as it required more time than the research had. Nevertheless, some instructors see technology enhanced learning replacing face-to-face sessions and some students use e-learning to dodge face-to-face sessions. At the University of Nairobi, an instructor asked, if e-learning will not take away all students from the lecture room as they would have all they need in terms of notes, assignments and coursework. This comes because of the factor that most instructors do upload all the notes they would have given in class. It would not be appropriate for one to upload the notes that the students will have in class, as this will not make any big difference between technology enhanced learning and electronic notes. It requires time to put notes design materials for uploading in a right format. E-learning would appropriately be a blended instructional method. This is the reason why some instructors have avoided getting involved in electronic instruction as they are used

to face-to-face instruction. E-learning is viewed as demanding considerable amount of time for one to make an effective contribution or use of it.

The presence of multimedia and interactive content in e-learning enables users to formulate a different perception about e-learning. Most of those who are not very conversant with computer use feel that e-learning is very complicated and needs very high intelligence for success. This may be the case but what is basic is, one should leave programming for computer scientists and look at the potential of multimedia in instruction. All that is needed are only the basics, which bring in the fact that there is need for teamwork in e-learning between computer scientist, administrators, teachers etc. The kind of support and administration in an e-learning environment also gives users a platform for different attitudes.

There are different motivational factors for engagement in e-learning both intrinsic and extrinsic in all the institutions. But the operational initiation of e-learning has an impact on its success. The universities are using a top-down approach and in this way, those who engage in e-learning might feel that it is imposed on them. On the contrary, if a bottom-up approach is used, it will bring in more ownership of the technology enhanced learning initiative. These approaches serve as either intrinsic or extrinsic motivators.

Users in all the three universities saw many benefits in e-learning including the ability to access advanced content, availability of content all the time, independent study and more effective communication. All these have changed and shaped the way institutions deliver and package their services now. For example, the University of Nairobi had a completely digitized library during the time of this research. The Universities of Makerere and Dar es Salaam have since then also embarked on digitizing their libraries (this publication has been done when the digitization is also complete), where catalogues, journal books and most services are becoming digital. All these bring in the perception that e-learning solves all

the problems which of course is not true. General comments indicated that in e-learning, users go for learning aspects including interactivity in e-content and the potential to improve teaching not technological issues.

Challenges of participation in e-learning exist in all the universities that included limited accessibility due to limited access points, high degree of computer illiteracy among both staff and students, incoherent policies for e-learning, and the need for mindset change among them. These are very limiting factors in the e-learning pilot given the fact that they relate to psychological orientation. Issues of computers being expensive can be solved by getting a few finances but issues of mindset are too personal. It is hoped that all institutions will try to engage in some sensitization to create awareness in ICT use.

CONCLUSION

Technology enhanced learning in the universities of Dar es Salaam, Makerere and Nairobi is here to stay. It is an evolving and gradual process. It has just started and has not yet reached the climax and users have a lot of expectations from e-learning. The universities are aware of this fact that the e-learning will not replace face-to-face teaching and learning but will be a complementary and blended aspect of learning in which learners have a diversity of media in learning. Users need patience with e-learning because it has just started and is not going to perform miracles. It is a journey. We can equate the introduction of e-learning in these institutions to a newly born baby, it is breast fed, and it sits, crawls, walks and one time it will run. The following are generic conclusions that may be generalized to all institution at the beginning of an e-learning journey

- There are scanty but clear indications of e-learning in the universities of Nairobi, Dar es Salaam and Makerere as seen from

the infrastructure available. There is internet connection, learning platforms, and e-content so far designed and developed. There is also a potential skill in users in the operation of e-learning. However, in all the universities, e-learning demand is outgrowing supply if measures are not taken to curtail this.

- There is utilization of e-learning infrastructure in instruction, learning and research in the universities of Dar es Salaam, Makerere and Nairobi. Utilization of e-learning has been the design of e-content, provision and search for content in a given course unit with little emphasis on the pedagogic issues. The potential of e-learning in instruction learning and research is therefore yet to be fully tapped. Technological and managerial concerns related to e-learn still prevails in these universities.
- Nevertheless, there is generally a very positive attitude towards technology enhanced learning in all the three institutions. Students, instructors and other administrators concur that e-learning presents a choice for them to operate in an environment they like best. Knowledge about many aspects of e-learning is still limited for some misconceived reasons. This hinders the real utilization of e-learning in teaching, learning and research.

In the Universities of Makerere, Nairobi and Dar es Salaam, based on the earlier discussions, the following specific conclusions can be obtained relating to the practice of e-learning:

- E-learning is clearly taking shape in institutions where there exists computer infrastructure, intranet, internet, learning platforms, e-learning policies and e-content course materials.
- E-learning in its first phase is being used for distribution of content though there is

an apparent move towards more interactive materials

- Students need effective communication and guidance from instructors concerning aspects of content in an e-learning environment
- E-learning use has not realized its full potential
- There is general satisfaction among users with regard to the use of e-learning in teaching and learning. This is supported by the fact that there is more strong agreement with perceived advantages and disagreement with disadvantages of e-learning.
- The potential benefits of e-learning in teaching and learning manifest but do not reflect in most instructors due to lack of course redesign.
- Motivators into participation in e-learning are intrinsic: teaching and learning issues (such as increased benefit to students).
- There is effective team management and administration of e-learning infrastructure.

RECOMMENDATIONS

On the basis of the findings of this project, in order to improve on the practice and enable change of attitudes towards the practice of e-learning, the following recommendations may be considered;

- Get more computers connected to the internet and liberalize accessibility in the institutions. In some e-learning centers there was evidence of numerous computers but with very few connected to the internet. This limits the number of access terminals for e-learning.
- Better infrastructure: computers, printers, e-learning centers, networks for more practice and utilization in e-learning.
- Greater sensitization about the practice of e-learning is called for to make it more

popular among all participants in the selected institutions.

- Develop a curriculum in e-content development similar to that used by the case with the University of Nairobi.
- Regular training and workshops should be encouraged to popularize e-learning amongst users in Nairobi, Makerere and Dar es Salaam Universities. In these workshops however, aspects of learning and effective communication and not technology should be emphasized.
- Specialized training in design of instructional materials. Many of the instructors are not teachers by training thus needing pedagogic training to make more appropriate instructional material in all the three universities. The capacity to exploit e-learning depends on users' skills.
- Increased bandwidth in all the three universities as the networks are still slow.
- Improve the kind of support given in e-learning centers, particularly in Makerere University though it may be applicable in all the three institutions. Learners complained about the technical support people and uncooperative end user personnel. This necessitated that people apt in use of ICT but with some background pedagogic training can do a better job than computer technicians in e-learning.

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KEY TERMS AND DEFINITIONS

Attitude: The feeling towards e-learning. This feeling comes either before or after engaging in e-learning

Blended Learning: Learning which is delivered using a mixture of both traditional methods like lecturers and technology enhanced instruction

E-Learning/ Technology Enhanced Learning: The delivery of learning, training or education program by electronic means. It involves the use of a computer or other electronic device in a way to provide learning material

E-Content: Materials that have been transformed from those that are delivered in the normal lecture room, to those that are highly interactive and allows self paced learning.

Application of E-Learning in Teaching

Digital Environment: A situation where there are electronic devices being used in instruction, learning and research

TEHEMA: Is a Kiswahili acronym (*technologia ehabari mawasiliano*) for Information and Communication Technology.

Multimedia: The act of a lesson integrating audio-visual and video interactions to make learners more engaged in a study.

Intranet: Is a local area network, where a university can use the available computers to access information from within the campus.

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Chapter 4.10

Asynchronous Online Foreign Language Courses

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INTRODUCTION

In 1999, the Board of Regents of the University System of Georgia (USG), in collaboration with a number of its member institutions, began developing a fully online set of courses that allows a student to complete a core curriculum that is transferable across the USG. The result of this effort is the USG's eCore® Program, developed by the Advanced Learning Technologies (ALT) unit of the USG. The eCore® Courses were created using a collaborative course development process that engaged teams of USG faculty, technical support and an instructional designer from ALT. The collaborative course development process was utilized in order to take full advantage of the expertise of the team members and to incorporate multiple perspectives of the content into

the courses. In addition, a set of guidelines for the development of eCore® courses was established to ensure the courses were of the highest quality possible. The eCore® course array was developed over a period of seven years. While many of the courses were well suited to the asynchronous online approach, there were content areas that were more controversial, such as physics, chemistry and foreign languages, due to the highly specific requirements in each of these disciplines.

The last courses to be developed for the USG's eCore® Program were two that comprised the Intermediate Spanish sequence. This course development process began with an intensive examination of the viability of an online language course by a team of content experts from a team of USG Foreign Language faculty. Foreign Language (FL) courses, by nature, must incorporate exposure to the target language and extensive practice communicating in that language. Technology is

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increasingly becoming an integral part of the FL classroom as students use computer-mediated communication (CMC) to practice the language with their peers, instructor, and native speakers of the language via chat rooms and message boards. The following discusses the development and implementation of the Intermediate Spanish levels I and II courses for the USG eCore® Program.

BACKGROUND: COMPUTER-ASSISTED LANGUAGE LEARNING (CALL)

The study of Computer-Assisted Language Learning (CALL), an emerging topic for educators and researchers, has provided language instructors and learners a great realm of possibilities in Second Language Acquisition (SLA). Warschauer (1997), in his study “Computer-Mediated Collaborative Learning: Theory and Practice,” provides a succinct review of relevant research in the second half of the twentieth century, confirming the relationship between the significant increase in investigation in the 1990s with the advent of the internet and the rise of the accessibility of computers. Warschauer firmly asserts that online communication “encourages collaborative learning in the classroom” (p. 472). Some of the more salient studies (Kern, 1995; Warschauer, 1997; Kinginger, 1998; Abrams, 2003; Poza, 2005) emphasize the advantages of incorporating CMC into face-to-face language courses. Kern contends that:

new medium-specific conventions . . . compensate for the absence of prosodic and paralinguistic features found in face-to-face oral communication. For example, facial expressions such as smiles [:-) I, frowns [:-) (I, or winks [;-)] become icons, and tone of voice is represented by capitalization, underlining, exclamation marks, and other symbols. (p. 459)

Many researchers agree that text-based computer conference technologies create a setting in which students experience a decrease in anxiety when compared to face-to-face conversation (Beauvois, 1994, 1996, 1999; Kivela, 1996; Lee, 2004; Meunier, 1998; Skinner & Austin, 1999; Warschauer, 1996). In addition, research shows that students indicate they feel a significantly lower fear of negative evaluation via the computer (Beauvois, 1996; Chun, 1994; Kelm, 1992; Kivela, 1996).

Recent advances in computer conferencing technologies expand communication from simple text-based tools, such as email, chat rooms, or bulletin boards, to voice-based technologies, further enhancing the language learning environment by allowing students to communicate with their own voices on their own time. Little research exists concerning the use of voice tools for CMC in foreign language classes; however a recent doctoral dissertation, “The Effects of Asynchronous Computer Voice Conferencing on Learners’ Anxiety When Speaking a Foreign Language” by Poza (2005) provides an in depth study of the many advantages of online oral interaction. Poza’s research utilizes an asynchronous voice web board developed by Wimba, a software company dedicated to the online education market. As defined by one of the co-founders and former CEO of the company, K. W. Ross (2003): “Asynchronous voice is the interactive communication process of people leaving voice messages for other people and the other people responding to their voice messages” (p. 60). The results of Poza’s investigation reveal that “a number of students experienced reduced anxiety attributable to both the elimination of the time pressure of the classroom, as well as the opportunity to edit their contributions before posting them to the voice board” (108).

DEVELOPING AND IMPLEMENTING ECORE® INTERMEDIATE SPANISH I AND II

In the spring of 2003 The Foreign Language Team (FLT) was formed to investigate the efficacy of an online eCore® Spanish course. This team was made up of USG Spanish, French, German and English faculty. The FLT report, (Barron, et al., 2003) was a comprehensive evaluation of the “state of the art” of online language education and offered a set of specific recommendations for developing asynchronous online language education courses for the USG eCore® project. The report began with the following:

This report examines issues surrounding the implementation of 2000 level online foreign language courses and makes specific recommendations to the University System of Georgia regarding implementing such courses as part of its eCore® program. In our examination, we consider outcomes and standards, pedagogical approaches, instructional materials, technology, teaching activities, and transferability issues.

The central challenge in designing an online foreign language course is to use technology effectively to assist in developing the students’ skills in reading, writing, speaking, and understanding. A related challenge is to create an online course that will effectively assess the students’ performance and growth. (p. 2)

In addition, the FLT recognized the importance of students having a foundation in the target language prior to taking online courses. This resulted in the implementation of the eCore® Spanish courses at the intermediate level with a prerequisite of elementary Spanish in a traditional classroom setting.

While this report provided an important framework for the eCore® Spanish courses, the actual development of the courses would be a greater

challenge. Beginning in April, 2004 a team of four Spanish language faculty, an instructional designer and a programmer began to develop the courses. As the FLT report emphasized, skill development and assessment were crucial components of any successful language course.

The first challenge was to determine how the oral aspect of language education could be accomplished in an online environment. The FLT recommended several possible technologies including Wimba, a suite of “voice tools” specifically designed for online language education, a voice enabled web conferencing program called Elluminate, as well as telephone and tape recorded audio sessions. After careful consideration, Wimba was adopted because of its ease of use, asynchronous application, and compatibility with Blackboard Vista, the course management system used within the USG. Wimba allows students to record their oral exercises and post them to a “voice board” where they can be retrieved by the instructor for review and comment. In addition, the application includes voice email, a voice recorder that allows faculty to record audio and a synchronous component called voice direct.

Next, the team developed the actual course content including the lessons, labs and assessments. While there are many Intermediate Level Spanish textbooks, *Enfoques* by Vistas Higher Learning had several advantages that led the development team to adopt it for the courses. One of the primary advantages of *Enfoques* is the online lab, Web SAM (Student Activities Manual) provided by Quia Books. The labs, which include the workbook, laboratory manual, and video manual, are based on the textbook and this saved the team countless hours of development time. In addition, the textbook package includes CD-ROMs with video, audio and tutorials that are also linked to the textbook. These ready-made resources allowed the development team to focus on writing the course content.

In addition to the written course content the development team had native speakers of the

language record readings that allow the students to experience in-depth recitations of literature in the target language. Finally, the team used the USG's Interactive Media Object Development Tool (IMOD) to develop flash cards that presented key vocabulary in each unit. These cards show the Spanish and English spelling of word along with audio of the word being spoken in Spanish.

The pilot eCore® Spanish course began in the spring of 2006 at the intermediate level with eleven students. Because the textbook, *Enfoques*, is integrated into the online course, students are able to use its many resources to guide them as they work through each lesson. *Enfoques* includes a unique and engaging situational comedy video episode in every lesson featuring native speakers from several different Spanish-speaking countries. As students watch the video, they see the structures they are learning put to use in the everyday lives and adventures of the owner and his employees of the lifestyle magazine *Facetas*. In addition, in every odd-numbered lesson, students watch an interesting short film by a contemporary Hispanic filmmaker. Because the textbook emphasizes authentic language and practical vocabulary for communicating in real-life situations, students are provided with abundant opportunities to both experience the language in context and practice speaking it in communicative activities, all of this despite the fact that the students may never meet face-to-face. In addition, in each lesson there are literary readings, cultural viewpoints, fine art, and quotations by famous Hispanics that recognize and celebrate the diversity of the Spanish-speaking world and Spanish speakers.

When students sign in to their eCore® Spanish course, they enter into a Spanish-speaking world, an environment where they can listen to the language in authentic situations via the videos, the interactive CDROM, the mp3 files, the comprehensive laboratory activities, the recordings within the course in each lesson, the Wimba voice boards, and the iMods. Using the materials within the WebCT course and the textbook with

its ancillaries, students have maximum exposure to the language, providing them with ample opportunities to improve their ability to speak, read, write, and understand Spanish.

Individual student language acquisition was the top priority in the design of these courses. One of the key features of the online eCore® courses is the dictation done by native Spanish speakers of much of the course content imbedded within the course itself. Students experience much of what students in a face-to-face class experience in that aspect, as they read along while the instructor explains the material to them from the textbook. As a follow up, the students are asked questions concerning the context and vocabulary of the lesson, and they must answer by recording their own voices to the Wimba voice bulletin board. Also accompanying each new grammatical structure is an additional explanation (in addition to the textbook) in Spanish for students to use as a guide. At the end of each chapter, students have the opportunity to listen while they read pieces of literature. Face-to-face students, for the most part, are unable to enjoy this luxury due to time limitations in the classrooms, but one can imagine how effective it would be to have a native speaker recorded for each piece of literature that is introduced in class.

One of the greatest advantages of an online FL course is the increase in communication in the target language among all students. In face-to-face classrooms, FL instructors often find it challenging to convince each student in a classroom to participate openly in oral activities. Poza (2005) affirms "that there is a strong relationship between anxiety and risk-taking in oral participation in a foreign language," and that "if foreign language educators can provide an environment where students can concentrate on language and meaning, rather than on fear of failure and negative evaluation, their level of anxiety will be lowered, and they will be able to speak more often and openly in the target language. (p. 18-19). The affective filter, an expression used to describe the negative emotional environment created by high

anxiety and low self-esteem in acquiring a second language, is indeed reduced in CMC. Students in a face-to-face classroom who fear negative evaluation, either from the instructor or their peers, are less apprehensive when communicating online, given the absence of both certain social cues and the intimidating presence of others nearby. In addition, “people with disabilities and those who would otherwise be reticent to participate in the communication act feel more inclined to take part in the interaction” (Poza, 2005). The online Intermediate Spanish eCore® courses provide a comfortable learning environment in which students communicate with ease. In addition to the added benefits of lowering student anxiety, CMC allows for students to produce more language with a richer vocabulary than they do in face-to-face conversations (Beauvois, 1997).

The scope and sequence of the eCore® Intermediate Spanish I and II courses is shown in Table 1. (taken from *Enfoques*):

Due to the quantity of topics and structures covered in each chapter, the eCore® Intermediate

Spanish courses are more time consuming for both the instructor and the student than the equivalent face-to-face courses. The activities within the textbook that are designed for use within the classroom are now assignments that students must complete on their own. Students type their answers to the corresponding textbook activities listed within each lesson in WebCT, record their voices in specific exercises, and complete the workbook activities, video manual, and laboratory manual on the Quia Books web site. The first semester that Intermediate Spanish I was offered in eCore®, spring 2006, the course included lessons 1 through 6, and students turned in each textbook activity separately, inundating the instructor’s assignment dropbox with dozens of submissions each chapter. Over the summer of 2006, the course was restructured to incorporate only lessons 1 through 5 and revised so that students would compile their textbook activities on one document per chapter and submit those at the end of each lesson.

Table 1.

eCore® INTERMEDIATE SPANISH I Lesson 1 - Las Relaciones Personales ➤ describe in the present ➤ narrate in the present ➤ express personal relationships Lesson 2 - Las Diversiones ➤ express actions in progress ➤ avoid redundancy ➤ describe your daily routine and activities ➤ express personal likes and dislikes Lesson 3 - La Vida Diaria ➤ narrate in the past ➤ express completed past actions ➤ express habitual or ongoing past events or conditions ➤ describe how, when, and where actions take place Lesson 4 - Los Viajes ➤ express past events and conditions ➤ make comparisons ➤ express your attitude toward actions and conditions Lesson 5 - La Salud y el Bienestar ➤ express will, emotion, doubt, or denial ➤ express uncertainty and indefiniteness ➤ convey purpose, condition, and intent ➤ give orders, advice, and suggestions	eCore® INTERMEDIATE SPANISH II Lesson 6 - La Naturaleza ➤ describe and narrate in the future ➤ express what you or others would do ➤ express events that depend on other events Lesson 7 - La Economía y el Trabajo ➤ reference general ideas ➤ express ownership or possession ➤ create longer, more informative sentences ➤ relate ideas more smoothly to other ideas Lesson 8 - La Religión y la Política ➤ describe actions in the passive voice ➤ express surprise or unexpected occurrences ➤ express contradiction to previously stated information Lesson 9 - La Cultura Popular y los Medios de Comunicación ➤ narrate events that depend on past events ➤ describe the position of people or objects ➤ express choice and negation Lesson 10 - La Literatura y el Arte ➤ express what will have happened ➤ express what would have happened ➤ make contrary-to-fact statements about the past ➤ describe changes in a mental, emotional, or physical state
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The second offering of this course, fall 2006, was more efficient and better organized. In both the spring and fall semesters of 2007, two courses of Intermediate Spanish I and one course of Intermediate Spanish II were offered. Both courses are currently undergoing another revision due to a new edition of the textbook, *Enfoques*. These changes will provide the student with more contemporary cultural activities with the integration of a new and exciting video series titled *Flash Cultura*, which depicts on-location scenes of real-world events and real Spanish speakers. In addition, *Enfoques* includes a new Supersite online which features an expansive set of tools and resources for both students and instructors.

FUTURE TRENDS

As mentioned above, there are few studies on the use of voice tools in online language courses. There is a great opportunity for research in this area, especially concerning student evaluation both prior to and following taking the fully online course. As video conferencing is gaining in popularity, it would provide another avenue of research for the possibility of incorporating into these online Spanish courses. In addition, podcasting has become an excellent way to reach students via their most chosen media, providing them the opportunities to view video and/or listen to audio files via their iPods as they approach learning a foreign language in a fully online classroom.

CONCLUSION

As of the spring of 2006 over 13,000 students had taken eCore® courses in 489 sections of the 25 courses offered. One advantage of these courses is that their credits are accepted system-wide by the 35 USG institutions. This flexibility, combined with the fact that the courses are offered in an “asynchronous” or anytime-anywhere format, has

a wide appeal to non-traditional students. Nearly 45% of the students enrolled in eCore® courses are over the age of 25, 72% are female, and there has been a steady increase in the number of minority students to almost 30% since the inception of the program. In the Intermediate Spanish courses now offered in eCore®, students are quite pleased with the many resources available to them, and several have expressed interest in continuing the language as a minor, perhaps even a major field of study.

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KEY TERMS AND DEFINITIONS

Affective Filter Hypothesis: The hypothesis credited to Stephen Krashen, an expert in linguistics, that declares that a student's anxiety, low self esteem, or lack of motivation can serve to cause a mental block preventing the successful acquisition of a second language. If the "affective filter" is lowered by creating a learning environment in which students are more motivated and suffer from less anxiety and low self esteem, the possibility of success in achieving SLA is greatly improved.

Asynchronous Course: A course that does not typically meet for regularly scheduled class meeting times and is available any time, any place and at any pace. This allows students to participate from any location. These courses generally make use of the Internet, CD-ROM, independent study, or a combination thereof. Students access the course material from a course web site or a course management system.

Computer Assisted Language Learning (CALL): A wide encompassing term that represents a methodology of language teaching and learning that involves the utilization of computer technology in assessment, reinforcement, interaction, communication, and presentation.

CALICO: The Computer Assisted Language Instruction Consortium, a professional organization whose members emphasize the combination of technology with language teaching and learning.

Computer-Mediated Communication (CMC): Any communication between two or more individuals using a computer as the means to exchange data.

Quintessential Instructional Archive (QUIA) : A web site (found at <http://www.quia.com/books>) that partners with textbook publishers to produce online workbooks and textbooks where students are engaged with interactive exercises, many of which provide immediate feedback.

Second Language Acquisition (SLA): The process by which people learn languages in addition to their native language(s). The term second language is used to describe any language whose acquisition starts after early childhood (including what may be the third or subsequent language learned). The language to be learned is often referred to as the “target language” or “L2”,

compared to the first language, “L1”. Second language acquisition may be abbreviated “SLA”, or L2A, for “L2 acquisition”. Synchronous Course: A course that meets for regularly scheduled class meeting times.

USG’s eCore® Program: eCore®—short for electronic core curriculum—allows University System of Georgia students the opportunity to complete their first two years (the “core” curriculum) of their collegiate careers in an online environment. While originally designed for the non-traditional student, many currently enrolled students find eCore® presents an opportunity for increasing flexibility and convenience in their course load management. eCore® consists of online freshman- and sophomore-level courses designed, developed, taught, and supported by faculty and staff from the University System of Georgia. eCore® offers courses in English, mathematics, science, history, and the social sciences. Courses comply with ADA standards to meet the needs of students with disabilities or special needs.

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Chapter 4.11

The Application of Sound and Auditory Responses in E-Learning

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INTRODUCTION

Prior to computer technology, several studies have concluded that multiple senses engage the learner to the extent that a person remembers 20% of what they see, 40% of that they see and hear, and 70% of what they see, hear and do. In general, the participant engages what is seen and what is heard. With this implication, instructional designer or developers try to use design guidelines to identify the main uses of sound in e-learning as multimedia agents to enhance and reinforce concepts and training from e-learning solutions. Even with such understanding, instructional designers often make little use of auditory information in developing effective multimedia agents for e-learning solutions and applications. Thus, in order to provide the learner with a realistic context for learning,

the designer must strive to incorporate the use of sound for instructional transactions. By sharing knowledge on this issue, designer can create a more realistic vision of how sound technology can be used in e-learning to enhance instruction for quality teaching and participant learning.

BACKGROUND

Prior to computer technology, many studies concluded that multiple senses engage the learner to the extent that a person remembers 20% of what they see, 40% of that they see and hear, and 70% of what they see, hear and do. “Human beings are programmed to use multiple senses for assimilating information” (Ives, 1992). Even with such understanding, instructional designers often make little use of auditory information in developing e-learning. “This neglect of the audi-

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tory sense appears to be less a matter of choice and more a matter of just not knowing how to ‘sonify’ instructional designers to enhance learning” (Bishop & Cates, 2001). The major obstacle in this development is that there is not a significant amount of quantitative study on the why, when, and where audio should or should not be used (Beccue & Vila, 2001).

In general, interface design guidelines identify three main uses of sound in multimedia agents in e-learning: (a) to alert learners to errors; (b) to provide stand-alone examples; or (c) to narrate text on the screen (Bishop & Cates, 2001). Review of research on sound in multimedia applied to effective e-learning solutions reveals a focus on the third use cited above. Barron and Atkins’s (1994) research found that there were few guidelines to follow when deciding whether audio should replace, enhance, or mirror the text-based version of a lesson. The results of her study showed equal achievement effectiveness with or without the addition of the audio channel. Perceptions were positive among all three groups. Shih and Alessi’s (1996) study investigated the relative effects of voice vs. text on learning spatial and temporal information and learners’ preferences. This study found no significant difference on learning. The findings of Beccue and Vila’s (2001) research supported these previous findings. Recent technological advances now make it possible for full integration of sound in multimedia agents to be employed in e-learning solutions. Sounds may enhance learning in multimedia agents, but without a strong theoretical cognitive foundation, the particular sounds used may not only fail to enhance learning, but they may actually detract from it (Bishop, 2001).

The three audio elements in multimedia production are speech (narration, dialogue, and direct address), sound effects (contextual or narrative function), and music (establishing locale or time; all of these identify characters and events, act as transition elements between contrasting scenes, and set the mood and pace of presentation (Kerr,

1999). Silence can be used to set a mood or to provide a moment for reflection.

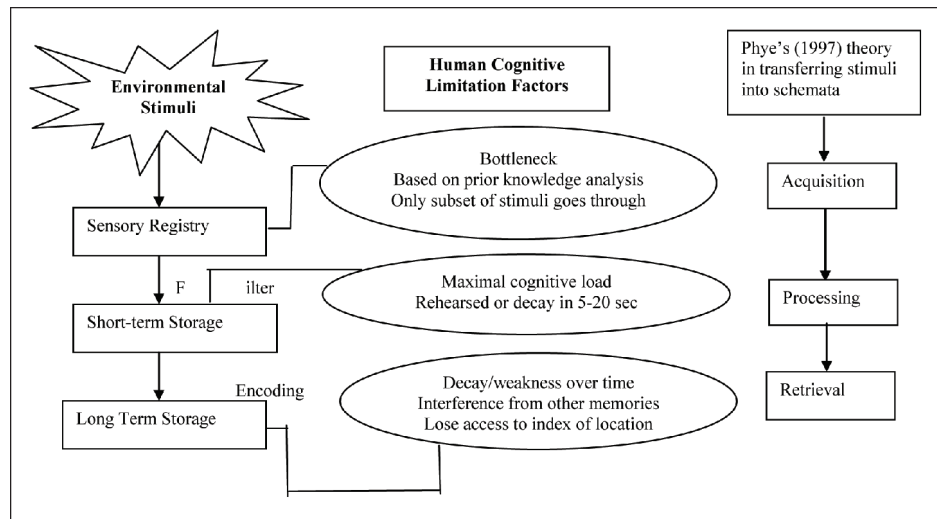
Mayer and his associates (Moreno & Mayer, 2000a, 2000b; Mayer 2003) have conducted a number of experiments with older learners, demonstrating the superiority of audio/visual instructions. These studies have shown that, in many situations, visual textual explanations may be replaced by equivalent auditory explanations, and thus enhance learning. These beneficial effects of using audio/visual presentations only occur when two or more components of a visual presentation are incomprehensible in isolation and must be mentally integrated before they can be understood.

Because some studies suggest that the use of multiple channels, when cues are highly related, is far superior to one channel, the more extensive use of sound may lead to more effective computer-based learning materials. In order to have design guidelines in using sound in e-learning, instructional designers must understand the cognitive components of sound’s use and the ways sound contribute to appropriate levels of redundancy and information in instructional messages. Bishop and Cates suggested that research should first explore the cognitive foundation. “Such theoretical foundation should address information-processing theory because it supplies a model for understanding how instructional messages are processed by learners; and communication theory because it supplies a model for structuring effective instructional messages.”

MAIN DISCUSSION: THEORETICAL FOUNDATIONS FOR THE USE OF SOUND IN INSTRUCTION SOFTWARE

Bishop and Cates proposed a theoretical foundation for sound’s use in multimedia instruction to enhance learning. They studied the Atkinson-Shiffrin information processing model, which

Figure 1. The Atkinson-Shiffrin information processing theory model and illustrations

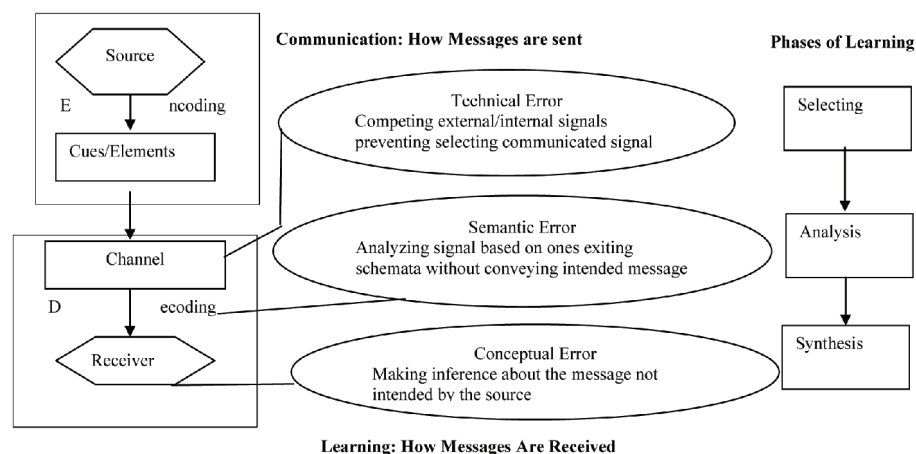


addresses the transformation from environment stimuli to human schemata and their limitation factors due to human cognitive constraints. They adopted Phye's categorization of this process to three main operations: acquisition, processing, and retrieval. Figure 1 summarizes the Atkinson-Shiffrin information processing model and its limitations. "Information-processing theory addressed human cognition.

Communication theory, on the other hand, addressed human interaction" (Bishop & Cates,

2001). Bishop and Cates also investigated the Shannon-Weaver Communication model and its limitations. They also adopted Berio's suggestion that learning models in terms of communication generally begin with and focus on how messages are received and processed by learners. The work of a number of authors identifies the three levels or phases of learning selection, analysis, and synthesis. Figure 2 summarizes the Shannon-Weaver communication model, its limitations, and the three phases of learning.

Figure 2. The Shannon Weaver communication model and illustrations



Built on these two theories, Bishop and Cates proposed an instruction communication system where acquisition, processing, and retrieval operations are all applied, in varying amounts, during each phase of learning. This orthogonal relationship is depicted in Figure 3. “Instructional communication systems could fail because of errors induced by excessive noise” (Bishop & Cates, 2001). Limitations within three information-processing operations can contribute to problems in instructional communications. Noise encountered within each operation is also shown in Figure 3.

The three diagonal cells highlighted represent the heaviest operation within each learning phase. During selection, learning calls on acquisition heavily while during analysis, processing is central. During synthesis, learning calls on retrieval most heavily. The relative strength of potential noise increases and the consequences become more serious at each deeper phase of learning when following the cells vertically down the information-processing operations. Bishop and Cates suggested that adding sound to instructional messages may help optimize communica-

tion by helping learners overcome various information processing and noise encountered at the selection, the analysis, and at the synthesis phase of the instructional communication process.

In overcoming acquisition noise, Bishop and Cates suggested that sounds could gain learners attention, help learners focus attention on appropriate information, and keep distractions of competing stimuli, engage learner’s interest over time. Bishop and Cates believed that sounds could help learners elaborate on visual stimuli by providing information about invisible structure, dynamic change, and abstract concepts. And because of the nature of sound to be organized in time, where images are organized in space, Bishop and Cates believed that sounds could provide a context within which individuals can think actively about connections between new information, therefore overcome processing noise. Bishop and Cates cited Gaver’s (1993) research that when we hear the sound of a car while walking down the street at night, we compare what we are hearing to our memories for the objects that make that sound, drawing from and linking to existing constructs and schemata to support our understanding of what

Figure 3. The Bishop and Cates instructional communication system--a framework of instructional communication system

	Acquisition Noise Competing internal and external message disrupts the signal transmission process	Processing Noise Students fail to isolate the communicated instructional input from other sounds	Retrieval Noise Elements or structure of the message fail to trigger link to existing schema structures
Selection	Learner has trouble directing attention to the instructional message	Relationships between the instructional part of message are not isolated/recognized from other stimuli	Prevents evoking the correct prior knowledge structure from memory
Analysis	Learner has trouble focusing attention on instructional message	Semantic difficulties cause interpretation errors and poor organization of the information	Learning cannot build upon prior knowledge structures
Synthesis	Learner has trouble sustaining attention to the instructional message	Learn cannot elaborate on the information in the instructional message	Message prompts fail to support learner's efforts to construct broader transferable connotative meanings.

is happening, and we step out of the car's path. However, if we hear the same automobile sound in a cartoon, we would be able to depict this event in terms of another existing knowledge of event, therefore draw different conclusion. "Sounds could tie into, build upon, and expand existing constructs in order to help relate new information to a larger system of conceptual knowledge, therefore overpower the retrieval noise" (Bishop & Cates, 2001). (Figure 4)

Most researchers acknowledge that it is important to employ multiple sensory modalities for deeper processing and better retention. Bishop and Cates used the example provided by Engelkamp and Zimmer that seeing a telephone and hearing it ring should result in better memory performance than only seeing it for hearing. Instructional designers could suppress information-processing noise by anticipating communication difficulties and front-loading messages by using redundancy—sound as the secondary cue. Bishop and Cates defined redundancy as the part of information that overlaps. They further explained that in order to overcome the acquisition, processing, and retrieval noise, instructional designers could use sound to employ content redundancy,

context redundancy, and construct redundancy respectively. Sound's content redundancy ("What I asked was, can you pick up some things on your way home?") could contribute to the instructional message addressing the learner's attention difficulties at each of the three learning phases. Sound's context redundancy ("No, I am baking a pie, I need flour not flower.") could contribute to the instructional message addressing the learner's trouble with information manipulation. Finally, sound's construct redundancy ("I am baking a pie for tonight's desert.") could assist learners in connecting new information to existing schemata. Bishop and Cates concluded that sound's contribution to optimize learning in e-learning could be in the form of secondary cues. Systematically adding auditory cues to instructional messages based on the proposed framework might enhance learning by anticipating learner difficulties and suppressing them before they occur.

Figure 4. Summarization of Bishop and Cates framework for sound usage in multimedia based instruction Instructional communication system

	Acquisition Noise	Processing Noise	Retrieval Noise
	Content Redundancy	Content Redundancy	Content Redundancy
Selection	▪ Gain Attention ▪ Hold Attention ▪ Help Focus and Engagement Over Time		
Analysis		▪ Provide information about abstract ideas ▪ Distinguish multiple temporal information ▪ Help make connection among the information	
Synthesis			▪ Build upon and expand constructs relating to new information

Suggested for sound potential role in e-learning

INSTRUCTIONAL COMMUNICATION FRAMEWORK

Bishop and Cates's (2001) instructional communication framework provided a theoretical foundation for answering the question of why we should incorporate sound into multimedia agents for effective e-learning solutions. Barron and Atkins (1994) also suggested that when complex graphics are involved, it might be more feasible to deliver instruction through audio than through text because there is insufficient room on the screen for the text. Shih and Alessi (1996) stated that each medium has its own characteristics and interacts with other media to produce different effects when put together. Their report also stated the advantage auditory system has over text: (a) voice is generally considered the more realistic and natural mode than displayed text; (b) voice has the advantage such as being more easily comprehended by children or poor readers; (c) voice does not distract visual attention from stimuli such as diagrams; (d) voice is more lifelike and therefore more engaging; and (e) voice is good for conveying temporal information. Bishop and Cates's framework provided the answer to how, where, and when instructional designers could use sound in designing software to enhance learning. Instructional designers should understand the cognitive components of sound's use and the ways sounds could contribute to appropriate levels of redundancy. By using sound as the secondary cue to complement the primary message and to provide new information, instructional designers could systematically add sound in the multimedia agent to e-learning to lead to more effective computer-based learning materials. This research leads to a wide range of research questions.

1. **Quantitative data collection:** The next step in supporting Bishop and Cates's framework is to conduct experiments with collection of quantitative data. Overcome channel noise. What is the appropriate redundancy level?

Which sound should be used to overpower channel noises?

2. **Audio quality:** Pacing, pitch and volume all play a role in setting the mood of instruction. The voice of a male or female and how its expressiveness affects learners are worth exploring.
3. **Cognitive load:** How can sound be incorporated into e-learning without exceeding learners' channel capacity?
4. **Redundancy between audio and graphics:** Research showed that the word-for word narrates redundancy could not improve learner achievement because no new information is supplied. Will there be appropriate redundancy between a complex graphic and audio?
5. **Interference factors:** Multiple channel cues might compete with each other, resulting in distraction in learning. A syntax and connection needs to be established between primary and secondary cues.
6. **Learner control:** Learners tend to achieve better performance when they have control of the learning experience.
7. **Logistics:** The speed, volume, and the repeatability should take into consideration when designing e-learning using sounds.
8. **Demographic:** Is there difference among gender, age group, and ethnic background in achievement and perception? How will learners speaking English as the second language learn differently from a native speaker? How will this affect the design of e-learning using sound?
9. **Content area:** Are there different consideration factors when designing e-learning using sound for different content subject such as math and science?
10. **Second language:** In designing e-learning teaching foreign languages, will sound be incorporated as the redundancy or should sound play a more essential role? What are the design guidelines for such software?

11. **Learning modality:** What is the relationship between learner's preferred learning modality in terms of sound and the delivery mode?

CONCLUSION

While the debate over pedagogical strategies for sound to reinforce the learning process in e-learning rages on, researchers and instructional developers continue to seek theories for effective applications of sound in the teaching and learning process via e-learning. It seems clear that sound and audio multimedia interventions are permanent fixtures in the future landscape of e-learning. If appropriately employed, the multimedia within the e-learning program not only becomes a stand alone learning reinforcement agent, but it also helps to extend the learning capabilities of the user, thus assisting the learning in their efforts to gain the concepts and knowledge presented in the e-learning program. As we continue to look to the future for new innovative strategies developed out of research, we can begin to harness the power of adding effective multimedia agents in the teaching and learning process for e-learning, thus reaching the goal of providing quality teaching and effective training solution via e-learning for organization performance improvement.

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KEY TERMS AND DEFINITIONS

Cognitive Load Theory: A term (used in psychology and other fields of study) that refers to the level of effort associated with thinking and reasoning (including perception, memory, language, etc.). According to this theory people learn better when they can build on words and ideas they already understand. The more things a person has to learn at a single time, the more difficult it will be to retain the information in their long term memory.

Communication: Communication is the process of exchanging information and ideas. As an active process, it involves encoding, transmitting, and decoding intended messages.

Information Processing Theory: The information processing theory approach to the study of cognitive development evolved out of the American experimental tradition in psychology. Information processing theorists proposed that like the computer, the human mind is a system that processes information through the application of logical rules and strategies. Like the computer, the mind has a limited capacity for the amount and nature of the information it can process. Finally, just as the computer can be made into a better information processor by changes in its hardware (e.g., circuit boards and microchips) and its software (programming), so do children become more sophisticated thinkers through changes in

their brains and sensory systems (hardware) and in the rules and strategies (software) that they learn.

Instructional Design: Instructional design is the analysis of learning needs and systematic development of instruction. Instructional designers often use Instructional technology as a method for developing instruction. Instructional design models typically specify a method, that if followed will facilitate the transfer of knowledge, skills, and attitude to the recipient or acquirer of the instruction.

Instructional Software: The computer programs that allow students to learn new content, practice using content already learned, or be evaluated on how much they know. These programs allow teachers and students to demonstrate concepts, do simulations, and record and analyze data.

Multimedia: The presentation of information by a combination of data, images, animation sounds, and video. This data can be delivered in a variety of ways, either on a computer disk, through modified televisions, or using a computer connected to a telecommunications channel.

Sound: The vibrations that travel through air that can be heard by humans. However, scientists and engineers use a wider definition of sound that includes low and high frequency vibrations in air that cannot be heard by humans, and vibrations that travel through all forms of matter, gases, liquids, and solids.

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Chapter 4.12

The Influence of Visual and Temporal Dynamics on Split Attention: Evidences from Eye Tracking

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ABSTRACT

This chapter introduces eye tracking as a method to observe how the split of visual attention is managed in multimedia learning. The chapter reviews eye tracking literature on multirepresentational material. A special emphasis is devoted to recent studies conducted to explore viewing behavior in learning from dynamic vs. static visualizations and the matter of pacing of presentation. A presented argument is that the learners' viewing behavior is affected by design characteristics of the learning material. Characteristics like the dynamics of visualization or the pace of presentation only slightly influence the learners' visual strategy, while user interaction (i.e., learner controlled pace of presentation) leads to a different visual strategy compared to system-paced presentation. Taking

viewing behavior as an indicator of how split attention is managed the harms of a split source format in multimedia learning can be overcome by implementing a user interaction that allows the learner to adapt the material to perceptual and individual characteristics.

INTRODUCTION

“Before information can be stored (...), it must be extracted and manipulated in working memory.” (Paas, Tuovinen, Tabbers, & Van Gerven, 2003, p. 64).

In multimedia learning environments, a learner often has to extract and integrate information from different sources of information like words and pictures. Empirical evidences as well as theoretical considerations led to various instructional design principles to present those different sources of

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information in a learner supporting fashion (e.g. Mayer, 2001, 2005; Sweller, van Merriënboer, & Paas, 1998). The attentional, perceptual, and cognitive demands of multimedia instruction, however, are mostly *inferred* from learners' performance on subsequent tasks or self-reported difficulties with the materials at hand. In order to advance theoretical approaches and to refine instructional design principles process-related but subjective measures (e.g. cognitive load) and objective but product-related measures (e.g. learning outcomes) need to be complemented with more objective *and* process-related measures (Brünken, Plass, & Leutner, 2003; Paas et al., 2003). An often suggested, well suited, albeit – in multimedia learning – seldom-used process-related observation is the learner's viewing behavior during acquisition.

The absence of studies applying, for example, eye tracking methodology in this area may at least partly be explained by a lack of satisfying theoretical understanding of how the presumably complex cognitive processes involved in multimedia learning correspond to viewing behavior. The chapter tries to take a step towards an understanding of such viewing behavior in multimedia learning environments. Before we can discuss and further investigate how a particular viewing behavior may correspond to a particular learning outcome it is necessary to explore, if and how multimedia design actually affects viewing behavior. Reviewing the eye tracking research on combined presentation of text and pictures and providing recent research results of eye tracking studies in multimedia learning the chapter aims to answer the following questions:

1. How do learners split their visual attention during learning from a multimedia instruction? And
2. Which attributes of a multimedia instruction *moderate* a learner's viewing behavior?

BACKGROUND

Currently, research on multimedia learning and instructional design is influenced by two theoretical frameworks, cognitive load theory (Sweller et al. 1998) and Mayer's (2001) cognitive theory of multimedia learning. The main aim of these theoretical approaches is to base instructional design on "how the human mind works" (Mayer, 2001, p. 41). The most central concept of human cognitive architecture in both, the cognitive load theory and the cognitive theory of multimedia learning, is working memory. The central role of working memory for the matter of understanding and learning stems from the assumption that, simply stated, working memory is the gateway between the external world and the internal cognitive entities. Meaningful learning requires the learner to select relevant information, to organize that information in a coherent structure, and to integrate this structure into existing knowledge. Working memory plays an essential role since it is here, where the selection, organization, and integration processes are assumed to take place.

Among the various models and theories of working memory (for an overview, see Miyake & Shah, 1999) consensus exists on two aspects that are relevant to multimedia learning. First, most theorists agree that working memory resources are limited, and second, in most models of working memory there are, apart from a central regulation system, two or more separate subsystems. The notion of separate subsystems comes into play whenever information is presented in different codes (e.g. words, pictures, etc.) and/or different modalities (eye, ear, etc.) as it is the case in multimedia learning. In accordance with Baddeley's (1986) working memory model cognitive load theory and the cognitive theory of multimedia learning assume different subsystems or processing channels for visual and auditory information. Visual information is processed in a visuo-spatial sketchpad; auditory information is processed in an auditory loop. The limited

processing capacities of the subsystems are easily exhausted by multimedia learning material. Consequently, the commonly assumed positive effect of multi-representational material on learning—as expressed by the multimedia principle (Fletcher & Tobias, 2005; Mayer, 2001)—is complemented by a set of design principles that deal with the issue, how to overcome problems connected with the presentation of multiple information sources (Mayer, 2001, 2005).

One of these principles is the so-called modality principle: “Students learn better when words in a multimedia message are presented as spoken rather than printed text” (Mayer, 2001, p. 134). The theoretical explanations for this superiority of spoken over written text presentation in multimedia learning basically rest on the limitations of visual processing. If verbal information is added to some visualization (illustration, graph, etc.) in written form, both information sources must be processed by the visual processing channel. As we know from everyday experience, we usually cannot attend simultaneously to spatially distinct visual information sources. Physiologically, visual acuity is restricted to an area of about 1° to 2° of visual angle which on a computer monitor in 80 cm distance roughly corresponds to a circular area with a diameter of 2.5 cm (approximately corresponding to the size of a quarter dollar coin). Thus, in order to extract all information learners are forced to split their visual attention between the information sources. Consequently, before integrating both sources, the source that was attended first must be held active in working memory until the corresponding information in the second source is found and processed. The more information is held active or the more capacity is needed to search for corresponding information the more cognitive resources are occupied, resulting in a higher cognitive load. Presenting spoken rather than written text is supposed to reduce this load by *eliminating* the need to split visual attention between the two sources.

The modality principle is supported by several studies verifying that it is more beneficial for learning if text in simultaneous presentation with visualizations is presented aurally rather than visually (Brünken & Leutner, 2001; Mayer & Moreno, 1998; Moreno & Mayer, 1999; Mousavi, Low, & Sweller, 1995; Schmidt-Weigand, Kohnert, & Glowalla, 2008; Tabbers, 2002; Tindall-Ford, Chandler, & Sweller, 1997; for a review see Ginns, 2005). For example, Moreno and Mayer (1999) used a sequence of 16 animated illustrations depicting the process of lightning. The illustrations dynamically visualized e.g. the motion of cool air that becomes heated or positive charges moving up to the cloud producing a flash light. Illustrations were accompanied by an expository text describing each of the major events. Text was spoken, written inside the illustration frame or written below the illustration frame. Participants performed better on subsequent retention and transfer tests when text was spoken rather than written (modality effect). Within written text conditions, participants performed better when text was written inside rather than below the illustration frame (spatial contiguity effect).

As outlined above, these effects can be explained by differing processing demands due to a visual split attention. However, as Moreno and Mayer (1999) point out “the superiority of concurrent animation and narration over concurrent animation with on-screen text might [also] be caused by students missing part of the visual information while they are reading the on-screen text (or vice versa)” (Moreno & Mayer, 1999, p. 359). Thus, split attention entails a cognitive and a perceptual component. In fact, due to the aforementioned physiological boundaries several theories on visual attention allocation (for an overview, see Allport, 1989) suggest that the eye itself is a limiting factor for information processing. The resources of working memory may or may not be sufficient to process all information gathered by the eye. But the eye itself is surely limited in the amount of information that can be

fixated and gathered in a discrete time interval. Reconsidering the introductory quotation, information may have to be extracted and manipulated in working memory before it can be stored (Paas et al., 2003), but it also must be extracted before it can be manipulated. Tversky, Morrison, and Betrancourt (2002) refer to this notion as the *Apprehension Principle*. The structure and content of the representation must be readily and accurately perceived and comprehended.

In most studies the actual split of a learner's visual attention has mostly been inferred from subsequent learning outcomes or self-ratings of cognitive load. In order to explore, *how* a learner actually splits his or her visual attention between written text and visualizations it appears reasonable, if not necessary, to observe the *process* of allocating visual attention and cognitive resources to split information sources. One method that is commonly associated with visual attention and cognitive processing is the measurement of eye movements. The relationship between visual attention and eye movements has been extensively investigated (cf. Rayner, 1998). In complex information processing such as reading, the link between the two is probably quite tight. For such complex tasks it is commonly assumed that there is a functional relationship between the allocation of visual attention, cognitive processing and eye movements. Before outlining these assumptions it is necessary to shortly consider particularities of eye movements.

Contrary to introspection we do not move our eyes smoothly over some static visual display (e.g. a text or a graphic) but instead make sudden jumps from one location to another. There are periods of 100 to 500 ms, called fixations, in which the eyes come to rest, interspersed with rapid eye movements of 15-40 ms (depending on the size of the eye movement), called saccades (cf. Reichle, Pollatsek, Fisher, & Rayner, 1998). During saccadic movements little visual information is acquired. Instead, the visual information necessary for reading or scene perception is

acquired primarily during the fixations (cf. Just & Carpenter, 1980). Consequently, fixating a discrete area (words, sentences, objects, etc.) is commonly taken as a correlate of attentional and cognitive processes allocated to the inspected area (eye-mind assumption). That is, at the beginning of each new fixation visual attention is assumed to be allocated to the stimulus at the center of fixation. When the information within this area is sufficiently processed attention may be reallocated to a new stimulus in order to program the next saccade while the eye remains fixated. These covert shifts of attention are assumed to occur shortly before the next saccade is executed (Henderson, 1992; Reichle et al., 1998).

For the matter of split attention in multimedia learning two general aspects of a learner's viewing behavior might be of particular interest, (a) the distribution of fixations across the split information sources, and (b) the pattern of saccades from one source to the other. Unfortunately, none of the theories in the field of multimedia learning predicts particular patterns of eye movements yet. However, applying the method of eye tracking may help gaining further insight into how much visual attention is captured by each of multiple visual information sources, how the integration of spatially separated stimuli is visually managed, and which attributes of a learning material moderate the split of visual attention.

EYE MOVEMENTS IN SPLIT ATTENTION CONDITIONS

Although eye movement studies have generated a good understanding of the processes involved in reading and in scene perception (for reviews, see Rayner, 1998; Underwood, 2005) only few experimental eye movement studies have addressed *combinations* of words and pictures in the past. Notable exceptions are studies from Hegarty on the comprehension of mechanical diagrams (Hegarty, 1992a, 1992b; Hegarty &

Just, 1993), Carroll, Young, & Guertin (1992) on the visual analysis of cartoons, d'Ydewalle and colleagues on attention allocation in subtitled television (d'Ydewalle, Praet, Verfaillie, & Van Rensbergen, 1991; d'Ydewalle & Gielen, 1992), Rayner, Rotello, Stewart, Keir, & Duffy (2001) on the integration of text and pictorial information in print advertisements, and more recently Holsanova and colleagues on newspaper reading (Holmqvist, Holsanova, & Holmberg, 2007; Holsanova, Rahm, & Holmqvist, 2006). Meanwhile, a growing number of eye tracking studies have been conducted with multimedia learning material (e.g. Ciernak, Scheiter, & Gerjets, 2007; Faraday & Sutcliffe, 1996; Folker, Ritter, & Sichelschmidt, 2005; Hannus & Hyönä, 1999; Schmidt-Weigand et al., 2008).

A common result among these eye movement studies is that people favor text over pictures. Rayner et al. (2001) investigated the pattern of viewing behavior for people looking at print advertisements. When looking at an advertisement viewers tended to read the large print first, then the smaller print and then they looked at the picture. Although some viewers did an initial cursory scan of the picture, most of them did not alternate fixations between the text and the picture part of the ad. Also the viewing behavior in subtitled television is largely text directed (d'Ydewalle et al., 1991; d'Ydewalle & Gielen, 1992). Clearly, when foreign movies are subtitled in the local language, reading subtitles is more or less obligatory. However, d'Ydewalle and colleagues (1991) found that reading subtitles is preferred even if the movie and the subtitles were both presented in the local language. Since this preference was observed no matter if the participants were familiar (Dutch) or rather unfamiliar (Americans) with subtitled television the authors conclude that either (a) reading subtitles is more efficient in following and understanding a movie or (b) processing of the visual modality is more dominant.

In learning material one may expect illustrations to attract some more visual attention because

of their functions in the learning context. Levie and Lentz (1982) distinguish four general functions: (1) attention guiding, (2) affective, (3) cognitive, and (4) compensatory functions. However, the assumed benefits of illustrations do not seem to be reflected in the learners viewing behavior. Hannus and Hyönä (1999) found that learning from illustrated textbooks is heavily driven by the text. They presented text passages from 4th-year elementary school biology books to elementary school children. The children spent 80% of their learning time on reading the texts. Furthermore, 66% of the time spent inspecting illustrations was devoted to read the figure captions! In accordance with Rayner et al. (2001) there was also little back-and-forth looking between a relevant text segment and a corresponding illustration. This viewing behavior may have been due to some text characteristics. As the authors note, in their text book passages, no reference was made in the text to any illustration.

Folker et al. (2005) used color-coding to make references between text and illustrations more explicit. Twenty students (mean age 24.3 years) read a textbook passage describing the function and the different phases of mitotic cell division. In the color-coding condition, passages of the text corresponding to structures or labels in the pictures were of the same color. Participants in this group were significantly faster in processing the material than participants who had no explicit color reference in the text (control condition). The faster processing, however, was due to fewer fixations on the picture region in the color condition while the time spent reading remained constant across conditions. Unfortunately, Folker et al. (2005) do not report the movement patterns between text and picture region. Thus, we do not know if color coding simply facilitated the processing of the illustration or if it evoked a different visual strategy.

It might well be the case that the textbook illustrations used by Hannus and Hyönä (1999) and Folker et al. (2005) were not sufficiently

helpful or necessary to understand the text. In multimedia learning, however, a special emphasis is given to the *integration* of text and pictures in working memory. Hegarty (1992a, 1992b; Hegarty & Just, 1993) applied diagrams and verbal descriptions of pulley systems in order to examine such integration processes. In a study from Hegarty and Just (1993) participants viewed text and diagrams describing pulley systems. Being instructed to understand how the respective pulley system worked, viewers tended to inspect the diagram at the ends of sentences and clauses. Approximately 80% of the participants' diagram inspections occurred after reading the segment describing that particular aspect of the diagram. Thus, the participants' viewing behavior as they read text accompanied by diagrams suggests that viewers attempted to fully interpret a sentence or clause before inspecting its referent in the diagram. Hegarty (1992b) concluded that the construction of a mental model from the material was largely text directed.

In another study, Hegarty (1992a) further examined the construction process of the mental model by using a sentence-picture verification task. Participants were presented with a static diagram of a pulley system and a sentence describing a dynamic attribute of a component of the pulley system. Participants were asked to respond whether the sentence was true or false of the depicted system. Recording reaction time and inspection time, she found that differences in reaction time were largely due to differences in diagram inspection time. Both, reaction time and inspection time were highly related to the statements' difficulty (number of inferences required to verify a dynamic attribute). Concerning the strategies, participants typically read the sentence before inspecting the diagram in 98.5% of trials, suggesting that the overall strategy was to construct a representation of the text first and then verify this representation against the diagram. However, participants also reread the text during a trial, thus switching back and forth between text and

diagram about three times per trial on average. The number of re-readings was again related to the statements' difficulty, being higher the more inferences were required to verify the sentence. Hegarty interpreted these results in terms of working memory load. The higher the demands of inferring and storing the motion of the pulley system, the earlier the sentence representation decayed and had to be reactivated by re-reading.

In the Hegarty (1992a) study participants had to infer motion from a static diagram of a dynamic pulley system. Exploiting the possibilities of computer-based instruction, processes that are dynamic by nature can be depicted by dynamic rather than static visualizations. In comparison to static visualizations, the cognitive demands to process and integrate written text accompanied by *dynamic* visualizations may be different. Motion does not need to be inferred by the learner but is readily available. This direct access to dynamic information may cause a visual strategy different from the one commonly observed with static visualizations. First, the depicted information does not need to be mentally animated. And second, dynamic visual information is more transient than a static display. Therefore, learners may be inclined to attend to dynamic visualizations earlier in the integration process, being not as much text directed as with static visualizations.

Taken together, the management of split attention during learning appears to be driven by written text. But how is the visual attention to written text influenced by the presence of dynamic compared to static visualizations and/or the presence and degree of time constraints? The following sections describe a series of four experiments in which learners' eye fixations were tracked as they watched a multimedia instruction on the formation of lightning similar to the one used by Moreno and Mayer (1999). Besides eye movements, the experiments applied measures of cognitive load as well as learning outcomes. In order to explore the influence of split attention on cognitive load and learning outcome measures the experiments

also entailed presentation conditions in which text was spoken. The focus, however, will be set on the learners' viewing behavior under split attention conditions.

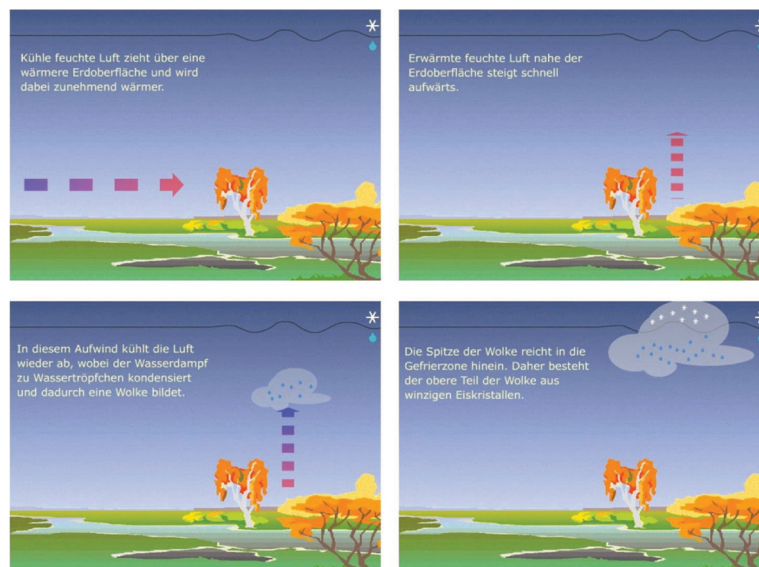
EFFECTS OF DYNAMIC VS. STATIC VISUALIZATIONS ON SPLIT ATTENTION

The purpose of the first two experiments was to examine whether characteristics of visualizations moderate the effects of split attention on viewing behavior. By comparing dynamic with static visualizations, the experiments ask whether and to what degree the transience of visualizations affects visual attention allocation. How much attention is devoted to dynamic compared to static visualizations? How is visual attention on written text affected by the presence or absence of dynamics in visualizations? And, how do learners estimate the presence or absence of dynamics in visualizations in relation to their split of attention? To answer these questions, the experiments observed view-

ing behavior and collected subjective estimates of students who received one of the following four presentation formats: a multimedia instruction presenting (1) dynamic visualizations together with written text, (2) dynamic visualizations with spoken text, (3) static visualizations with written text, and (4) static visualizations with spoken text. The learning material consisted of a 16-step multimedia instruction on the formation of lightning. The content of the material was based on an animation used by Moreno and Mayer (1999). Visualizations were designed to illustrate the dynamics of the major events (cf. Figure 1).

Both experiments confirmed that split attention during learning from the applied multimedia instruction was largely text directed. The presence of written text led learners to attend to the text before splitting their visual attention by switching back and forth between text and visualization. Overall, participants spent up to twice as much time reading than inspecting visualizations and switched on average 4 times per scene between written text and visualizations. Both, viewing time on text and visualizations as well as the number

Figure 1. Selected frames of the multimedia instruction (scenes 1 – 4)



Note: The expository text is written in German since the experiments were run at Justus Liebig University, Giessen, Germany.

of transitions between both information sources were slightly affected by the presence vs. absence of dynamics within the visualizations. Participants spent some more time on dynamic compared to static visualizations and, thus, less time reading text. Furthermore, experiment 2 revealed that visual attention was captured by dynamic visualizations, indicated by a lower number of transitions between text and visualizations compared to static visualizations. However, the amount of initial reading after a scene change was not affected by the presentation format of the visualizations.

Experiment 2 obtained self-ratings in order to assess cognitive load. These measures allow a more detailed view on the attentional aspects of presentation format. Participants reported a higher difficulty with the learning material for written compared to spoken text presentation (“How easy or difficult was it for you to learn something about lightning from the presentation you just saw?”), confirming the afore mentioned effect of text modality. In addition, participants were asked to give subjective estimates of the following more detailed statements: (1) “I would have preferred to stop the presentation myself at certain points“, (2) “I would have preferred to look at some illustrations again“, (3) “I would have preferred to rewind and repeat parts of the text“, (4) “I missed parts of the textual information“, (5) “I missed parts of the illustrations“, (6) “It was difficult for me to relate textual and pictorial information to each other“, (7) “The illustration distracted me from textual information“, (8) “The textual information distracted me from the illustration“, and (9) “How did you perceive the presentation pace? The pace was ...”. Statements 1 to 8 had to be rated on a 6-point scale from completely false, false, rather false, rather true, true to completely true. Statement 9, concerning the pace of presentation had to be answered on a 7-point scale from very slow, slow, rather slow, optimal, rather fast, fast, to very fast. The internal consistency of the statements was considerably good (Cronbach’s $\alpha = .83$). Correlations between

single statements and overall difficulty with the material range from $r = .25$ to $r = .51$. The highest correlation is reached by statement (3) (repeat parts of the text). This correlation highlights the role of text comprehension in cognitive load.

Furthermore, the initial and constant reliance on written text, as found in numerous eye tracking studies, suggests that learners follow a visual strategy, i.e. voluntarily attending to written text. In contrast to this hypothesis, participants in the experiment reported a significantly higher agreement with statement (8) than with statement (7), i.e. they felt distracted from inspecting visualizations by the presence of written text (and not vice versa), no matter if visualizations were dynamic or static. Thus, initial reading appears to be rather automatic than intended.

Since the presentation time was limited (i.e. once the animation was started it proceeded with a constant pace), the time spent reading was lost for inspecting the visualizations. Consequently, participants rated presentation time as less appropriate in written compared to spoken text conditions (statement (9)), i.e. the split of visual attention was subjectively time consuming. Thus, the effect of split attention can be described as a distraction effect evoked by written text in a time limited presentation condition. Participants felt they needed more time to sufficiently attend to all offered information sources.

Taken together, presenting written rather than spoken text in a multimedia instruction leads to a rather automatic initial reading behavior that is, compared to spoken text presentation, perceived as a time-consuming process. Consequently, one should expect that with longer presentation duration learners devote relatively more time to visualizations than to written text. Once enough time is given to attend and integrate all information sources the harms of split attention should disappear. Furthermore, the visual strategy may change as soon as the learner can control the pace of presentation. The experiments presented in the following section were designed to test these hypotheses.

EFFECTS OF TIME CONSTRAINTS ON SPLIT ATTENTION

The main idea of these two experiments was that pacing is an additional source of cognitive load. If learners have more time to read expository text, the need to split visual attention between written text and visualizations should be less harmful. Moreover, if learning is largely text directed, as indicated by prior studies, split attention should have a larger effect on visual compared to verbal information. Finally, it is an open question how additional time is used in terms of visual attention allocation. We may expect that after reading has been successfully completed relatively more time can be spent viewing visualizations.

The purpose of the first of these experiments was to examine the influence of system-controlled pacing of instruction on effects of split attention and text modality. The learning material consisted of the same multimedia instruction as in the first two studies. Dynamic visualizations on the formation of lightning were accompanied by expository text (visualization format was not varied). The text was either presented in spoken or written format. The variation of pacing was derived in the following manner. In the fast condition, timing was set to a ratio of 120 words per minute resulting in a presentation duration of 140 s. This pace approximates a timing originally applied in Mayer and Moreno (1998) by adjusting the pace of presentation to a normal speaker's rate. Medium and slow paces were obtained by reducing the ratio successively with a factor of 0.75. Thus, the ratio was 90 words per minute for medium pace and 67.5 words per minute for slow pace resulting in durations of 187 s and 249 s respectively. These variations resulted in a 2 (spoken vs. written text) x 3 (fast, medium, and slow pace) factorial design. Results are presented for the split attention conditions, i.e. where text was written.

Overall, learners under split attention conditions showed a comparable viewing behavior at the beginning of each scene, i.e. they started

with a reading sequence. However, the longer the presentation lasted relatively more time was spent inspecting visualizations. As it was expected, the absolute number of transitions between text and visualizations increased with presentation duration. However, also the *relative* number of transitions (i.e. transitions per second) increased with presentation duration. All these changes emerged in the additional time for each scene. Comparing the viewing behavior only in the time intervals of the fastest pace of presentation revealed no differences in the ratio of time spent reading to time spent inspecting visualization or in the number of transitions. Deviating viewing behavior obviously settled in the additional time given by slower pacing.

In accordance with this viewing behavior, the difference between written and spoken text presentation became more evident in a visual memory task compared to a text retention task. This difference was larger the faster the pace of presentation was. In addition, subjective cognitive load revealed that the harms of split attention (i.e. the modality effect) were apparent under serious time constraints. Overall, cognitive load dropped down for longer presentation durations. A modality effect could only be found under fast presentation.

The observed patterns of viewing behavior and its contribution to cognitive load and learning outcome can be understood in terms of particularities of reading. People are known to differ in reading speed (cf. Just & Carpenter, 1987). Reading speed reflects individual abilities (e.g. Jackson & McClelland, 1975, 1979; Just & Carpenter, 1992) but it is also adjusted to characteristics of the text (e.g. Graesser, Hoffman, & Clark, 1980) and task demands (e.g. Hartley, Stojack, Mushaney, Annon, & Lee, 1994). Concerning the specific task of reading to summarize expository text, Hyönä, Lorch, and Kaakinen (2002) identified different types of eye movement patterns. Participants read (and subsequently summarized) two expository texts (approximately 1,000 words each). 75% of their participants followed a linear reading strategy, i.e.

most readers went through the texts from left to right with only few backward saccades to earlier passages, so-called regressions. Such regressions usually do not exceed 10% of the saccades occurring during reading (cf. Rayner, 1998). The linear readers in the Hyönä et al. study could be further divided into “fast linear readers” (mean reading rate: 231 words/minute) and “slow linear readers” (133 words/minute). These results confirm (a) the linear reading behavior consistently found across various reading tasks and (b) the inter-individual differences of the pace of progressing through the text. There was, however, a group of 20% of readers who followed a distinctive strategy, the “topic structure processors”. With a reading rate of 139 words per minute this type of reader was rather slow. Compared to the linear readers the topic structure processors devoted additional visual attention to headings and topic-final sentences as expressed by significantly more and longer reinspective fixations. Most notably, these readers turned out to have the highest working memory span (Danemann & Carpenter, 1980) and to have written the best summaries. The worst summaries were produced by the slow readers. While the comparably slow reading rate of the topic structure processors appears due to deliberate, probably effortful strategies for remembering and summarizing the expository texts, in the case of the slow linear readers this same rate appears to be a rather unsuccessful attempt to compensate for comprehension difficulties.

Individual differences in reading speed may interfere with the learning task in a system paced multimedia instruction for several reasons. First, the faster the pace the more likely some – especially visualized – information is missed or not sufficiently processed due to the general tendency to attend to written text first. Second, a faster pace of presentation especially challenges slow readers probably resulting in even poorer text comprehension. And third, adjusting ones reading speed to a system-controlled pacing may hinder an adjustment to the complexity of the content and

the application of deliberate viewing strategies. Thus, split attention effects might at least partly be caused by a mismatch of system-paced instruction with self-paced reading. These hypotheses gain support from a final study to be reported in this chapter. In this study, learners were under control of the pace of presentation. Each of the 16 scenes lasted until participants hit the space bar to start the next scene. Text was again either written or spoken.

First of all, learning under self-paced presentation did not reveal any differences between written and spoken text presentation in terms of learning outcomes and cognitive load. That is, the learners were able to adjust the pace of presentation to be comparably successful in learning from the animation and to experience a comparable cognitive load. One may expect the higher cognitive load under split attention to be expressed in a longer time on task for written compared to spoken text presentation. Contrary to this hypothesis, the learner-paced presentation durations in written text presentation were almost identical to spoken text presentation in terms of means, variances, and ranges. Overall, the variation of system-paced presentation durations in the former experiment (140, 187, and 249 s, respectively) roughly fitted in with the range of learner-paced presentation durations (132 to 285 s). It is also notable that the average presentation duration in this experiment (183 s) was very close to the medium system-paced presentation duration of 187 s in the former experiment. Due to these similarities on the time dimension, differences in the observed viewing behavior of both experiments can be devoted to the issue of learner control. Figure 2 depicts the amounts of time each participant spent reading and inspecting visualizations under system controlled (left panel) and learner controlled (right panel) presentation. Figure 3 depicts the number of transitions for each participant in both experiments.

As can be seen in the right panel of Figure 2 time on task under learner-controlled presentation is almost exclusively driven by the time learners

Figure 2. Time spent reading (triangles) and time spent inspecting visualizations (circles) for each learner under written text conditions in system controlled (left panel) vs. learner controlled (right panel) presentation

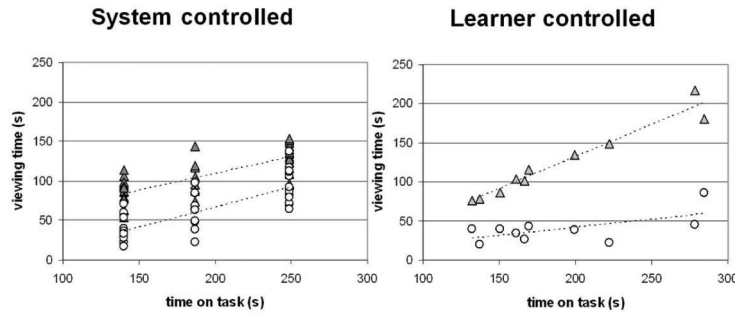
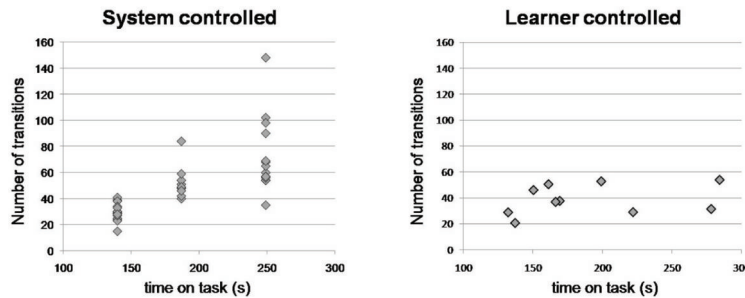


Figure 3. Number of transitions between text and visualizations for written text conditions in system controlled (left panel) vs. learner controlled (right panel) presentation



spent viewing text. That is, while participants in system-paced instruction used additional presentation time in favor of illustrations (Figure 2, left panel) participants in learner-paced instruction used additional presentation time exclusively for reading. Furthermore, transitions in learner-paced instruction did not systematically vary with time on task (Figure 3, right panel) while in system-paced instruction additional presentation time lead to an increase of transitions between text and visualizations (Figure 3, left panel). Taken together, participants in system-paced instruction used additional presentation time in favor of visualizations and switches between text and visualizations while participants in self-paced instruction used additional presentation time mainly for reading. Apart from the time learners spent read-

ing the text, they showed a highly stable fixation pattern in a self-paced instruction. Learners adjusted the pace of presentation to their individual reading speed and engaged in an otherwise systematic viewing behavior.

These results can be interpreted in the following manner. The longer the system-paced presentation duration was the more participants can be assumed to have read the written text. They really had additional time to spend on inspecting visualizations and “to look around”. In learner-paced instruction, the split of visual attention between text and visualizations appears rather systematic and is comparable to the viewing behavior shown by the medium system-paced presentation group. The general strategy was to read (some portion or all of the) text, then switching to inspect the

visualization, re-reading some portion of text and going back to the illustration once more. The inter-individual difference in the time spent reading almost perfectly correlated with the chosen presentation duration. Thus, an optimal fit of presentation pace to task demands in concurrent presentation of text and visualizations is apparently driven by individual reading speed.

THEORETICAL IMPLICATIONS

The findings of the studies reported in this chapter have some implications for theoretical accounts of split attention effects in multimedia learning, namely cognitive load theory (Sweller et al., 1998) and the cognitive theory of multimedia learning (Mayer, 2001). Split attention effects are usually explained in terms of limited cognitive resources. Two further resources were introduced in this chapter that may interact with the cognitive processes associated with split attention: (a) visual perception and (b) learning time. As noted earlier, due to restrictions of visual acuity our eyes have to move in order to gather all information given in a multimedia learning material. In fact, the term “split attention” may rather refer to the common insight that we cannot look at a text and an illustration at the same time. Eye tracking studies revealed that we manage this limitation of our eyes in a fairly consistent way. Learners almost immediately look at written text and usually spend much more time reading than viewing visualizations. Some researchers concluded that text is perceived as the main medium for the acquisition of information. In this view, the observed eye movements indicate a strategic and reasonable decision made by the learners. In fact, expository text is a highly structured information source and people are used to gain much information from reading. Visualizations are usually not self-explaining and are often accompanied by written text. Reading the text first might often have been experienced as being helpful in order

to understand visualized information. In one of the presented studies, however, participants felt distracted from inspecting visualizations by the presence of written text – although they spent most of their time reading! Thus, the observed viewing behavior rather indicate a preconscious attentional capture of written text.

One may conclude that due to the attentional capture of written text visualizations are not sufficiently processed. But the comparably short fixation times on visualizations may also indicate a higher computational efficiency of pictures compared to text. As Larkin and Simon (1987) point out, “sentential representations [i.e. text] are sequential while diagrammatic representations [i.e. visualizations] are indexed by location in a plane. The information displayed by [visualizations] is only implicit in sentential representations and therefore has to be computed, sometimes at great cost, to make it explicit for use” (p. 65). In other words, reading requires word-by-word fixations, lexical access, and syntactic as well as semantic processing while the information depicted by visualizations may be gathered at a glance. In accordance with this interpretation, eye movement studies on scene perception have led to the conclusion that “participants get the gist of a scene very early in the process of looking. [...] The gist of the scene is abstracted on the first couple of fixations, and the remainder of fixations on the scene are used to fill in details” (Rayner, 1998, p. 398). However, whether the ‘gist of a scene’ is sufficient for learning depends on the complexity of the visualization and the complexity of referential connections between the text and the visualization.

A necessary precondition for split attention effects to occur is that one source of visual information cannot be understood without the other (Sweller, 1999), i.e. both sources have to be attended in order to “get the full picture” of what is to be learned. There is evidence that the interdependence between different learning elements moderate effects of split attention, being harder

to handle for learning material of high compared to low “element interactivity” (Tindall-Ford et al., 1997). Element interactivity refers to the extent to which the learning task requires the learner to hold several related chunks of to-be-learned information in working memory simultaneously. As Ginns (2005) notes, there is no objective measure of element interactivity. However, eye movements may be interpreted as an indication of this interplay between text and visualizations. In the studies reviewed in this chapter eye movements varied with the complexity of the material. A picture in an advertisement is almost surely less complex than, for example, the diagram of a pulley system. As a result, participants in the Rayner et al. (2001) study did not look back from the picture of an ad to the text while those re-readings occurred between a pulley diagram and the accompanied text (Hegarty, 1992b). Hegarty (1992a) interpreted the number of switches between the text and the visualization in terms of working memory load. More re-readings occurred when more inferences were required. Concerning the perceptual aspects of split attention there may be less content-specific variables that moderate split attention as well. For example, dynamic visualizations may be considered as less complex than static visualizations since the depicted dynamics are readily perceivable and do not need to be inferred by the learner. Accordingly, in one of the presented studies more alternations occurred between text and static visualizations compared to text with dynamic visualizations.

The presented studies also highlighted the role of learning time for the management of split attention. In contrast to the physiological restrictions of visual perception, learning time is a resource that is either set by the ‘instructor’ or allocated by the learner. If learning time is restricted by a system-controlled pacing of instruction, it is an obvious source of extraneous cognitive load. Consequently, the pacing of instruction moderates effects associated with split attention (cf. Ginns, 2005). In the presented studies learners perceived

multimedia instructions as “faster” when verbal explanations were written rather than spoken, a higher cognitive load only occurred for fast presentation paces, and no effect of text modality occurred at all when learners controlled the pace of presentation. Given the general tendency to attend to written text first, split attention under time constraints especially impairs processing time for the pictorial information. The results of the presented eye tracking studies support this view in showing that especially visual memory proved sensitive to the modality of text presentation. Furthermore, participants spent relatively more time viewing visualizations when the pacing of instruction was slower.

But the influence of time constraints is not restricted to visualizations. Conversely, the comparison of viewing behavior under system-paced and self-paced instruction rather highlights the prominent role of reading for split attention effects once more. The pattern of viewing behavior in self-paced instruction is fundamentally different from the one observable in system-paced instruction. Under self-paced instruction, learners spent a comparable amount of time looking at visualizations while their time on task strongly varied with the time spent reading. In the absence of extraneous load in terms of time constraints, the inter-individual differences in reading time suggest that the main source of cognitive load in the instructional material was the text. In fact, text comprehension is well recognized as a matter of managing working memory load (Graesser & Britton, 1996; Just & Carpenter, 1992). The difference between system-paced and self-paced viewing behavior may indicate a change in cognitive strategies. Reading is an inherently self-paced activity. Individual reading speed does not only reflect text comprehension abilities but also the contribution of deliberate, probably effortful, strategies for remembering expository text (Hartley et al., 1994; Hyönä et al., 2002). While under system-paced presentation reading speed has to be adapted in some way to the pace of presenta-

tion, self-paced presentation allows the learner to engage in a more elaborated processing of verbal explanation. Consequently, written text must be assumed more compatible with self-paced than with system-paced instructions. In this view, under self-paced presentation written text may also be superior to spoken text. Actually, there already exists empirical evidence for such a “reversed” modality effect (Tabbers, 2002).

PRACTICAL IMPLICATIONS

The research presented in this chapter allows suggesting how split attention effects may be overcome. In time-limited presentation, (a) the perceptibility especially for the visualization is decreased, and (b) written text comprehension is disturbed. Consequently, negative influences of split attention on learning can be avoided if both information sources are sufficiently perceptible and/or if the design of a multimedia instruction ensures not to bother a regular reading behavior.

To make sure that all information sources in a multimedia instruction are sufficiently perceptible the instructional designer must consider the split of visual attention that occurs whenever two or more visual information sources are presented concurrently. In fact, current design guidelines already recommend presenting written text near rather than far from visualizations in order to minimize split attention (spatial contiguity principle). Furthermore, guiding visual attention to appropriate referents, e.g. by color-coding, can have positive effect on visual processing (Folker et al., 2005) and cognitive load (Kalyuga, Chandler, & Sweller, 1999). Due to the fact that learners consistently attend to written text first one might be seduced to present text and visualizations sequentially rather than concurrently. Indeed, sequential presentation eliminates visual split attention, which may facilitate text comprehension. But sequential presentation also eliminates the temporal contiguity between the text and the corresponding visualization. A

number of studies have shown that concurrent presentation is superior to sequential presentation of corresponding information sources (‘temporal contiguity principle’, Mayer, 2001; for a review, see Ginns, 2006). In his meta-analysis, Ginns (2006) also identified the complexity of learning materials as a moderator of temporal contiguity effects. Indeed, complexity in terms of referential connections between text and visualizations may require alternations between both information sources. Thus, it is recommendable to present corresponding information sources close together in space *and* time as well as to make referential connections explicit.

Reducing split attention by spatial contiguity or color-coding while the presentation is still system-paced (as it is indeed the case in many of the studied materials) always bears the risk for the learner to miss some information. This risk is probably higher for visualizations than for text and if the material is rather complex. Furthermore, system-paced presentation may interfere with individual differences in (self-paced) reading speed. An easy way to avoid these problems is learner-paced instruction. Instead of specifying a system-controlled pace that may be appropriate for an average learner, this minimal form of user interaction allows each learner to adjust the pace of presentation to his or her individual needs. Doing so, the learner can ensure to capture all information that is displayed. An individually chosen pace allows the learner to follow a regular reading behavior that is susceptible to cognitive strategies. In this view, learner-control is not only recommendable to overcome difficulties with split attention in multimedia learning but learner-paced instructions can even benefit from written text presentation.

CONCLUSION

Two main conclusions can be drawn from the eye tracking studies outlined above. First, viewing

behavior in combinations of text and visualizations follows a fairly stable pattern that can be moderated by design attributes of the instruction. In general, written text drags visual attention away from inspecting visualizations. Thus, visualizations have to “compete” with the text, whenever it is written. The degree of competition is influenced by visual dynamics as well as the presence and degree of time constraints. Learners adapt to these properties of a multimedia instruction by distributing their visual attention between written text and visualizations differently. Furthermore, they are able to adjust the pace of presentation to a regular reading strategy that only varies in the time taken to read text.

Second, under less attentional competition, less time constraints, and learner control of pace, effects of split attention change, decrease, or even disappear. The competition between written text and visualizations was stronger when visualizations were dynamic rather than static and when presentation time was seriously constrained. Especially when learners are relieved from time constraints, the need to split visual attention loses much of its detrimental effects. These differential effects on cognitive load and learning outcome are associated to particularities of the viewing behavior. In general, presenting written text forces the learner to read text. When learners can follow a regular reading strategy by controlling the pace of presentation they do not suffer from written (compared to spoken) text presentation. Thus, the need to read written text may or may not interfere with extracting information from visualizations depending on how seriously reading and viewing visualizations are disturbed by the design of a multimedia instruction.

A theoretical implication of these results is that current explanations of split attention need to incorporate resources of visual perception and learning time in addition to cognitive resources. As a practical consequence, the question for an instructional designer is if the displayed information can be sufficiently extracted by an individual

learner. Understanding the demands of a particular learning material on the learner’s perception and accounting for individual differences by implementing user interaction appears promising to advance the design of multimedia instructions in a learner-supporting fashion.

FUTURE RESEARCH DIRECTIONS

Concerning the limitations of the presented eye tracking studies, the applied learning materials consisted of rather short presentations. A three-minute multimedia instruction on the formation of lightning can be considered to be a prototypical case of an application of dynamic visualizations. For the matter of generality, this research must be extended to broader classes of multimedia learning material. For example, the comparison of viewing behavior under system-paced and self-paced instruction led to the hypothesis that reading strategies play an important role even in split attention. Effects of a strategic behavior may be rather small in an instruction of 3 minutes length. Thus, it appears worth examining if and how visual strategies may change with the amount of content, especially the amount of text.

Visual and temporal dynamics of a multimedia presentation are only two design characteristics that may be expected to affect a learner’s viewing behavior. The patterns of viewing behavior in the presented studies highlighted the role of expository text in split attention. However, one can easily imagine more complex and/or abstract pictorial information, for example electric circuits or statistical graphs that may require more processing resources for visualizations than for written text. Similarly, text difficulty depends on the text structure and the subject matter. Furthermore, multimedia learning material can differ with respect to the referential connections between text and visualizations. It can be assumed that all these characteristics of a learning material affect the learner’s viewing behavior

and, thus, the way split attention is managed. In order to gain a better understanding of split attention effects one direction of further research is to explore the viewing behavior with learning material that systematically varies those aspects. Such research can help estimating the relative contribution of verbal explanations in comparison to visualizations and the contribution of “element interactivity” (Tindall-Ford et al., 1997) between textual and visual information.

Finally, eye tracking offers an extensive database. There are numerous ways in which those data can be analyzed that go way beyond the level of analyses presented in this chapter. For example, in reading research viewing behavior is usually not described in the overall time spent reading a text but in terms of gaze durations or single fixations on words and the saccadic movements between these gazes or fixations (Rayner, 1998). Such analyses are accompanied by theoretical models accounting for eye movements on the same level of description (e.g. Reichle et al., 1998). These fine-grained cognitive process models can be tested by tracing the eye-movement protocol (e.g. Salvucci & Anderson, 2001). So far, there is no such interplay between theories of multimedia learning and observations of viewing behavior, i.e. current models on the integration of verbal and pictorial information do not predict the time course of visually attending to the information sources. However, models develop with the level of observations they have to account for. Further eye tracking studies may stimulate to advance current models in order to allow predictions of fixation paths based on an accurate model of the learning process.

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Chapter 4.13

Leveraging Libraries to Support Academic Technology

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ABSTRACT

Through leveraging the relationship between libraries and technology, colleges and universities can make the best use of the skills that librarians bring to the table. At DePaul University, three positions have been created, which report to two campus units: The University Libraries and Instructional Technology Development. The consolidation of both library and instructional technology perspectives to create this first group of blended positions at DePaul has been successful, due in large part to the fact that the primary responsibilities of these positions are in areas of mutual interest: instruction, collection development, and technology support for faculty and students, whether on a consulting basis or at the reference desk. As libraries and librarians become

ever more closely and actively aligned with the teaching mission of the university, universities and colleges can transform librarians' roles within the academy by leveraging their skills to enhance teaching and learning in today's online environment.

INTRODUCTION

As more and more library services and resources are delivered online, libraries and technology become increasingly intertwined. In their article "*Merging Library and Computing Services at Kenyon College: A Progress Report*," Oden Jr. et al. (2001) describe the phenomenon as follows:

...the era when computers largely performed repetitive and otherwise tedious tasks (such as data processing) transformed to an era when computers

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served equally to store, retrieve, and manipulate information. The transformation has meant an increasing overlap between library services and computing services, making an integrated approach seem sensible. (Oden Jr. et al., 2001)

More and more institutions are exploring this model of combined library and IT services in various ways. Ferguson, Spencer, and Metz (2004) give brief descriptions of similar undertakings at Bucknell University, Pacific Lutheran University, and Wheaton College, and note “the need for the library and IT organizations to work together to support today’s scholars and students in a much more seamless fashion.”

Jerry D. Campbell, CIO and Dean of University Libraries at the University of Southern California, Los Angeles, points to initiatives undertaken “within academic libraries in the digital age: providing quality learning spaces; creating metadata; offering virtual reference services; teaching information literacy; choosing resources and managing resource licenses; collecting and digitizing archival materials; and maintaining digital repositories.” (Campbell, 2006) These are just a few examples of how libraries have expanded services and resources using technology. To make the best use of the skills that librarians bring to the table, colleges and universities must continue to explore further avenues to leverage the relationship between libraries and technology.

In some environments as at Kenyon College, described by Oden Jr. et al. (2001), the integration occurs not only at the departmental or administrative level, but also within individual positions, requiring staff with expertise in both arenas. Barth and Cottrell (2002) describe in some depth the Librarian Technology Consultant model adopted at Kenyon College, in which positions serve as liaisons to specific departments and schools. They state, “This type of cross-focus began to build bridges with constituents, notably faculty, to better serve the user by bringing a more holistic approach

to service through focusing on the patrons rather than the collections.”

BLENDING LIBRARY AND INSTRUCTIONAL TECHNOLOGY POSITIONS

Library mission statements generally speak to providing support for the instructional and research programs at a given university. DePaul University’s library mission is no exception to this rule, and states that “as an integral part of the academic function of DePaul University, the libraries’ mission is to support the current and anticipated instructional and research programs of the University by providing collections, services, facilities, and personnel to satisfy the information and research needs of DePaul students, faculty, and staff.” (Brown, 2002)

To serve this mission, the libraries have facilities on all six DePaul campuses, with paper, microform, video, and audio collections as well as extensive electronic collections available 24×7×365 to university affiliates from anywhere in the world via the Internet. Each library facility also has public access computers, and all students, faculty, and staff have electronic access to reference services, document delivery, and course reserves. As libraries increasingly deliver their services online, our patrons begin to expect this type of access, and are beginning to demand the same type of access to their other course materials. Because libraries have led in this area, librarians become natural advocates for electronic access to materials.

According to its mission, the University’s department of Instructional Technology Development (ITD) “advocates for students and collaborates with faculty and university departments in developing a learning environment enriched through effective use of technology in the curriculum.” The compatible missions of ITD and the libraries make these academic support units

natural collaborators. Guan and Morrisett (2006) emphasize the importance of “taking advantage of the long-established trust relationship between librarians and faculty.” As they point out, librarians are already seen as trusted members of the academic community. Faculty are accustomed to asking for assistance in finding library resources for their classes and in acquiring materials for their research, as well as inviting librarians to provide library research instruction for their students. Expanding this role so that librarians show faculty how to integrate library resources entirely into their online course sites, or into course sites complementing in-person instruction, is a natural place to begin the consultation. Leveraging this relationship allows instructional technology departments a way to reach faculty in a non-threatening way.

Librarians also bring an understanding of the organization of information, including experience with indexing and database construction. These skills, along with librarianship’s emphasis on user-centered services, are valuable skills and can be applied in many arenas, from online course organization to assisting with the creation of database-driven Web sites.

At DePaul, the blending of librarian/instructional technology consultant positions began in 2003 with the hiring of a suburban campus coordinator who also served as instructional technology consultant for the suburban campuses. Two additional librarian-consultant positions were developed in summer 2005 and resulted in the changing of job duties for two existing assistant coordinators of library instruction positions. As DePaul increases the numbers of these dual positions, it has become important to look at the personalities and skill sets of the individuals who are either hired or reorganized into them.

Though specific job titles vary widely, this type of position is referred to within the library world as a “hybrid” or “blended” librarian, which Steven J. Bell and John Shank (2004) define as “an academic librarian who combines the traditional

skill set of librarianship with the information technologist’s hardware/software skills, and the instructional or educational designer’s ability to apply technology appropriately in the teaching-learning process.” While the skills themselves are important, of equal if not more importance is the way in which the blended or hybrid librarian executes his or her work—to be able to communicate genuine enthusiasm for the potential uses of technology in the teaching environment. It is the combination of enthusiasm with the library background, subject knowledge, and technical and teaching skills that truly transform and reframe the way faculty perceive the use of technology in their classes.

Librarians who report to both the Libraries and Instructional Technology Development are not only enthusiastic promoters of teaching with technology, but are also able to draw connections between the activities of both units from a unique perspective. At DePaul University these blended librarians have aided in the development of, and participated in, a number of cooperative projects and cross-departmental trainings.

COLLABORATIVE TRAINING: BLACKBOARD

The earliest training collaboration, “*Linking to Resources in Blackboard*,” began as a day-long workshop to teach faculty how to use the Blackboard course management system at the University’s newest and smallest residential campus. In addition to learning the functionality of the Blackboard course management system from an instructional technology consultant (ITC), a librarian instructed faculty in linking to content contained in library databases. In the course of delivering the workshop, it was discovered that faculty could also benefit from a more basic overview of library resources. In time, the combined library and instructional technology development

staff also recognized there was an audience for a more intensive Blackboard training workshop.

The *Blackboard Institute* (BI) evolved as an endeavor to offer brief, intensive training in Blackboard. Existing instructional programs offered by instructional technology development were structured over a five-week period, and many faculty members balked at this extended time commitment. Coordinated by one of the blended librarians, the hands-on workshop is offered over three consecutive days to faculty members interested in building a Blackboard course site to complement classroom instruction. When the inaugural Blackboard Institute filled to capacity within a few days, a second institute was added, which also filled to capacity. Future institutes are planned during academic breaks with two more to follow immediately prior to the fall term. An additional *Advanced Blackboard Institute* is also planned, designed to expand the skills of the initial institute participants.

During the Institute, participants develop and/or upload a course syllabus, structure course information, identify and link to online resources, and create learning activities to engage learners. Hands-on activities are complemented by showcases, discussions, and critiques among the participants. As different instructional technology consultants and librarians present, other staff members are available, roaming to assist faculty members as needed. This helps to build the role of librarian as technology expert.

A presentation on linking to library resources takes place during the morning of the second day. The benefits of the online course reserve system are demonstrated first. Faculty need only to submit citations for items to be put on reserve for their courses. The library determines whether the item may be linked through an existing database subscription, and if not, scans the relevant articles or chapters. Items which cannot be placed on electronic reserves due to limitations of format or of copyright are placed on print reserve and a link is created to the catalog record. Faculty are

also taken through the process of creating stable, persistent links to articles of their choice in the library's online database collection, and are taught how to include those links in their course sites or course Web sites. Faculty appreciate being able to recommend online full-text articles, and provide links to them to at a moment's notice.

In addition to the blended librarians leading the session, librarians representing the subject areas of the participants are invited to the presentation and encouraged to continue the discussion over lunch. The positive outcome of this training endeavor supports Bell's finding that when "library staff is involved in managing the course management system (CMS) or providing training for new users ... [t]hat is a favorable condition for librarians to influence faculty to create links to the library." (Bell, 2002)

Faculty awareness of, and facility with, electronic reserves and linking should lead to inclusion and promotion of resources already purchased by the libraries. These outgrowths can improve student work as well—when faculty know how easy it is to include an article from the day's newspaper, they are more likely to add that link into their course site. In turn, students are more likely to read and access items that are immediately available. Cohen agrees: "Integrating course-management software with the library's digital offerings is essential for getting the maximum value from the institutional investments of both money and expertise." (Cohen, 2002) Gibbons also argues that integrating library resources into course management systems makes students regard them more favorably, and thus increases the likelihood those students would turn to the linked electronic resources provided by the library. (Gibbons, 2005a) Furthermore, according to studies cited by Gibbons, it is the convenience and efficiency of course management systems that appeal most to students. (Gibbons, 2005b) Students rated being able to access syllabi and course readings as the most attractive and useful features.

ADDITIONAL FACULTY TRAINING OPPORTUNITIES

Librarian members of the instructional technology consultant staff also assist with the development and delivery of instructional technology development workshops on using word processing applications, developing presentations, and building Web sites, as well as on homegrown applications such as QuickData, instructional technology development's online survey development tool. Aside from the obvious point-of-service opportunities to promote and recommend related library resources, librarians working with faculty in this capacity increase the possibility that faculty will think of the library when designing their assignments.

Instructional technology development workshops provide an ideal forum for promoting the library's "Just for Faculty" section of the library's Web site. (DePaul University Libraries, n.d.) This page includes information about course reserves, the library's instruction program, suggestions for purchase, and interlibrary loan. It also includes step-by-step directions for linking to library resources and provides a tool that wraps code around each link to enable proxy access for off-campus university affiliates.

TECHNOLOGY COLLABORATIONS: LEARNING CONTENT MANAGEMENT SYSTEM

Several additional outgrowths of the library-ITD collaboration exist, resulting in technical solutions primarily utilized or supported by the library. Ranging across functional units in the libraries and instructional technology development, these applications are critical to the delivery of library services and resources. The successful use by the library of one jointly developed application has led to its adoption by other university units.

The first and most established of these is instruction builder (IB), a learning content manage-

ment system (LCMS). This tool can be used to build interactive lessons by creating and linking together instructional elements such as animations, and assessment elements such as quizzes, tests, and assignments. All of these objects can be shared with other users of the application and used or re-used in multiple contexts. The library's instruction program makes heavy use of IB, currently delivering nine targeted, class-specific workshops to four schools or units across the University. In sum, over 7,000 students have taken at least one of the ten workshops that have been available over the life of the application. Additionally, the University's Office of Institutional Compliance utilized the application to deliver training to all employees.

Instruction Builder 3.0 was released in August 2005, the third version release in the project's five year lifespan. This release of the product was the culmination of a multi-year joint development process between the University Libraries and Instructional Technology Development, undertaken by a cross-functional team of stakeholders, including the library instruction coordinator, the head of library Web services, Instructional Technology Development's lead developer, and three of the Library/Instructional Technology Development joint-report positions, one of whom served as project manager. For the two previous releases, the same collaborative model has been used to generate system requirements, test beta versions, and compile lists of enhancements.

Feedback collected from the development team, librarian graders, and student users of the system has led to a number of changes to the application over its lifespan. In conjunction with the library-driven enhancements in the third release, the project manager worked with the Office of Institutional Compliance within the University, for which a separate instance of the IB application was established to integrate their requirements and feedback. Interface changes, restructuring of user permissions, and enhanced functionality

are a few results of this iterative, collaborative design process.

INSTRUCTION BUILDER: CURRENT STRUCTURE AND FUNCTIONALITY

The instruction builder (IB) system is flexible and allows instructional objects created within it to be linked together into one of two delivery methods:

- Workshops, which are built using a combination of instructional elements and assessment elements, and which are linked to specific DePaul courses via the University's student information system
- Tutorials, which may be freely accessed (i.e., they are not linked to any course) and which are primarily composed of instructional elements, with no required assessments

IB is role-based; display options and permissions are assigned according to role. The three major categories of roles are student, instructor (faculty), and administrator. All three log in to a common interface to access workshops and other data. Students complete workshops at their convenience, and are not required to complete them in one sitting. Once submitted, depending on their content, workshops may be graded automatically by the system or interactively by a faculty member, librarian, or instructional designer.

Instructors may view workshop content and class roster data from their login screen. Additionally, they are provided with a direct URL to each workshop, which they may add to their course within a course management system, or send via e-mail.

Administrative access to the system is managed at several tiers. Most users have access to view published content and to grade submitted workshops. A smaller group of users have the ability to build individual content items, to com-

bine them to form workshops or tutorials, and to "publish" or release them to students and instructors. Higher-level administrative tasks such as activating and deactivating users, assigning user permissions, creating and populating groups, and editing released content, are restricted to only a few select users.

ELECTRONIC RESOURCE MANAGEMENT

The two units also work collaboratively on an application for managing electronic resources. The University initially contracted with a vendor providing aggregated, single-entry access to library electronic subscriptions over five years ago. This vendor also provides a link resolver, which uses the OpenURL protocol to provide more seamless access to electronic full-text content across all library databases and vendors. At the time of inception, the library's Web services department was maintaining its own database of information on library subscriptions to online journals and databases. Over time, the library Web services department worked with the vendor to customize the look and feel of search and results screens so that they blended seamlessly with the library's Web site.

In July 2005, reorganization consolidated several positions with technical or Web site management responsibilities from both the libraries and instructional technology development into a single department, responsible for all systems and development projects for the larger teaching and learning resources unit. At this time, day-to-day maintenance of technical and interface issues for these services is managed by the new, merged systems and applications development department, with assistance from collection development on a case by case basis for subscription/vendor contacts.

FUTURE DIRECTIONS AND POSSIBLE APPLICATIONS

With each year bringing more integration of technology across the whole of higher education, and with the technology landscape constantly changing, it is likely that more and more of the services offered and resources provided by libraries and instructional technology support units will be inextricably intertwined with the online world.

Most important, though, must be the examination of why this effort will prosper. It is already immediately apparent that some of the areas most profoundly impacted by technology include:

- Instruction, whether in-class or online, and whether conducted by faculty or by academic support units such as the libraries or instructional technology development
- Library collections, including online databases and indexes, electronic journals, and books
- Technology support for faculty, staff, and students, as new technologies are adopted and integrated into the curriculum (recent examples include streaming multimedia, podcasting, and blogging)

The consolidation of both library and instructional technology perspectives and responsibilities to create this first group of blended positions at DePaul has been successful, due in large part to the focus of these positions on the areas previously listed. The Institute of Museum and Library Services (IMLS) recent white paper publication, *“The Future of Librarians in the Workforce Project—University Libraries”* confirms this:

Faculty will still expect librarians to understand their intellectual needs and to anticipate those needs in the works they acquire and license (including GIS and other non-traditional resources). More than ever faculty look and will look to librarians to deliver instruction to the community

in the productive use of all manner of resources. (Institute of Museum and Library Services, 2006)

Further, the organizational structure at this institution supports such an arrangement, since both the libraries and instructional technology development are part of the same overarching administrative unit, teaching and learning resources.

In addition, as previously mentioned, the success of these and similar positions is affected by other, less quantifiable factors related to the personal characteristics of the individual filling the position; it is essential that the individual possess appropriate technical skills and discipline background, as well as certain elements of personality (e.g., enthusiasm, self-direction, flexibility, curiosity/interest in technology), which are the most difficult to quantify when developing “hybrid” or “blended” positions.

It is also important to remember that although many of the trends and forces in the current environment indicate a shift toward an environment where more and more “blended” positions exist, the audience for library services and resources remains rich and varied in its interests, needs, and approaches. “Traditional” library services such as reference, cataloging, circulation, archives, and preservation have become neither superfluous nor outmoded, as evidenced by their continued utilization, and they retain their importance to the support of teaching and learning within the academic enterprise. This carryover of skills and values, albeit with new and different methods of delivery, is recognized within the IMLS paper: “... There is also a need to assure that the basics of library work do not change in the electronic age.” (Institute of Museum and Library Services, 2006) In fact, circulation of DePaul’s print collections increased 23% for the 2005 fiscal year, despite yearly increases in e-book and electronic journal subscription access, illustrating the continuing impact of one the library’s most basic resources: books.

Campbell grapples with these issues of transition in his article “*Changing a Cultural Icon: The Academic Library as a Virtual Destination*.” The library is still seen as a cultural icon, but it has become increasingly apparent that the public face of the icon needs to be updated to better reflect the ideals of a new society. If libraries fail to take advantage of opportunities to change their image, their role in the academy may be threatened by the impact of technology and its perceived ease of use. Libraries will always be keepers of information, but their previous service model, primarily passive, will need to shift in order to retain its importance in a society that values desktop- and doorstep-delivery services. He concludes, “Over the next decade, colleges and universities will have to make critically important practical and policy decisions about the future of libraries, about the space devoted to libraries, and about the roles of librarians.” (Campbell, 2006).

It is clear that a crossroads has been reached. We argue that these decisions can be made easier as libraries and librarians become ever more closely and more actively aligned with the teaching mission of the university, and as universities and colleges look at transforming the librarians’ roles within the academy by leveraging their skills to enhance teaching and learning in today’s online environment.

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KEY TERMS AND DEFINITIONS

Blended or Hybrid Librarian: A librarian with a skill set consisting of traditional library skills, facility with hardware and educational software, and the ability to communicate the appropriate use of technology in a teaching and learning environment.

Course Management System (CMS): An online learning environment, which bundles teaching and communications tools. These tools can be used to supplement classroom learning or can stand alone as an online learning experience.

Learning Content Management System: A system where instructional designers and other instructional content developers can create, store, reuse, manage, and deliver digital learning content using a central learning object repository.

Link Resolver: A software application that uses the OpenURL protocol to provide more seamless access to electronic full-text content across all databases and vendors for a desired citation.

OpenURL: An ANSI standard (Z39.88) used to transport metadata and/or other identifiers about a source object to a target object. In libraries, this standard is used by link resolvers to connect patrons to resources and services.

Persistent Links: Links provided by a database that allow direct and stable access to a particular document or item.

Reference Services: Service provided by libraries whereby patrons are assisted in the location and retrieval of information relevant to their information needs.

Student Information System: Often part of enterprise solutions that also manage human resources and financial services, student information systems are responsible for maintaining the records of course enrollment, grades, course history, and other data related to a student's academic career.

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Chapter 4.14

Student Decision Making in Technology Application

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ABSTRACT

This study investigated factors that influence students' decision-making processes in selecting a classroom or online course, student technology skills and experience, and concerns students have about Internet integration. Students completed a survey questionnaire and Web-based pretests and posttests. A Likert scale instrument was completed by students in both a control group and an experimental group. Independent two-sample t-tests and an analysis of covariance (ANCOVA), using the initial score as the covariate, were conducted. Level of significance (alpha) was set at .05 to achieve statistical significance for all analyses. Both groups in this study were full-time, on-campus students with access to the same tech-

nology resources. Findings reveal that students' perceptions and experiences were quite similar.

INTRODUCTION

Educational reform is exerting pressure on prospective and experienced teachers to model authentic teaching and to demonstrate understanding and knowledge of various instructional techniques and tools. Teachers are being trained or retrained to reduce the lecture-and-listen styles of instruction that have traditionally been used and to enhance their facilitation of appropriate student-centered instructional methods. Technology is one of the new teaching and learning tools that teachers are expected to use. As more schools invest in technology and students increasingly obtain technological sophistication, teachers are

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expected to not only demonstrate technology competency but also be effective at integrating technology into their teaching.

The use of technology as an instructional tool and medium is usually determined by the pedagogical style adapted by the instructor (Shovein, Huston, Fox, & Damazo, 2005). However, during a time when active student participation in the learning process is receiving widespread attention, educators must consider student learning preferences and technology abilities when planning a course delivery format. Various factors determine students' preferences and perceptions about technology application in both classroom and online environments. In this study, the authors studied the factors that influence students' decisions to learn in a classroom vs. an online setting. In addition, the authors also examined students' technology skills and concerns about Internet integration within classrooms.

INSTRUCTIONAL ENVIRONMENT

Participation in Web-enhanced classrooms or online distance learning is influenced by student motivation, technology experience, learning styles, and learning expectations (Shovein et al., 2005). According to Shin and Chan (2004), education level, online learning experience, and Internet skills affect student participation in online learning.

Many institutions of higher education are using Web-based instruction for classroom and distance education (Falvo & Solloway, 2004). Various online course management systems have evolved within the last decade and have been widely adapted by educational institutions. Course management systems such as Blackboard™, WebCT™, and Desire2Learn™ have been used in classrooms to supplement learning and as an online distance education delivery medium. In a comparison study of two online course management systems, Storey, Phillips, Maczewski, and

Wang (2002) revealed that ease of technology use and access to technology are important considerations when deciding whether to use technology. Buzzell, Chamberlain, and Pintauro (2002) stated that both Web-based and classroom learning are effective instructional environments.

Advocates of online learning mention the flexibility that online learning provides. Although online learning offers flexibility, it is not yet regarded by many educators as an appealing replacement of classroom learning; therefore, the significance of flexibility should not override other factors that affect learning such as student learning styles and technology skills. Atan, Rahman, and Idrus (2004) recognized the benefits of Web-based instruction such as increased opportunities for using different instructional strategies, use of multimedia, improved communication and interaction, and easy access to course materials; however, they also argued that the impact of a traditional course delivery system supercedes that of online learning.

Due to the time and technology skills needed to manage online classes and to teach and support students, online learning is more demanding and involved than is generally assumed (Shovein et al., 2005). Atan et al. (2004) observed that, "distance education learners need constant reminders regarding learning strategies, time management skills, motivation, and discipline" (p. 105). Students require online support for successful online learning. Although concerns about the effects of technology on learning and course management are raised when teaching online, the presence of technology in traditional classrooms also calls for a reassessment of classroom management practices. The physical space in classrooms and disruptions of student learning by the Internet require new classroom management styles (Lim, Pek, & Chai, 2005).

Effective integration of the Internet requires careful consideration of individual learner differences and needs. If online learning is to be integrated into campus-based courses because of the potential of the Internet as an effective learn-

ing tool, a mixed-mode delivery format should be adapted to supplement face-to-face learning (Sheard & Lynch, 2003). This view is consistent with the findings of Rovai, Wighting, and Liu (2005) who reported that hybrid learning increases persistence and commitment to online learning.

TECHNOLOGY USE AND PERCEPTION

Educational scholars and practitioners have long reported that students prefer learning in environments in which they are comfortable. As educational institutions and instructors began to integrate the Internet as an instructional tool and delivery medium, students learned and developed the technology skills that became important, if not required, for this new method of learning. However, not all students were fascinated with the use of technology for teaching and learning. A study by Rule, Barrera, Jolene, Dockstader, and Derr (2002) reported that students in a technology-rich environment had higher technology skills than classroom students with limited access to computers. Although Rule et al. found no significant differences in students' attitude toward computers, their study revealed that students who were highly motivated were more likely to use computers than their less motivated counterparts. They further reported that access to computers and technology support are important factors in a student's decision to utilize computers.

When Buchanan, Brown, Casanova, Wolfram, and Xie (2000) contrasted two student groups in online and classroom environments, they found that Web-based students considered technology skills, organization, and personalities more important for learning compared to classroom students. Other studies point out that student choices and decision-making are influenced by personal relationships and technology support. In a survey of student perceptions about Internet use for learning, an overwhelming number of students

stated that an online medium facilitates learning more thoroughly than face-to-face environment (Cottrell & Robinson, 2003). Cottrell and Robinson posited that two potential reasons for these perceptions are the independence of and access to materials that Web-based learning provides. Cottrell et al. further noted that online learning environments individualize learning because students can learn according to their learning preferences, style, and pace. Web-based instruction increases collaboration and mentoring, enhances students' self-confidence, and provides students with alternative learning styles (Chang, 2003). In a comparative study of online and on-campus students, Rovai et al. (2005) discovered that no difference in learning and performance exists as long as students using the online environments have a sense of community and collaboration similar to that found in classroom environments.

In examining the role of student perceptions about the instructional delivery medium, Miller, Rainer, and Corley (2003) found that perceived ease of use and usefulness of a medium encouraged students to enroll in a course utilizing such a medium. Possessing the necessary skills to successfully learn in such an environment creates a positive perception about the instructional medium. Miller et al. further demonstrated that students who exhibit technology anxiety or lack technology skills are less motivated to learn in an online environment.

DESCRIPTION OF THE STUDY

Students enrolled in an introductory educational technology course took part in this study to investigate the various factors that influence student decision making with regard to technology use. The study explored whether differences in student technology experience, skills, or concerns about Internet integration play a role in learning in a classroom or an online environment.

The experiences and perceptions of two groups of students who were either enrolled in classroom or online sections of the same course were compared. Students in the two course sections were full-time, on-campus students with access to similar resources such as computers, printers, university networks, and the Internet. The only difference was that the online group completed the course as distance education students while the classroom students used the Internet as a supplement to face-to-face learning.

DATA COLLECTION

To study student technology experience including learning environment and concerns about technology use, students completed a survey questionnaire and pretests and posttests. To compare and investigate students' perceptions about technology integration, a Web-based pretest was administered to both groups (online and classroom) during the first day of the semester; a Web-based posttest was administered again at the end of the semester. Both tests were executed and scored automatically using an online assessment tool. This study was conducted to answer the following research questions:

1. How do student technology experience and skills determine student preference for online or classroom learning?
2. Are there any significant differences between online and classroom students' decision-making processes in the use of the Internet as an instructional medium?
3. Are there any significant differences in student concerns about the use of the Internet as an instructional tool?

SUBJECTS

Participants consisted of two groups of pre-service teacher education students. Although all students were full-time, on-campus students, one section of the course was taught online as a distance education course. One group of 24 students was enrolled in the classroom section of the course, while the other group of 23 students completed the course online.

Many of the participants were undergraduate students of junior and senior standing. The course is one of the required courses in the education program and is designed to introduce students to the field of educational technology.

INSTRUMENT AND DATA ANALYSIS

The first goal of this study was to compare the level of "computer and Internet technology skills" of students in the two sections. A Likert scale instrument (1 = Expert, ..., 5 = None) was completed by the students in both classes. This was part one of a questionnaire on Web-based educational technology (Tetiawat, 2003) consisting of eight items. Independent two-sample t-tests were conducted to determine the difference in the mean scores between the two groups.

The second purpose of the study was to assess and compare the factors that influenced the students' decisions to use Internet/Web technologies. A Likert scale instrument (1 = Very strong influence, ..., 5 = No influence) was completed by the students at the beginning and the end of the semester. This was part two of a questionnaire on Web-based educational technology consisting of 12 items. Analysis of covariance (ANCOVA), using the initial score as the covariate, was conducted to determine the difference in the mean of the scores for each class at the end of the semester.

The final purpose of this research was to compare the students' levels of concern regarding the use of the Internet in teaching and learning. A

Likert scale instrument (1 = Extremely concerned, ..., 5 = Not concerned) was again completed by the students at the beginning and at the end of the semester. This was part three of a questionnaire on Web-based educational technology consisting of 16 items. ANCOVA, using the initial score as the covariate, was conducted to determine the difference in the mean scores for each class at the end of the semester. The level of significance (alpha) was set at .05 to achieve statistical significance for all analyses.

RESULTS

To examine student decision-making procedures in using technology as a learning tool, this study researched the role of student technology skills, student perceptions about the influence of technology on learning, and student concerns about incorporating technology in learning. Forty-seven students completed the assessment at the beginning and at the end of the semester. The data on sex, age, and degree program are presented in Table 1.

The study assessed students' level of technology skills. Normal probability plots reveal that the normality assumptions were valid. Leven's

test for homogeneity of variance indicated that the assumption for equality of variance was not violated. Independent two-sample t-tests indicated no significant difference ($P\text{-value} > .05$) in the mean scores of level of skills among the two classes for seven of the eight items. The only significant difference ($p < .05$) among the two classes was found for the item, "using the Internet for other communication forms (e.g., chat, discussion forum, listserves, bulletin-board)," (see Table 2) where online students revealed more experience in Internet use for communication compared to the traditional (classroom) group. Most students in both groups ranked their word processing and presentation software skills as advanced or intermediate. Students ranked their skills in developing Web courses as the lowest of the eight skills.

Student responses to several statements were analyzed to examine the factors that affect student decision-making processes. The results from the analysis of covariance (ANCOVA) indicated only a significant difference ($P\text{-value} < .05$) among the two groups in item two (studying performance is improved) regarding the factors that have influenced or would influence their decision to use the Internet/Web (see Table 3).

According to the data (see Table 4), both the online and classroom students were most influenced in their decision-making by the need to communicate with instructors and friends (item 4), their confidence in the value of the Internet (item 11) to improve studying performance (item 2), and the ease of Internet Study (item 3). Conversely, the data reveals that the ability to use technology on a trial basis (item 9) and the availability of other courses on the Internet (item 12) had the least influence on student decision-making process.

In investigating students' levels of concern when deciding whether or not to use Internet/Web technology instruments, ANCOVA indicated a *marginal* significance ($p = .08$) between the two groups for the item "ownership of the Web-based

Table 1. Student demographics (age, sex, and degree)

Variable	<i>n</i>	%
Age		
21-29	2	4.3
30-39	0	0
>40	1	2.1
Sex		
Male	9	19.1
Female	38	80.9
Degree Seeking 45 (2 missing)		
Bachelor	42	89.3
Master	1	2.1
Other	2	4.3

Student Decision Making in Technology Application

Table 2. Means (SD) for level of skill instrument; ** (What level of computer and Internet technology skills do you have?) *significant at .05 **1=Expert, 2=Advanced, 3=Intermediate, 4=Beginner, 5=None

Item	Classroom	Experimental	P-Value
1. Word processing software.	2.29(0.69)	2.13(.081)	0.467
2. Spreadsheet software.	3.25(.079)	3.00(0.61)	0.232
3. Presentation software.	2.92(0.77)	2.87(0.76)	0.834
4. Programming.	3.75(0.61)	3.70(0.70)	0.785
5. Using Internet for communication forms.	3.17(0.87)	2.61(0.93)	0.040*
6. Using Internet to do research.	2.63(0.57)	2.36(0.89)	0.290
7. Developing Web pages.	3.54(0.59)	3.74(0.55)	0.241
8. Developing Web courses.	3.92(0.28)	3.79(0.67)	0.373

Table 3. ANCOVA results: "Influence factors"; *significant at .05 **1=Very strong influence, 2= Strong influence, 3=Somewhat influence, 4= Weak influence, 5=No influence

Item	F (1,43)	P-Value
1. Task achievement is more rapid	0.84	0.365
2. Studying performance is improved	7.10	0.011*
3. Making studying easier	0.256	0.616
4. Communication with instructors and friends is enhanced	1.26	0.267
5. Use of Internet/Web technology is easy to learn	0.487	0.489
6. Acquisition of Internet/Web technology skill is easy to achieve.	0.715	0.402
7. Suitability for my courses.	0.25	0.620
8. Compatibility with my learning style.	0.052	0.82
9. Ability to use Internet/Web technology on a trial basis	0.922	0.343
10. Knowing where to go to try out Internet/Web technology	0.595	0.445
11. 11. Value of Internet/Web technology	0.865	0.358
12. 12. Availability of other courses on the Internet/Web	0.358	0.553

courses." The results from ANCOVA are given in Table 5.

Table 6 shows that students were most concerned about technical problems (item 11), effectiveness of Web-based courses compared to face-to-face learning methods (item 4), keeping up with the speed of technology (item 10), and the possibility of the Internet replacing face-to-face classrooms (item 16). Students seemed to have been less concerned about the ownership of courses, lack of support from their own institution, and the limited use of the Internet in their subject areas.

DISCUSSION

Unlike distance education or classroom learning, the use of technology such as the Internet as an instructional tool and medium requires students to have at least basic technology skills. Students are becoming increasingly familiar with technology application in classroom learning and distance education settings and many have some form of technology experience, regardless of their learning environments and fields of study.

Table 4. Means $\pm$ standard deviation for pre and posttest of influence factors

Traditional				Experimental			
Item		Pre		Post		Pre	
Mean	n	Mean	n	Mean	n	Mean	n
1. 88 $\pm$.741	24	2.50 $\pm$.978	24	2.04 $\pm$.878	23	1.86 $\pm$.774	22
2. 1.75 $\pm$.608	24	1.92 $\pm$.584	24	1.39 $\pm$.583	23	2.09 $\pm$.811	22
3. 1.83 $\pm$.761	24	2.33 $\pm$.917	24	1.86 $\pm$.793	21	1.91 $\pm$.868	22
4. 1.75 $\pm$.794	24	1.67 $\pm$.565	24	1.57 $\pm$.728	23	1.82 $\pm$.664	22
5. 2.04 $\pm$.806	24	2.21 $\pm$.833	24	1.91 $\pm$.793	23	2.14 $\pm$.560	22
6. 2.25 $\pm$.676	24	2.42 $\pm$.776	24	2.00 $\pm$.905	23	1.86 $\pm$.640	22
7. 2.25 $\pm$.737	24	2.29 $\pm$.690	24	2.09 $\pm$.733	23	1.95 $\pm$.722	22
8. 2.04 $\pm$.751	24	2.58 $\pm$.776	24	2.00 $\pm$.853	23	2.14 $\pm$.889	22
9. 2.46 $\pm$.884	24	2.88 $\pm$.680	24	2.05 $\pm$ 1.046	22	2.36 $\pm$.658	22
10. 2.13 $\pm$.680	24	2.42 $\pm$.717	24	2.04 $\pm$.928	23	1.95 $\pm$.653	22
11. 2.21 $\pm$.779	24	2.33 $\pm$.637	24	1.91 $\pm$.848	23	1.95 $\pm$.486	22
12. 2.46 $\pm$.884	24	2.71 $\pm$.955	24	2.32 $\pm$ 1.129	22	1.91 $\pm$.750	22

In this study, the findings did not reveal widespread discrepancies in student technology skills and perception about the incorporation of technol-

ogy in instruction. The mean score of classroom (3.18) and online (3.02) students' overall skill levels reveals that students in both groups had some

Table 5. ANCOVA results: "Level of concern"; *significant at .05 **1=Extremely concerned, 2= Very concerned, 3=Somewhat concerned, 4= A little concerned, 5=Not concerned

Item	F(1,43)	P-Value
1. Lack time to use Internet/Web technology for my classes	0.520	0.483
2. Limited knowledge of Internet/Web technology	0.009	0.925
3. Effectiveness of Internet/Web technology in supporting learning	1.145	0.705
4. Effectiveness of Web-based courses compared to face-to-face learning methods	0.021	0.884
5. Availability of suitable Internet/Web software	0.72	0.401
6. The quality of content of Web-based courses	0.177	0.676
7. Institutional support and service	0.261	0.612
8. Accessibility of Internet/Web technology to students	1.98	0.166
9. Availability of technology infrastructure	1.441	0.237
10. Keeping up with the speed of technology changes	0.127	0.792
11. Technical problems	0.048	0.83
12. The ownership of the Web-based courses	3.125	0.084*
13. Lack of support and encouragement from my institution	0.009	0.93
14. Health issues	0.26	0.62
15. The use of Internet/Web technology in my subject area	1.215	0.277
16. Internet/Web technology may replace face-to-face classroom	0.302	0.57

Table 6. Means $\pm$ Standard deviation for pre and posttest of levels of concern

Traditional				Experimental			
Item		Pre		Post		Pre	
Mean	n	Mean	n	Mean	n	Mean	n
1. 3.38 $\pm$ 1.135	24	3.29 $\pm$.999	24	3.13 $\pm$ 1.100	23	3.36 $\pm$ 1.093	22
2. 2.92 $\pm$ 1.142	24	3.00 $\pm$ 1.142	24	2.86 $\pm$ 1.167	22	3.05 $\pm$ 1.253	22
3. 2.83 $\pm$ 1.239	24	3.17 $\pm$ 1.239	24	3.00 $\pm$ 1.314	23	2.77 $\pm$ 1.232	22
4. 2.63 $\pm$ 1.056	24	2.83 $\pm$ 1.090	24	2.65 $\pm$.832	23	2.86 $\pm$ 1.153	21
5. 2.96 $\pm$.751	24	3.38 $\pm$ 1.013	24	3.13 $\pm$.757	23	3.05 $\pm$.950	22
6. 2.92 $\pm$.929	24	3.13 $\pm$ 1.116	24	3.04 $\pm$.928	23	2.95 $\pm$ 1.174	22
7. 2.92 $\pm$.974	24	3.00 $\pm$.885	24	3.09 $\pm$.668	23	2.95 $\pm$.999	22
8. 2.75 $\pm$ 1.073	24	3.17 $\pm$ 1.049	24	3.22 $\pm$ 1.126	23	2.95 $\pm$ 1.090	22
9. 3.00 $\pm$ 1.022	24	3.50 $\pm$.933	24	3.35 $\pm$ 1.027	23	3.05 $\pm$ 1.090	22
10. 2.63 $\pm$ 1.173	24	2.83 $\pm$.963	24	2.74 $\pm$ 1.096	23	3.05 $\pm$ 1.090	22
11. 2.46 $\pm$ 1.021	24	2.25 $\pm$.989	24	2.39 $\pm$.839	23	2.45 $\pm$ 1.184	22
12. 3.75 $\pm$.897	24	3.63 $\pm$ 1.096	24	3.22 $\pm$.998	23	3.33 $\pm$.796	21
13. 3.42 $\pm$ 1.283	24	3.38 $\pm$ 1.173	24	3.35 $\pm$ 1.265	23	3.32 $\pm$ 1.041	22
14. 3.71 $\pm$ 1.334	24	3.54 $\pm$ 1.103	24	3.96 $\pm$ 1.186	23	3.59 $\pm$.796	22
15. 3.58 $\pm$ 1.139	24	3.63 $\pm$ 1.173	24	3.83 $\pm$ 1.114	23	3.40 $\pm$ 1.095	20
16. 2.88 $\pm$ 1.541	24	2.83 $\pm$ 1.129	24	2.64 $\pm$ 1.217	22	3.00 $\pm$ 1.298	20

technology experience. At the very least, both groups of students had intermediate skills in Internet use, presentation applications, and common productivity software, such as word processing. Additionally, many colleges offer workshops that provide training in the aforementioned programs. However, despite the training and the importance that word processing and presentation skills hold, students did not acknowledge any expertise in the programs. Students reported to have fewer competencies in the less commonly used skills of programming and Web site development. In investigating student technology skills, Dexter and Riedel (2003) reported that students only exhibited competency in technology that they found useful to their learning process.

Overall, the only significant difference between the two groups' technological skills was found in the use of the Internet for communication. This is an important factor for students when choosing

course delivery format. In fact, the online students reported to have better Internet communication skills compared to the classroom group. This point is consistent with other studies of online learning because effective use of the Internet for learning and communication requires greater interaction and use of different communication media such as email, online chats, and discussion forums. For successful Web-based instruction and improved learning outcomes, students must engage in asynchronous communication in addition to the real-time, synchronous media during group discussions. Although the Internet is a great communication tool, many students see no need for other tools other than email, and therefore fail to develop skills in other communication media. On the other hand, students who have more skills in various Internet communication technologies are more inclined to use the Internet as a medium of learning.

Communication plays an important role in determining the quality of online learning. Successful online learning requires virtual learning communities and increased peer interaction (Rovai et al., 2005). Frequent and immediate communication leads to increased interaction and improves learning. Because students value peer interaction and support (Falvo et al., 2004), educators must utilize various strategies to complement online discussion in order to have effective communication (Ortiz-Rodriguez, Telg, Irani, Grady Roberts, & Rhoades, 2005). Furthermore, Ortiz-Rodriguez et al. found e-mail to be an effective one-on-one communication tool and online forums to be good for group discussion.

The learning environment and delivery format are important to consider when making decisions about course enrollment. In this study, students were told to identify some technological factors that influenced their decision-making. Overall, students' selection showed the significance of the Internet as a communication tool as the most influential factor, although they had mixed perceptions about the value of the Internet as a learning tool. The mixed perceptions about the instructional value of the Internet could be attributed to past technology experience that involved using technology as a communication tool rather than a learning tool. This experience could have swayed students' perceptions about how the Internet influenced their decision-making.

The fact that most students selected the availability of other courses (item 12) on the Internet as the factor that least influenced decision-making supports studies that report undergraduate students are less inclined to enroll in distance education courses (Rovai et al., 2005). In this study, meeting the maximum enrollment in the online section may have been due to the fact that the classroom section of this course had reached maximum capacity enrollment.

Students in both groups were interested in using the Internet to help in course completion rather than as a tool to help them learn the course

content. The similarities in responses students gave to this issue revealed that regardless of the learning environment (online or classroom), students preferred to use technology as an instructional aid and communication tool.

In examining students' concerns about the use of the Internet in online or classroom learning environments, analysis of the statistical comparison did not show any significant differences in student responses. Widespread access to technology and support in using the technology are however crucial considerations. Respondents in both groups were more concerned about technical problems impeding the use of the technology rather than the effectiveness of the Web to improve academic performance. The data reported that students did not consider an institution's role in a course to be important as long as they were obtaining support and services in completing the course. Students were not very concerned about the institution that owned and delivered the course. This finding is incongruent with the view of Shin et al. (2004), who found that affiliation with a university does affect student online learning outcomes; a strong, student-university connection was found to lead to positive learning outcomes and a more persistent online learning presence.

Students considered technology an add-on to the content that they are required to learn in order to graduate. Students voiced concerns about developing new technology skills because technology evolves quickly. This concern could have contributed to hesitation on the part of some students to adapt to and embrace technology even though they are aware of its potential. Software and hardware are constantly upgraded, and students are required to keep up to pace with the changes. This could have diminished students' abilities to develop competency even in basic technologies such as word processors.

Some people might expect the classroom students to have been more concerned about technology application because of the general belief that online students have better techno-

logical competencies. Though such a premise is understandable, the amount of time students spend online increases the likelihood of technical problems, therefore making online students' levels of concerns identical to classroom students. Also, the Web was used to supplement classroom learning of traditional students and therefore was not much of a concern.

The lack of significant differences in many of the issues raised among the two groups is partly due to the fact that although the online students completed the course online, they were also on-campus students and had access to the same technology resources and facilities as their classroom peers. The course instructor was also available for meetings in case individual online students needed to meet in person.

CONCLUSION

As both groups of students in this study were full-time, on-campus students with access to the same technology resources and support, this study found that students' perceptions and experiences were quite similar. Responses may have differed if the online group completed the course while stationed off campus. The only notable difference between the two groups was that the online group did not meet face-to-face with the instructor in a classroom-learning environment. Significant differences could be found in many of the items in the study that addressed factors that influence student decision-making and their levels of concern if the students do not have access to similar resources. Although the subjects in this study were predominantly undergraduate education students with similar access to technology resources and support, many online distance education students are working adults with diverse experiences and expectations and different levels of technology skills and support, and are enrolled in a course by choice rather than to complete a requirement.

Though the online students liked the constant communication and flexibility Web-based instruction provides, a danger exists that students may lack the discipline and commitment that online distance education requires. Considering that the majority of the students in this study were young, the flexibility of the online course had its complications. For example, students tended to submit assignments late and had difficulty coordinating the online group interactions and activities, especially when such interactions involved real-time communication. Distance education requires more self-discipline and planning compared to a classroom environment, where students rely heavily on instruction from the teacher.

Students' responses revealed that technology use in a course was not a major issue of concern. However, the course in which the students are enrolled can make a difference. Some courses require more technology skills than others. In this study, respondents were enrolled in an instructional technology course that involved the development of technology skills and technology application in curriculum; therefore students' level of concern potentially may have been different compared to if they were enrolled in another course that did not focus on instructional technology. Students in this course were aware of the technology skills and technical support they were to receive.

Although the participants in this study were required to enroll in the online course, many other on-campus students nationwide are enrolling in online distance education courses as a way to graduate more quickly. Completing an online course is no longer complicated or overwhelming because many students develop technology skills much earlier than in the past, more technology training and support is available, and access to online courses delivered by colleges has increased. However, the use of Internet is not limited to online distance education as an increasing number of faculty are also incorporating the Internet in their traditional classrooms. No matter how the technology is applied, the concern is less about

technology skills and availability and more about how to incorporate technology as an effective instructional tool. In considering use of technology, students' decision-making processes will be influenced by a combination of several factors, notably how the Internet can facilitate and enhance learning. Meanwhile, as online learning is increasingly becoming popular among traditional students, more studies need to be conducted to examine how students can concurrently be on-campus and distance education students in a meaningful and effective way.

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Chapter 4.15

Transforming a Pediatrics Lecture Series to Online Instruction

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ABSTRACT

A major issue facing medical education training programs across the USA is the recent advent of universal mandatory duty hour limitations and the time pressure it places on formal face-to-face educational sessions. In response to these mandates and associated issues many medical education programs are exploring the use of online instruction to address issues of accessibility. This chapter describes the instructional development process followed to transform a classroom-based pediatrics residency lecture series into an on-demand, video-enhanced, online instructional environment. An overview of the learning principles and instructional sciences that guided the design process is provided. The phases of the designed solution are then described in the context of en-

hancing the lecture series as it was transformed into online instruction. Implementation logistics are described followed by an overview of the benefits, barriers, and initial project outcomes. Plans for future enhancements and research projects are also discussed.

INTRODUCTION

Designing good instruction is predicated on understanding learning. Effective learning is predicated on accurately defining learning outcomes and providing instructional environments that support the achievement of learning outcomes. Both are essential to successful online instruction (Koszalka, 2007, p. 2).

Principles of learning and the instructional sciences were used to enhance the overall strength of the pediatrics residency curriculum at SUNY

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Upstate Medical University in Syracuse, New York. In response to the recent advent of universal mandatory duty hour limitations and the time pressure it places on formal face-to-face educational sessions, the entire residency curriculum, consisting of a year-long classroom-based lecture series, was transformed into a blended video-based online format supported by application-based classroom experiences. The online lectures component was not a straight conversion where lectures were simply videotaped and offered to the residents through a distance education program, rather the demand for change was used as an opportunity to re-evaluate the design of the lecture series and apply sound learning and instructional design principles to enhance the overall residency instructional process.

Application of learning principles. Learning at its foundation is about change, change in human condition based on experiences. Principles of social learning theories posit that learning is a construction of knowledge based on an individual's observations of, and interactions with, information and people around them. Learning can occur both at surface and deep levels depending on how individuals interact with new information.

Surface learning suggests storage and remembrance of information, facts, concepts, principles, and procedures. It often results in recalling basic information and demonstrating new procedures and behaviors, for example. Deep learning, or critical thinking, suggests activation of higher order thinking. Outcomes of this type of learning include constructing knowledge to evaluate, apply, diagnose, problem solve, debate, critique, and other activities that require successfully addressing complex and ill-structured problems, such as those encountered by medical professionals.

The construction or learning of knowledge at these different levels is supported through different types of interactions (instruction) with content and people that accommodate individual preferences and learning styles of the learner (Akdemir & Koszalka, In-press; Akdemir & Koszalka, 2005;

Kidney, G., & Puckett, 2003). Thus, instruction is thought to be richest and most effective in facilitating deep learning when:

- Learners are *engaged* in solving real-life problems;
- Existing knowledge is *activated* as a foundation to new knowledge;
- New knowledge is *demonstrated* to the learner;
- When new knowledge is *applied* by the learner;
- When new knowledge is *integrated* into the learner's world (Merrill, 2000).

Application of instructional sciences and design processes. The instructional sciences inform how activities can be designed to prompt and facilitate required levels of learning that meet expected outcomes. To design instruction and learning experiences that apply learning principles successfully an instructional system design (ISD) process can be undertaken. The process includes: (A) analyzing the gap in knowledge (what does the learner know and what should they learn), (D) designing an instructional and learning solution, (D) developing the solution based on the design, (I) implementing and testing the solution, and (E) evaluating the results (Dick, Carey, & Carey, 2005; Smith & Ragan, 2005). An ADDIE approach, guided by principles of learning and instruction, is especially important when designing instruction for online applications, as the perceived separation of learner and facilitator can be distracting to the learner or fail to provide information and social learning interactions required by the learner.

Distance education of the past was designed to stand on its own as correspondence courses in which learners received an instructional packet and submitted assignments at their own pace. There was little or no social interaction with peers or an instructor. Distance education today however mostly refers to technology-delivered instruction and learning activities that are designed to provide

informational and instructional elements as well as social learning elements to actively engage learners with content, peers, and the instructor through digital technologies (Grabowski & Small, 1997). The major benefit is posited to be providing instruction to those who have limitations of time or travel (Hawkrige, 1999; Stock-McIssac, 1999).

Incorporating these interaction elements however, comes at a price. Learners in distance education seem to have a wide range of technology skills and content application knowledge (Lamb & Smith, 2000). Thus, addressing the needs of such a wide variety of learners can be a challenge. Designing for such a diverse audience often means incorporating multiple and rich representations of the same information (e.g., lecture, readings, learning aides) and providing learners with multiple ways to interact with content and demonstrate their learning (e.g., discussion boards, online assessment, reflective journaling). Thus, it is critical when converting from classroom-based instruction to online delivery that instructional materials and learning activities be well integrated and aligned with expected learning outcomes, e.g., surface recall or knowledge application in problem solving.

THE PROBLEM WITH THE CURRENT RESIDENCY CLASSROOM-BASED CURRICULUM AT SUNY UPSTATE

Prompted in part by a recent citation for poor resident attendance at the pediatric core conference (classroom lecture) series a curriculum reform effort was undertaken at SUNY Upstate Medical University. As part of this reform an analysis of the formal didactic educational program was undertaken. This analysis revealed that as a result of significant clinical responsibilities the 36 pediatric residents could only attend approximately 30-40% of the offered lectures. This attendance situation has recently been made worse across the country in medical education with the introduction

of mandatory work hour limitations that restrict residents' ability to attend standard face-to-face lectures series (Higgins, 2006). The curriculum analysis that was undertaken also revealed that the offered lecture series did not cover the necessary scope of content as outlined by the American Board of Pediatrics (ABP). As a result of these findings it was decided by Upstate's Pediatrics departmental administration to take advantage of distance education technologies to provide greater access for the residents to 'attend' the lectures and address the above noted challenges. Specifically, there were three gaps the institution has tried to overcome from the traditional formal didactic component of the pediatric residency program:

- Lack of overarching design in the core curriculum to cover a defined scope of content.
- Poor conference attendance due to mandatory duty hour limitations making lectures increasingly inaccessible.
- Lacked meaningful learning objectives and measures of knowledge acquisition in core lecture curriculum.

The previous core face-to-face lecture curriculum consisted of a 50-minutes didactic conference series offered 3 days per week. At the end of the academic year the same series was repeated with the assumption that any missed lectures would be attended the next year by the resident as needed. The 120+ annual lectures in this face to face lecture series were organized and presented monthly according to the identified clinical domains. See Table 1. It is important to note that missing from this list of face-to-face lecture topics are the domains of Dermatology, Genetics, Orthopedics and Pharmacology. Because Upstate has limited access to content experts in these fields robust face-to-face lectures in these content domains could not be delivered. However, with the development of the online curriculum content experts could be recruited to cover these domains so that our online curriculum covers a proper and expected scope of content.

Transforming a Pediatrics Lecture Series to Online Instruction

Table 1. Pediatrics residency curriculum listing clinical domains

Clinical domain	*New Domains	Topics covered in clinical domain
Adolescent Med.		Adolescent History; Adolescent Physical Exam; Eating Disorders; Depression
Cardiology		
Developmental Peds.		Patterns of Development & Disability; Spinal Dysraphism; Disorders of Communication & the Autistic Spectrum Disorders; Disorders of Language, Learning & Cognition; Diagnosis and Treatment of ADHD; Cerebral Palsy; Parent Partners in Health Education: Introduction; Parent Partners in Health Education: Communication; Parent Partners in Health Education: Educational Advocacy
Dermatology	X	Principles of Atopic Dermatitis; Acne; Newborn Skin
Emergency Med.		
Endocrinology		Type 1 Diabetes; Type 2 Diabetes; Diabetic Ketoacidosis (DKA); Hyperthyroidism; Acquired Hypothyroidism; Congenital Hypothyroidism; Short Stature; Delayed Puberty; Precocious Puberty
Gastroenterology		Vomiting; Diarrheal Disorders; Gastroesophageal Reflux Disease (GERD); Jaundice (Part 1); Jaundice (Part 2); Gastrointestinal Bleeding; Malabsorption; Abdominal Mass; Refeeding Syndrome; Celiac Disease
Genetics	X	Prenatal Diagnosis; Newborn Screening & Metabolic Emergencies; Chromosomal Abnormalities; Teratogens; Malformations & Deformations; Common Genetic Syndromes
Hematology/Oncology		CBC Interpretation; Coagulation Disorders; Neoplastic Disorders; Pediatric Transfusion (Indications & Complications)
Infectious Disease		Public Health: Prevention of Infectious Diseases; Laboratory Diagnosis of Infectious Diseases: Bacteriology; Laboratory Diagnosis of Infectious Diseases: Virology; Infectious Gastroenteritis; Antiviral Therapy; Antibiotic Treatment of Common Respiratory Tract Infections; Pertussis; Tickborne Diseases; Enterovirus Infections; Respiratory Viral Infections
Intensive Care Med.		
Neonatology		Term Newborn - Part 1 (The Basics); Neonatal Resuscitation; Apnea, SIDS, and Sleep Position; Management of Jaundice; Hematologic Problems of the Newborn; Respiratory Disorders of the Newborn; Neonatal Abstinence & Fetal Alcohol Syndrome
Nephrology		Hematuria and Glomerulonephritis; Congenital & Inherited Disorders of the Urinary Tract; Proteinuria & Nephrotic Syndrome; Normal and Abnormal Renal Function; Urinary Tract Infection in Children; Hypertension
Neurology		
Outpatient Peds		Immunizations; Infant and Child Nutrition; Monitoring Growth and Development; Disorders of the Eye; Childhood Obesity; Child Abuse
Orthopedics	X	Infections of the Bones & Joints; Disorders of the Hip 2: Perthes and SCFE
Pharmacology	X	Developmental Pharmacology & Pharmacokinetics; Clinical Implications of Pharmacokinetics
Pulmonology		Hypnosis; Cystic Fibrosis - Diagnosis & Pathophysiology; Cystic Fibrosis - Treatment; Bronchopulmonary Dysplasia; The Wheezing Infant; Allergy & Related Disorders; Urticaria, Angioedema, Anaphylaxis & Food Allergies; Asthma (etiology, epidemiology & natural history); Asthma (diagnosis); Asthma (outpatient treatment); Chronic Cough; Breathing Disorders of Sleep; Spirometry, Chest X-ray & Blood Gas Analysis
Rheumatology		

*Expertise not previously available at Upstate to conduct classroom sessions in these domains

The pediatrics faculty consists of 50 physicians all of who are content experts, but who have varying degrees of expertise in instructional design and no formal training in instructional concepts or designing online instruction. The lectures that they provided were of a similar quality typical of most academic medical institution. The lectures however consistently lacked educational objectives and rarely had measures of knowledge acquisition by which achievement can be assessed.

THE PROPOSED PEDIATRIC ONLINE CORE CURRICULUM

In order to address the issues of accessibility and lack of content scope it was decided by the department's education committee to develop an online core curriculum that covers the full scope of content outlined by the American Board of Pediatrics Blueprint Document (ABP 2006). The ABP outlines the content that is tested by the national board certifying examination.

The Associate Program Director for Resident Education at Upstate took the lead in developing the pediatric online core curriculum. This core curriculum now consists of approximately 130 learning units divided into 20 basic clinical

domains. Figure 1 provides a view of the online table of contents of the clinical domains (menu on the left) that residents see once logged into the course. Refer to table 1 for a complete listing of the clinical domains and topics covered within each.

This online pediatric core curriculum is offered through a commonly used Course Management System (CMS) called Blackboard. Within each domain folder are the basic learning units that comprise the core content of that knowledge domain (figure 2). For example in the Genetic domain topics on prenatal diagnosis, new born screening and metabolic emergencies, chromosomal abnormalities, etc. are accessible. Within each of the topics is access to lectures, supporting slides, reading materials, and short self-assessment quizzes.

By clicking on one of the learning topic folders (e.g., Prenatal Diagnosis) inside the clinical domain (Genetics) the basic architecture of each learning unit is revealed. This structure has been kept intentionally simple and consistent across domains to avoid interface complexity (Grunwald 2006). In designing online learning environments it is desirable to keep the basic architecture simple so that learners will quickly learn to navigate their way around the site without wasting time and effort learning complex linking and

Figure 1. Main menu of pediatric core curriculum at Upstate Medical University

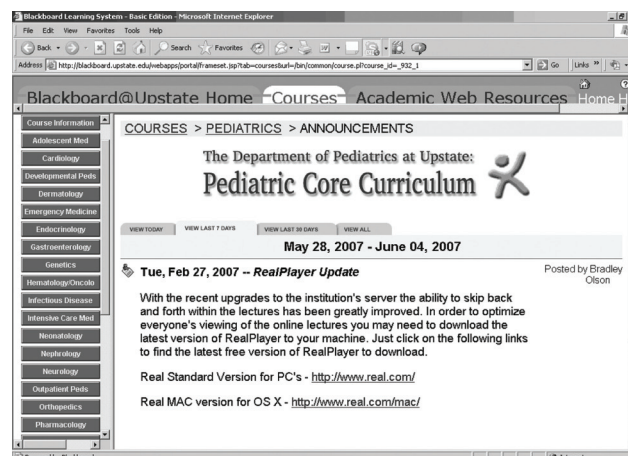
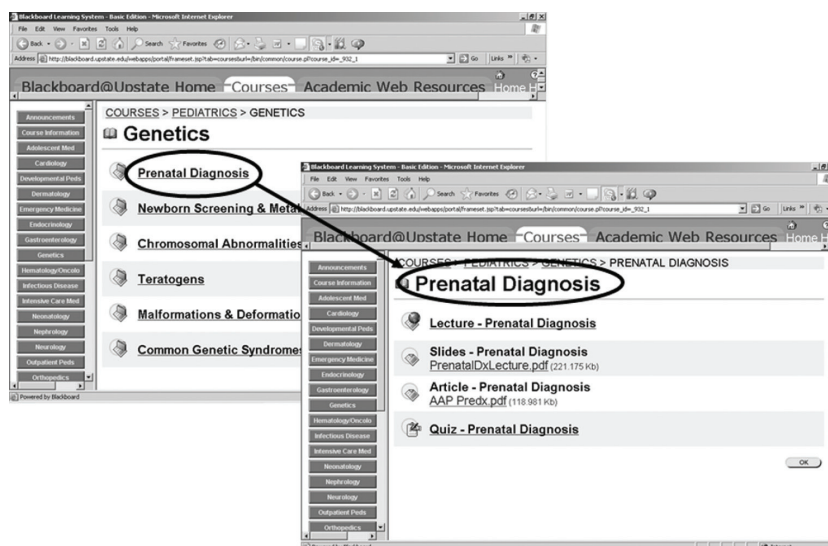


Figure 2. Learning unit architecture and navigation



technology strategies. This way the learner dedicates a majority of his or her cognitive efforts towards learning the content rather than navigating a complex interface. A common mistake often found in the design of online learning environments is to use features of the technology simply because they are available (Gilbert & Moore, 1998; Kidney & Puckett, 2003; Koszalka & Ganesan, 2004). Non-purposive - not explicitly related to a specified learning outcome - use of technical features can inhibit learning (Kersley, 1997; Koszalka & Ganesan, 2004). Thus a consistent and easy to follow technical infrastructure is recommended.

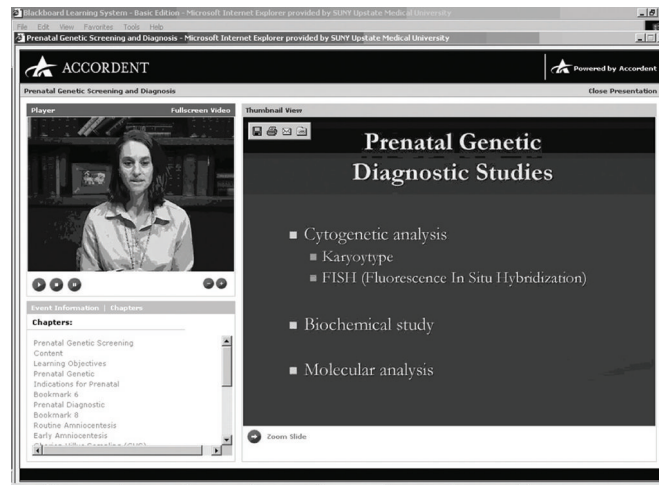
The basic architecture of each learning unit in the pediatric core curriculum consists of four components: a video lecture that highlights the essential points of the learning unit, a printable copy of the lecture slides, a review article that serves as a summary document of the essential material, and a quiz that assesses the learners' acquisition of the content material. The video lecture is integrated with synchronized PowerPoint slides to effectively present of the topic content. See figure 3. This component mimics face-to-face lecture with the exception that learners have the

advantage of being able to start and stop a video lecture at any time. They can also skip forward and backward within a lecture to review points that they recall from a previous viewing, supplemental reading or quizzing materials, or from outside experiences. As mentioned previously the learners may also download the PowerPoint presentations and review them without the video.

The overall design of the online core curriculum provides the residents with flexibility to review required content domains and topics when they have time and access. To help them develop deeper understanding of the content the lectures and presentation notes are supplemented with learning objectives, focused reading materials, and self-check quizzes. Although provided as a self-paced, anytime-anywhere accessible format, the delivery of the content online has also provided opportunities for the university to revise the format of classroom sessions.

The in class session are now more focused on case-based discussions that engage the residents in applying information from the online lectures and activities. Thus, residents are now engaged in surface and deep learning activities during all aspects of the new curriculum with a focus on

Figure 3. Sample video and synchronized PowerPoint topic lecture



discussion, application, and case-based social learning activities during classroom sessions.

IMPLEMENTATION: PROCESS, BENEFITS, CHALLENGES, AND INITIAL RESULTS

The pediatric online core curriculum is the result of a two-year educational reform effort that employed learning theory and the ADDIE model of Instructional development. This model involved the analysis, design, development, implementation, and evaluation of an instructional solution to Upstate's pediatrics residency education program challenges of non-attendance in lecture series, gaps in presented content domains, and weak/non-existent learning assessment approaches. This stepwise systems-based approach for designing and implementing instructional solutions involved analyzing instructional problems followed by designing solution that address identified learning and instructional problems. Once the solution was designed instructional materials were developed and the instruction was implemented and tested. Through out this process both the instructional product and the process were evaluated to verify that the product addressed the problem originally

identified and learners were able to achieve expected outcomes. The following is a description of each of the phases conducted during the development of Upstate's pediatric online residency core curriculum.

Analysis Phase. The initial step in the curriculum reform efforts involved analysis of the curriculum content, learners, and environmental factors to define the instructional problem and scope of this project. As in any system, the educational systems is made up of multiple stakeholders (e.g., administrators, educators and learners) who may have differing opinions of the problem and different ideas of problem causes and what the next steps should be in reforming the current system. Lacking a common understanding of the problem will make it difficult, if not impossible to reach consensus on possible solutions. Thus, the analysis phase is critical in identifying gaps in knowledge and skills, describing the key problems (gap between current knowledge and expected knowledge), articulating causes of the gaps, and suggesting potential instructional and learning solutions.

The steps to perform a gap analysis primarily involve collecting a variety of data from key of stakeholders and the instructional and practice environments. Questions that are addressed to

stakeholders should be designed to elicit information from their perspective on current practices, ideal practices, problems (gaps) faced by the educational organization, potential causes of identified problems, and potential solutions. The data collection methods that Upstate used included the following:

- External review of our educational program by a nationally recognized pediatric educator and leader.
- Telephone interviews of 10 former pediatric residents (5 in practice/5 in fellowship) concerning their perceived strengths and weaknesses after having completed training at our institution.
- Survey of all department chairs about their perceived educational needs within their departments.
- Analysis of an external governing agency's review of our educational program.
- Focus group discussions with current residents, faculty and the education committee about each group's perceptions of the strengths and weaknesses of the educational program.

The results of this data collection method were analyzed in order to clearly define the gaps faced by the educational program from the perspective of the various stakeholders. These gaps were then synthesized into 3 statements that were easily communicated and agreed upon by the entire faculty. The gaps that the Upstate pediatric residency program faced were as follows:

- The face-to-face core lecture series did not cover the full scope of content defined by the American Board of Pediatrics blue print document.
- Lecture attendance was poor (<30-40%) partially because of resident commitments to service obligations and mandatory duty hour limitations.

- There were no clearly defined learning objectives for each of the lectures in the core series and consequently no measure of whether our learners had achieved those objectives.

Once these gaps were clearly defined it was a relatively straightforward process to gain the acceptance of the faculty on an online curriculum that accomplished the following three goals.

- Create a designed curriculum that covers a defined scope (i.e. the *American Board of Pediatrics* blue print document).
- Create a lecture series that is accessible to the residents when and where they need it.
- Develop learning objectives for the core lecture series that covers the scope described above and provides learners with ways to check that they have achieved the objectives.

This proposal was presented to the faculty during a 3-hour workshop dedicated, in large part, to launching the online curriculum. The response of the faculty was overwhelmingly positive to this project proposal as they were able to easily see the gaps and follow the rationale for a proposed solution that would be helpful in closing identified gaps.

Design Phase. The chief step in the design phase is to devise an instructional plan that specifically addresses the gaps outlined in the analysis phase. At Upstate the online curriculum was designed to address the 3 gaps in access, content, and learning assessment outlined above. In response to the gap in the content scope of the face-to-face curriculum the ABP blueprint document was used to define the scope for the new online core lecture curriculum. The ABP document, revised every 3 years, keeps up with the advances in medical knowledge and outlines the material that is covered by the annual certification examination, thus is useful in preparing instruction that readies residents for this exam.

A major decision during curriculum design for delivery with any type of media is to define the scope of the curriculum. Critical to these decisions is defining the boundaries of the core content knowledge that is required within a content domain. This is only possible in consultation with individuals who have sufficient domain expertise to make appropriate decisions as to what novices do and do not need to master within the specific domain. If the choices of what to study are left entirely to the novice scholarly research suggests that their learning will be less efficient and they will develop feelings of being overwhelmed by the volume of the material to cover (Leff, 2006). Thus the ABP was helpful in defining content updates to the lecture series.

Thus, Upstate's approach was to rely on an external source (ABP blueprint document) to define the boundaries of the overall curriculum. The project instructional designer partitioned the ABP document and distributed it to the various pediatric divisions with expertise to serve as the outline for the material that they were responsible for covering in the revised curriculum. This approach aborted any discussions/arguments that may have occurred between various stakeholders in regards to content ownership and facilitated the ultimate timely development of the curriculum material.

In order to address the accessibility gap the solution was to develop the new core curriculum for an online environment. By doing so the material would be accessible to learners anytime and anywhere. It is this accessibility that our learners cited as one of the most appealing aspects about the revised pediatric curriculum.

Finally, in addressing the 3rd gap, lack of learning objectives or measures of achievement, Upstate required each of the faculty to include specific learning objectives in their video presentation and 4-5 multiple choice questions that related specifically to those learning objectives and presented content. Each learning unit was designed with the same architecture of video lecture, followed by core reading material, and ending with self-

test of knowledge acquisition in the form of an online quiz. By requiring the faculty to develop these basic components for each learning unit the development of a more uniform core curriculum focused on the most important aspects of the key curricular topics was fostered.

Development Phase. The chief task of the development phase was to build the instructional materials that were designed in the previous phase. During development of the online curriculum there were two main tasks to achieve. First the 50 faculty members in the department of pediatrics were introduced to models and sample templates of curricular materials in the new instructional medium, BlackBoard. In order to accomplish this, prototype lectures were first prototyped and piloted tested with pediatric residents. Once the pilot series was developed and implemented residents were surveyed to determine their satisfaction with online pilot curriculum, which was overwhelmingly positive. This pilot study provided important feedback that was used to enhance the prototype prior to sharing with the faculty.

After testing the pilot series and obtaining positive feedback a faculty development workshop was scheduled that was dedicated to launching the project to create the online curriculum. During this 3-hour workshop the faculty were introduced to the pilot series and the user results. The response of the faculty to this workshop was quite positive and it proved to be an instrumental step in moving the entire development process forward.

The second step to the development phase was to partition the ABP blueprint document among the 19 divisions within the department of pediatrics. This task was led by the project instructional designer who is also a board certified pediatrician. Once this document was partitioned it was distributed to key faculty members within each division who served as section editors. These individuals partitioned their sections of the ABP blueprint document and distributed it among their individual faculty members to develop their lectures covering the content outlined in their portion

of this document. Each followed the guidelines provided during the faculty development workshop to revise or create their topic curricular materials, e.g., lectures, presentation, reading list, and assessment questions. Once topics were ready a technical development process was conducted to videotape and synchronize the lectures and presentation slides, upload all instructional materials, create online quizzes, and integrate the topic into the BlackBoard interface.

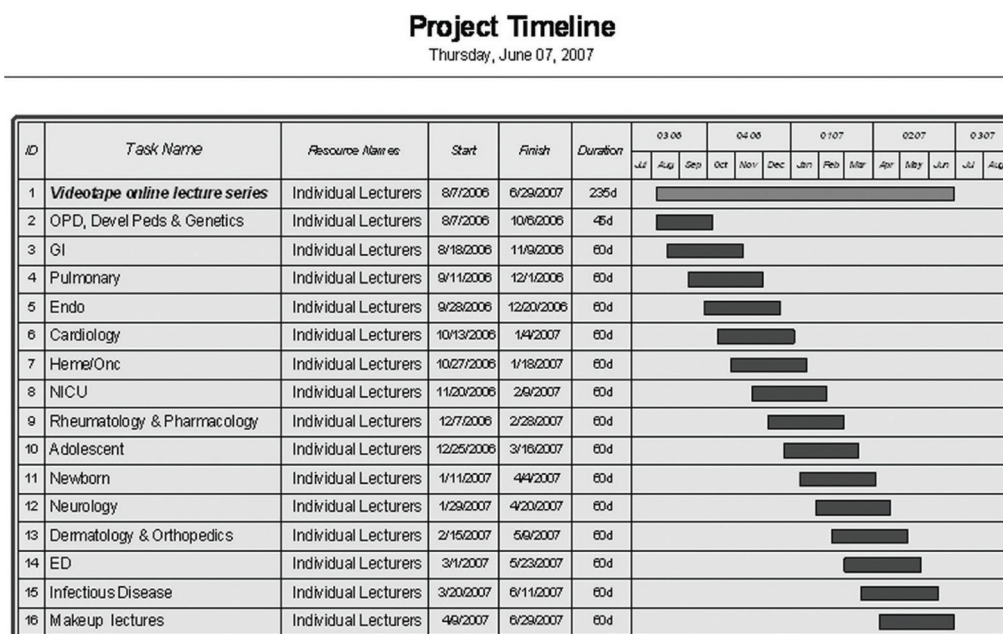
Implementation Phase. The chief step of this phase is to implement the educational materials that were developed in the previous step. At Upstate there were 3 main tasks required to implement the online curriculum. First, it was necessary to set up a project timeline to facilitate communication and logistical management among the 50 faculty members involved in the process of generating over 100 lectures. Project management is critical to using limited project resources in a timely manner, like technical development and support personnel and video editing suites. A commonly used project management tool, a

Gantt chart (see Figure 4.), was developed to show progress toward an agreed upon project timeline. This chart helped to facilitate the coordination of multiple aspects of a project within the timeline and greatly enhanced the communication process with the disparate faculty members involved in the project.

The 2nd step in the implementation phase was to verify that the technical infrastructure (e.g., BlackBoard, video taping and editing suites,) was adequately in place and set up to support the various aspects of constructing the online curriculum. This included obtaining the technology to create video lectures with coordinated PowerPoint slides that could be embedded in the CMS. It also meant designating an individual to serve as the central coordinator in the collection of articles & quiz questions for each of the 100+ lectures.

The 3rd step in the implementation phase was to set up a monitoring process for the learners' progress through the curriculum. Once an online curriculum is designed and developed the in-

Figure 4. Portion of the core curriculum revision project gantt chart



instructional designer must decide how to monitor learners' progress thorough the curriculum. This is largely automated when using a CMS such as BlackBoard. However, decisions on what benchmarks will be followed in order to document a student's completion of a curriculum must still be made. At Upstate the completion of the online quizzes was used as the marker of the learner's completion of an individual learning unit. Benchmarks for the expected number of completed learning units by the end of each year of training were identified, published, and distributed to the residents. One additional part of implementation is to test the instructional program and material before final release. This assures that the materials are accessible and working before the audience begins to engage in the instruction.

Evaluation Phase. The final step of the instructional development process is the evaluation phase. Two basic types of evaluation are common in such projects: process evaluation (formative) and outcome evaluation (summative). Process evaluation asks the questions, "is the project progressing according to plan and what enhancements need to be made before final release?" Outcome evaluation asks the question, "did the instruction address the gaps it was intended to at the outset?"

Process evaluation measures for this project included completion of the total number of lectures which have been placed into the CMS. Commitments were obtained from each of the divisions on the number of lectures that would be provided to cover their respective domains as outlined in the ABP blueprint document. As the curriculum has continued to be constructed over the past year it has been a simple matter of checking off each of the lectures from a master list once they have been completed and uploaded to the online course management system. At the time of this writing 90 of the final 130 lectures are complete and available to our learners through Blackboard.

One other measure examined as part of the formative evaluation was the results of a learner satisfaction survey. The two main areas of interest

were (i) information on overall user satisfaction with the online curriculum and (ii) suggestions that the users had for improving the curriculum. The level of satisfaction questions resulted in >90% of the survey respondents rating the pilot curriculum as outstanding or very good. Several minor suggestions for improvements were provided based on the two following open-ended questions:

- Please describe any technical difficulties that you experienced with the pilot phase of the online lecture series.
- Please suggest any changes to the online lecture series that you would like us to make.

Suggestions in response to these survey questions as well as direct personal feedback from participating residents were used to enhance the final version of the curriculum. Continued data collection of satisfaction with the online curriculum will be solicited and analyzed to continually upgrade the online curriculum throughout its life.

The final (summative) outcome measures were designed to gauge whether the online curriculum effectively addressed the gaps that it was designed to address. We queried:

- Comparison of the scope of the final curriculum to the ABP blueprint document (verifying the final curriculum covers the full scope of content as outlined by ABP)
- The overall use rates of the online curriculum by the residents to verify that we have adequately addressed the issue of accessibility.
- Review of uploaded curricular materials to verify that each learning unit has a statement of the objectives followed by a measurement of the achievement of those objectives

The preliminary results of the review of the scope of the online curriculum compared to the

ABP blueprint document reveal that of the nearly 90 lectures that have been developed to date, approximately 20% are entirely new lectures on material that was not previously covered in our face-to-face curriculum. This is a significant improvement over what our program was previously providing. When the curriculum is complete a final analysis will be performed to see if there are any significant gaps in the scope of content of the online curriculum compared to the ABP blueprint document.

The utilization rate that was expected of the residents and provided to them as a benchmark was a 50% completion by the end of the first year of the online curriculum. Our project team has been actively recording and posting the online lectures for the past 8 months so 90% of the curriculum was accessible. The overall use rate of the curriculum by the residents has been 40%. It is fully anticipated that the final use rate, after completing the first year of development, will meet the 50% threshold for the curriculum.

Finally, the online curriculum was reviewed to verify that each learning unit has learning objectives and accompanying measures of achievement. Nearly 100% of the posted curriculum complies with these criteria. Effective communications of requirements, sample templates, and review processes are credited with the nearly perfect compliance.

Thus, following a systematic process of instructional development, ADDIE, with accompanying project management checks and balances, professional development for faculty that provided rational for and clear steps toward curriculum re-form, technical support, and department buy-in led to the successful development of an enhanced pediatrics online curriculum. The learning and instructional design principles provided a framework that guided the construction of robust and effective instruction that seem to be well accepted by residents, the learners. Certainly enhancements will be necessary in the future as content revisions are suggested and new

technologies emerge. There is also a greater need now to develop a better understanding of what affects this new delivery mechanisms is having on resident learning and practice in the long-term and the relationships between online learning and board scores.

PLANS FOR THE FUTURE: ENHANCEMENTS, RESEARCH, CONCLUSIONS

In moving forward with this project it will be important to measure the future achievement of the learners exposed to this new curriculum on norm referenced examinations like the American Board of Pediatrics' certification examination. The 3 and 5 year running averages will be followed to see how the new online curriculum effectives the performance of the pediatric residents on exams. Other interesting future areas of investigation may be to examine the barriers and affordances that promote and interfere with the use of online curriculum by pediatric residents or the use of new technologies to make the learning engagement more portable and on-demand with new technologies like smartphones. This will be particularly important to examine, as it appears that E-learning and the use of new portable technologies will continue to grow in medical education. The needs of users will need to be clearly understood in order to avoid developing curricula that are ineffective and under utilized.

Following established instructional design processes and considering learning principles becomes even more important as education shifts away from face-to-face modes. This work for the Upstate Medical University pediatrics residency program was deemed successful based on it approach to transforming its classroom lecture series to online instruction using instructional design principles and process.

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KEY TERMS AND DEFINITIONS

American Board of Pediatrics (ABP): The governing agency that certifies pediatric practitioners within the United States of America. The certification process involves passing a norm-referenced examination upon completion of pediatric residency training.

American Board of Pediatrics Blueprint Document: This is a 212-page document that outlines the core content of the *American Board of Pediatrics* certification exam that is taken upon completion of pediatric residency training.

Core Curriculum: The core curriculum is the agreed upon scope of material that defines the significant knowledge that is contained within a domain like pediatrics. It encompasses what would be reasonably expected for a practicing pediatrician to know.

Course Management System (CMS): A packaged program that is used for creating, delivering, and managing online instruction. Often course management systems include menu and template based tools to help developers easily build content, communication, testing, and other types of screens that support teaching and learning. These systems often also include management functions that support assignment grading, monitoring learner access, and completing course evaluations. Examples of popular CMS include BlackBoard, WebCT, and ANGEL.

E-Learning: Also referred to as online learning, it is the use of internet technologies to deliver a broad array of educational materials.

Instructional Design: Phase with the instructional systems design process where instruction is planned that is designed to close an instructional gap based on learning theory and instructional design theory.

Instructional Development: Phase with the instructional systems design process where instructional materials and processes are built based on a blue print developed during a design phase.

Instructional Systems Design: Systematic process for designing and developing instruction. Generally includes analysis, design, development, implementation, and evaluation phases.

Interface Complexity: A term that describes the degree of complexity that a user encounters when engaged with a digital medium like a website. With increasing complexity of the interface of a webpage, for example, the user required to dedicate cognitive energy to learning the intricacies of the interface as opposed to the content that is contained within the website.

Chapter 4.16

A Collaborative Approach for Online Dementia Care Training

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INTRODUCTION

There are several reasons why university-based researchers and community groups may choose to collaborate together on research projects. Involving the end-users of the research data in the research process often motivates them to integrate the results into new policies, procedures, and education programs. Research outcomes therefore become more relevant to the community members than would be the case using a more traditionalistic approach to research (Morrison & Lilford, 2001; Patton 1997). Community-based partners fully immerse themselves in a collaborative research process as they strive to underpin their interventions with other complementary concepts

or evidence-based theories. They are then better positioned to promote social change.

Furthermore, collaborative projects provide an educational opportunity for partners to develop a collective consciousness in addressing the issues at hand (Gallagher, Easterling, & Lodwick, 2003; Karim, 2001; Minkler & Hancock, 2003). The problem is viewed from multiple perspectives as university-based researchers and community professionals contribute unique strengths and share research-related responsibilities within the social and cultural dynamics of the partnership (Gibbon, 2002). Simultaneously, university-based researchers are able to come to a better understanding of the community of interest and its changing realities. The cultural differences of both groups are acknowledged, and sensitive strategies can be collaboratively developed in which the roles

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and expectations are clearly outlined (Agency for Healthcare Research and Quality, 2003). Full advantage can be taken of the knowledge, experiences, and perspectives of professionals in the community as they provide input on all aspects of the research project. Thus, the research process becomes a collaborative, co-learning, community-building experience.

There are obvious benefits to working in collaboration. However, real collaboration takes time; time to engage in meetings, complete accountability processes, and resolve problems. The delicate balance between democracy and efficiency can be compromised when you have to choose between equal participation and looming deadlines (Stoecker, 2003). Weaver and Cousins (2004) described this dilemma as assessing manageability or having to make a choice between achieving complete diversity on the researcher-community team and the unwieldiness of working with a large committee. Compromise is often necessary.

This article describes our experiences using a collaborative approach involving university-based researchers and community professionals—in this case, long-term care (LTC) managers, administrators, and hospital-based educators and researchers—to create an online dementia care training program.

BACKGROUND

The Sisters of Charity of Ottawa Health Service (SCOHS) is a corporation with a teaching chronic care hospital and two LTC facilities. Community professionals at SCOHS recognized that their healthcare providers were facing challenging behaviours from persons suffering from dementia, which has been known to lead to staff burnout, distress, and high turnover rates. The community professionals felt that this problem could be partially ameliorated with staff education through e-learning. They contacted a professor in the Fac-

ulty of Education at the University of Ottawa who was conducting research on e-learning. Together, they agreed that conducting a project involving frontline workers in LTC facilities that addressed this issue would be mutually beneficial. Additional experts were recruited to join the project, including psychologists as content experts, e-learning course developers and pedagogy experts, and evaluators experienced in online course evaluation. Six pilot LTC facilities were identified, and representatives from each facility were included in the research team.

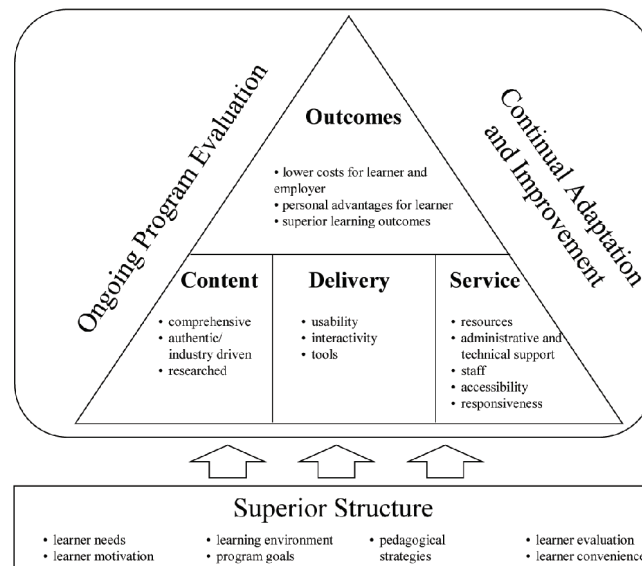
THE ONLINE DEMENTIA CARE TRAINING PROJECT

The research group used the Demand-Driven Learning Model (DDLM) (MacDonald, Stodel, Farres, Breithaupt, & Gabriel, 2001, see Figure 1) to guide the design, development, delivery, and evaluation of the bilingual dementia care training program. The program was targeted towards frontline healthcare providers (registered and nonregistered) who care for persons experiencing dementia in LTC facilities.

Conducting the Needs Assessment

As advocated in the DDLM, the first step of the project involved identifying the needs of the learners. The university-based researchers conducted three in-depth focus group interviews with seven healthcare providers (prospective learners) and two site coordinators who would serve as the on-site support persons for the learners during the implementation of the program. Through the needs analysis process, community-based stakeholders were able to provide input regarding the design, development, and delivery of the dementia care training program. The results of the needs analysis are published elsewhere (MacDonald, Stodel, & Coulson, 2004).

Figure 1. The demand-driven learning model (MacDonald, Stodel, Farres, Breithaupt, & Gabriel, 2001)



Designing and Developing the Program

The course facilitator, a content expert and psychogeriatric nurse with no e-learning experience, was responsible for putting together the first draft of the program content and learning activities. To ensure the content was authentic to the community experience, as recommended by the DDLM, the course facilitator drew on her experiences working with frontline personnel who provide care to individuals with dementia. Once she developed the content, the pedagogy team reworked it into an appropriate format for e-learning. This was a time-consuming process, but one the academics felt strongly about as they were concerned with respecting online pedagogical principles and the quality of the online course design.

The pedagogy team encountered competing tensions as they developed the content using a collaborative approach. Ensuring the content was comprehensive, another DDLM component, was difficult to achieve due to time limitations. The content had to be chunked into sections that could be completed in 30-minute learning sessions,

which limited the amount of content that could be included. Thus, content experts were advocating for the inclusion of a wide range of content, while other stakeholders wanted to reduce the amount of content, as they were aware of the limited time the learners would have to engage in the program.

Other issues related to time also affected the collaborative process. The pedagogy team had limited time to develop the content and adapt it to an online format, due to deadlines imposed by the funding agency and delays in hiring qualified project staff. Once the content was approved, it was given to the instructional designer to be put online. The instructional designer developed the online program using WebCT, the online course management system adopted by the University of Ottawa. However, the pedagogy team quickly realized that, while having many advantages, this system limited certain aspects of course design and evaluation. Time constraints and the initial decision to work with the University of Ottawa's Centre for E-Learning prevented the research team from exploring alternatives to WebCT.

The instructional designer questioned the efficiency of the collaborative process adopted in

this project. He felt there were too many people trying to reach consensus. He postulated the lack of efficiency was because “the roles of the people involved were not well-defined.” Similarly, not all stakeholders felt they were heard when they contributed expertise. One team member stressed that learners must be honestly informed about the time commitment required to participate in this project, prior to their consent and participation. Another found the program hard to navigate, and suggested changes be made in the online layout. However, despite these warnings, neither the amount of content was reduced to meet the learners’ expectations and needs, nor the navigation improved before the program was offered, and both were identified as weaknesses of the program in the evaluation (MacDonald, Stodel, & Casimiro, 2006). These changes did not occur due to time constraints and/or lack of project ownership. Compromise, rather than consensus, became the decision method of choice, especially as the deadlines loomed closer.

A significant factor in the lack of project ownership was that the principal investigator had to leave the project suddenly at the beginning of the production phase. This temporarily compromised the project’s leadership. Leadership is necessary for the smooth running of a project. This leader should bring expertise in optimizing group functioning, such as defining roles and orienting the group towards action. This person should also ensure equality among members and aim for consensus.

Delivering the Program

The completed program was delivered to 95 learners at six sites in three provinces across Canada. Forty-nine (52%) enrolled in the French language program, and 46 (48%) enrolled in the English language program. Learners were expected to spend two hours each week, at their convenience, reading the content and completing the learning activities and evaluations. Each site

had a coordinator whose role was to support the learners in their learning and with the technology. These site coordinators were an integral part of the pedagogy team.

Throughout the delivery of the program, the site coordinators met with the pedagogy team for 30 minutes each week via teleconference. These meetings enabled site coordinators to keep track of the timelines set out for the learners, and allowed them to provide feedback to the pedagogy team regarding the learners’ experiences and progress with the program. These meetings were instrumental to the success of the program. Because of the regular feedback from the site coordinators, the pedagogy team was able to address problems and concerns that arose in an expedient fashion. For example, when it became apparent that the program required significantly more than two hours a week to complete, and that some of the learners felt frustrated and overwhelmed, the pedagogy team promptly adapted the program by reducing the number of required exercises and extending the deadlines to complete the program. A number of site coordinators attested that the learners immediately felt less pressure once the amount of work was reduced.

Evaluating the Program

One of the reasons the community created a partnership with academics was to help develop strategies for evaluating the program. The university-based researchers had specific knowledge of evaluation and online data collection procedures. Using the DDLM evaluation tool (MacDonald, Breithaupt, Stodel, Farres, & Gabriel, 2002) as a guide, they drafted the evaluation instruments and invited the pedagogy team to provide input. As a result, survey questions were added, deleted, or modified. This collaborative process resulted in the development of relevant evaluation tools tailored to the needs of learners in LTC facilities. Further, the evaluation team conducted in-depth semistructured interviews in order to obtain a rich

description of the stakeholders' experiences with the program, specifically in terms of the DDLM components. Interviews were conducted with ten learners, all six site coordinators, the course facilitator, and the instructional designer. Knowing the importance of management buy-in for this program to be viable in the future, the pedagogy team also interviewed the higher management of the six LTC facilities to gather their impressions of the value of the program for their organizations.

The evaluation team conducted, transcribed, and analyzed all the interviews, compiled and analyzed both the quantitative and qualitative data (French and English), and wrote the final report (MacDonald & Stodel, 2004). The evaluation continued to be a collaborative process as both community professionals and university-based researchers were part of the evaluation team. Moreover, the evaluation team received input from the pedagogy team. This decision making process worked well; the group weighed the importance of outcomes relevant for the learners' practice—a reality best understood by the community—against the outcomes related to the e-learning experience—a reality best understood by the university-based researchers.

Disseminating Findings

The university-based researchers took the lead role in the dissemination activities. However, input received from community members was critical to ensure the quality and relevance of the final products. Input from community members allowed the university-based researchers to create a PowerPoint presentation and two professional posters comprising an overview of the project and its findings that could be used by the community to share details of the project at conferences or in their local healthcare communities. While these individuals may not have had the time or the interest to prepare the presentation material, they were able to actively participate in the dissemination process by using materials created by

the university-based researchers. This highlights another benefit of taking a collaborative approach.

Writing this article involved a collaborative effort between three university-based researchers and one community member. The collaborative approach added to the amount of time necessary to complete the manuscript, yet it added to the quality and accuracy of the article on several fronts. First, both the university- and community-based members' perspectives were reflected. Second, perceptions of the process of running the project were shared and elaborated. Lastly, the workload was shared between the authors. In the end, the process of collaborating in the publication process was a positive experience in which co-learning took place, and a stronger article resulted.

FUTURE TRENDS

The implications and lessons learned from this research are important to consider when conducting future research in this area. Although several of the community members were experienced at and capable of conducting research and disseminating the findings without the assistance of the university-based researchers, they felt a partnership with academics would strengthen their research position in the field of e-learning, and they would gain information on quality e-learning design. In turn, the academics wished to apply their knowledge to the healthcare field, but lacked the intimate knowledge of this group of learners. Consequently, they benefited from the input of the community members and gained valuable knowledge of the content area (dementia care) and healthcare culture. Even though the university-based researchers had much to gain from the partnership, this project was instigated and led by members of the community.

Our experience suggests that taking a collaborative research approach significantly increases the amount of time required to complete a project, though the research team felt it was a worthwhile

trade-off, given the contributions made by each member. We acknowledge that failure, at times, to reach consensus and the pressure of timelines to complete this project by a specific date compromised the quality of the design. From an e-learning perspective, it is critical that the content be developed early in the process. A common fallacy is that once the content is developed, it can be put online quickly.

Stoecker (2003) suggested that it is an unrealistic expectation that those involved in a collaborative project be equal partners in all aspects of the process. His claim appears to be grounded in concerns for the time demands on community members. Indeed, as Israel, Schulz, Parker, Becker, Allen, and Guzman (2003) have suggested, efforts were made to involve community members in the publications resulting from the research process, but few had the time to do so. Sullivan, Chao, Allen, Koné, Pierre-Louie, and Krieger (2003) recommended that communities receive concrete benefits in return for their involvement in research partnerships, noting that without such tangible benefits, the partnership may not be advantageous to the community.

We also realized how important communication is to successful collaboration. Working in a large team means that many relationships need to be developed and maintained. In this project, constructive criticism about the program was sometimes taken as a personal affront by the individual responsible for that aspect of the program, and hard feelings resulted. This point becomes even more poignant when communication between members is conducted via e-mail where tone, emotion, and other nonverbal cues are lost. In the case of this project, misunderstandings in communication caused some minor conflicts, but effective communication also allowed the rifts to be resolved.

Clarification of members' roles at the beginning of the project is also critical. In writing this article, it emerged that the evaluation team was

ill-defined; each of us had a different view of whom the evaluation team comprised. Further, one of the pedagogy team members who had experience in online pedagogy and e-learning applications in healthcare felt that her expertise was not used as much as it could have been. Not only was this a frustrating experience for her, but she also predicted many of the problems reported during program delivery.

In the end, the project resulted in an educational opportunity for all involved (Minkler & Hancock, 2003). The community of program personnel succeeded in offering a generally well received e-learning program to help healthcare providers manage persons with dementia. They also enhanced their skills for designing, developing, delivering, and evaluating a successful e-learning program by using the DDLM. The university-based researchers learned more about healthcare in general, and dementia care specifically, obtained further appreciation for healthcare providers' needs for learning online, and became aware of the values and complexities of collaboration. Further, the university-based researchers also profited by gaining access to data for research purposes.

CONCLUSION

In sum, the adoption of a collaborative research approach with a community of professionals is not only beneficial but also desirable. Collaboration allowed multiple views, attitudes, and experiences to strengthen the program. By describing the complexities involved in this process, we reveal both the challenges and achievements inherent in designing a quality online learning event through collaboration. Moreover, by addressing some of the details involved in this process, we hope that our experiences help others plan collaborative partnerships with community professionals, and develop collaborative e-learning programs for healthcare providers.

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KEY TERMS AND DEFINITIONS

Collaborative Research Approach: A research approach that uses the strengths of both researchers and community-based practitioners to increase the quality of the research process and the impact of the research outcomes.

Demand-Driven Learning Model: An e-learning model that is grounded within a constructivist framework and defined by five interrelated dimensions that, in concert, create a high-quality e-learning experience: superior structure; three consumer demands of content, delivery, and service; and learner outcomes.

E-Learning: Learning that takes place via the Internet.

Long-Term Care Facility: A licensed residence for individuals who require personal support and nursing care, and who cannot remain in their family home, because support at home (from family or agencies) is insufficient or unavailable. While funding sources may differ, LTC facilities and nursing homes can be categorized together under this definition.

Instructional Designer: Person who uses technology (media) to design optimised learning events. Instructional design is historically grounded in cognitive and behavioural psychology.

Pedagogy: The profession, art, science, theory, principles, or methods of education, instruction, and teaching.

Psychogeriatric Nurse: A nurse whose practice is focused on older people (usually 65 years of age or older) with mental illness and/or cognitive impairment.

Web Course Tools (WebCT): An e-learning platform and online course management system used extensively in colleges, universities, and other educational institutions. WebCT supports online tools such as discussion forums, e-mail, live chat, and whiteboarding, as well as content in various formats (e.g., html documents, Web pages, and so on). WebCT recently merged with Blackboard, another leading provider of educational software.

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Chapter 4.17

Gaming and Simulation: Training, and the Military

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ABSTRACT

The purpose of this chapter is to provide a brief summary of the military's use of gaming and simulation to accomplish training. Historically, the military has been a forerunner in the exploration of training techniques that incorporate aspects of games and simulations. Training tools emerge in various gaming formats such as simulations, edutainment, commercial-off-the-shelf games (COTS), and serious games. To develop training in the form of games or simulations, elements of instructional design must be considered to include learning objectives, game play, and feedback. Emerging technologies provide possible solutions to training challenges such as achieving affective

learning domain objectives and the portability of training. The military, as an early adapter of games and simulation, continues to forge the way by integrating gaming and simulation, instructional design, and emerging technologies to achieve the ever growing demands of training.

INTRODUCTION

Gaming and the military have a long tradition together, beginning with the use of toy figures within sandbox representations, progressing to complex board games requiring complex analytical skills, and evolving into current use of sophisticated computer models, gaming engines, and high definition 3-D graphics to create virtual worlds of combat. The military has historically

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used technology to “maximize the efficiency and effectiveness of all their activities, training and education.” (Fletcher, 2009, p. 72). Current training tools include a wide range of application of technologies. Simulators, sophisticated machines relying on computational models to mimic the actual experience of soldiers, assist to train in various tasks such as driving a truck, steering a ship, flying an airplane, or shooting a weapon. Games are created to encourage thought and practice in decision making from simple tasks to more complex work of war planning. When simulation is combined with elements of gaming, opportunities emerge to encourage effective training with the unique audience of learners found in the military.

The military considers each member a life-long learner. This core principle presents many challenges to the development of training and becomes accentuated in the development of games and simulations. Specifically is the challenge of reaching today’s military audience of Soldiers, Sailors, Marines, and Airmen; mostly made up of young adult males. (Watkins & Sherk, 2008). They are members of what is known as the Net Gen, the generation cohort who came of age with the evolution of the internet and exponential growth of technology’s role in society. For this military audience, “Learning is participatory; knowing depends on practice and participation. Digital resources enable experiential learning—something in tune with Net Gen preferences. Rather than being told, Net Geners would rather construct their own learning, assembling information, tools, and frameworks from a variety of sources.” (Oblinger & Oblinger, 2005). The military has responded with various methodologies to include games and simulations, serious games, commercial-off-the-shelf (COTS) computer games, and Massive Multiplayer Online Games (MMOG). This chapter discusses the success and challenges of these methodologies, identifies critical aspects of instructional design when developing games for military training, and suggests emerging technologies be examined as new methodologies in the military training field.

History of Gaming in the Military

Roberts (1976) noted that gaming as training was “often used to train military officers” (p. 3). Games found in the military took many forms and emerged as effective methods for training. Chessboards acted as terrain maps and chessmen as soldiers. Sand tables with miniature models to represent armies gave leaders the ability to visualize battles and play out possible scenarios. The Prussians instituted the practice of wargaming around 1824, with the American military adapting wargaming for training later that century. William McCarty Little admired the value of wargaming and ensured that it became a significant part of the curriculum at the newly established U.S. Naval War College in Rhode Island. (Gray, 1995).

Eventually, terrain maps and wooden blocks replaced chessboards and chessmen as civilization progressed. By World War II, wargaming marked an immense turning point for training and development. War games were something used by all super powers (Roberts). The simulation that occurred during the game process was treated as a training technique and evolved into paper based exercises that integrated mathematical algorithms to model elements of warfare such as movement and attrition (Smith, n.d.).

During the 1950’s the Rand Corporation used ideas that emerged during the evolution of simulation training and war gaming to create a board game. Building upon their research and the ideas of Clark Roberts, the project resulted in:

“the formalization of the playing board with a gridded overlay to manage movement and engagements; the use of a Combat Results Table to formalize the results of the battle; the incorporation of terrain types that influence combat activities; a turn-based play mechanism; and the use of dice to add random outcomes to the battle” (Smith, n.d.).

With the onset of the computer age, the abilities of wargaming as training grew exponentially.

A presentation by Hilton G. Weiner at the 35th National Meeting of the Operations Research Society of America in 1969 (Weiner, 1969), examined the trends of the time in regards to military gaming. He likened the games with “confrontational analysis” (p. 1) and identified the ability of computers to advance the technique. Specifically, he noted that computers allowed greater detail in simulation and provided accelerated bookkeeping skills. These advancements furthered abilities of time-sharing, multi-agency and standardization. However, he felt that while phenomena of warfare such as machines and munitions could be captured in the war games, much work was needed to capture the other phenomena of motivation, morale, and miscalculation (p. 5). He called for further research in the improvement of understanding the phenomena and increasing the ability to model them.

The use of wargaming in training continued to evolve throughout the 1970s and at the beginning of the 1980’s, an emphasis was placed on combining the best features of war gaming and analytic modeling to build strategic analysis for existing threats of nuclear warfare. Building upon RAND’s expertise in these areas, the US Defense Department supported the efforts of the Rand Strategy Assessment Center (RASC) which guided much of the research and advancement in the area of training and war gaming throughout the decade. (Davis & Winnefeld, 1983). Davis (1986) called for the need to create computer programs that were transparent yet able to explain the decision that occurred during the simulations of wargaming. While much advancement was made with the now familiar Red and Blue Agents programs (Schwabe & Wilson, 1990), the end of the decade and the Cold War would bring new demands to the field.

Throughout the 1990’s, investigators of wargaming as a training technique recognized in numerous studies the need to advance the models driving the artificial intelligence with the computer programs and increase the ability to share data across those institutions engaged in the field.

(Bennett, 1993, Hillestad, Bennett, & Moore, 1996, and Davis, Bigelow, & McEver 2001). As mentioned by Bankes (1991), many of the models did not adequately reflect the new requirements of warfare, a shift from the force on force of the Cold War to more of contingency based operations known as Military Operations Other Than War (MOOTW) (Joint Publication 3-07, 1995). Yet, the focus of wargaming as a training technique remained that of increasing understanding as opposed to outcome based performance, i.e. winning the war. (Schwabe, 1994).

Today, games and simulations function as military recruiting tools (Zyda, 2005), educational learning tools (Gredler, 2004; Gee 2003), and corporate training tools to foster learning in professional, corporate, or adult education. As for the military specifically, games and simulations are teaching tools at all levels of education (Babus, Hodges, & Kjonnerod, 1997). Collective and individual training designs benefit from the critical thinking and flexibility encouraged by games and simulations. These learning tools address many objectives: rehearsing behaviors, teaching skills to troops, and assisting policy makers in evaluating, identifying, and improving protocol.

Current regulations within the military identify distributed learning as a key to facilitating continuing education programs (AR 370-1, 2007). Included within distributed learning are various forms of gaming and simulation described as interactive multimedia instruction, computer aided instruction, simulation, and interactive training technology (including stand-alone and on-line games.) Training commands are encouraged to leverage “distributed-learning concepts, when cost efficient and effective training will result.” (p.15)

The military possesses a rich history of training and education to draw upon as it continues to develop and implement games and simulations as viable training tools. Central to this effort is the ability to consider the learner, more specifically the range of learners that exist in the military, when designing games and simulations for training.

As noted by Klopfer, Osterweil, & Salen (2009): “Lastly, it is important to acknowledge that games and learning has a history that predates the advent of modern video games... This history has taught us several important things, not the least of which is that players determine how they learn.” (p.8).

Range of Gaming within Training

The study of gaming within the military is somewhat confounded by the wide range of definitions that exist to explain what is and is not considered a game. As noted by Klopfer, Osterweil, and Salen (2009), “...perceptions of what games are (are or aren’t) continue to cast a heavy shadow over the games and learning space.” (p.7). The range of games considered for training, to include occurrences within the military, are games, simulations, serious games, COTS games, and massive multiplayer online games (MMOGs). Perhaps the best approach in examining games within military training is suggested by Caspian Learning (2008), “...it is more useful to look at the general literature placing these terms in their cultural context.” (p. 14).

Games and Simulations

Games and simulations have unique characteristics that differentiate them from each other (Kirkley & Kirkley, 2004; Prensky, 2001; Ricci, Salas, & Cannon-Bowers, 1996). Games are defined by Gredler (2004) as “competitive exercises in which the objective is to win and players must apply subject matter or other relevant knowledge” (p. 571). Simulations conversely are “open-ended evolving situations with many interacting variables” (p. 571). Understanding games paves the pathway for recognizing the structures, standards, and techniques found in simulations (Aldrich, 2004). Mike Zyda, a professor of gaming at the University of Southern California and a key contributor to the successful game, *America’s Army*, explains that, “The definition of games is story, art and

software.” (Federation of American Scientists, 2006; Zyda, 2005). The primary difference, when considering military applications, may be found in the purpose or application of the game.

While it is important to understand that games and simulations differ in many aspects; they often share an important commonality. Each works to foster experiential learning (Gredler, 1996). Within this model of learning, elements such as reflection and debriefing are significant (Thatcher, 1990; Kriz, 2003). If the context of the game or simulation is primarily to construct a story whose intent for learning is to encourage game play for entertainment, it remains a game albeit with learning requirements. The game may employ experiential learning as an element, perhaps a motivator. However, the game would not be classified as an “instructional game”. According to Tennyson and Jorczak (2009), “Instructional games have specific learning outcomes as primary goals.” (p. 5).

A helpful comparison of games and simulation within the military is found with *America’s Army* and *DARWARS Ambush*. *America’s Army* is a game that was developed specifically for the purpose of recruiting new soldiers by the U.S. Army. The game takes the form of a first person shooting perspective and role plays the life of a soldier. While some military units have used the game for training, its primary purpose and design is to attract young men who enjoy gaming and may gain an interest in the U.S. Army while playing. *DARWARS Ambush* is a simulation game that simulates a vehicular movement (patrol) within a combat environment. The purpose of simulation is to train multiple people within an immersive environment how to react to possible ambushes when part of a vehicular patrol. While *DARWARS Ambush* evolved from a stand-alone, single player simulation to the current version of an immersive environment that changes based on lessons from the actual combat environment and involves multiple players, its primary training purpose persists.

The military's success with games and simulations may be found in the wide variety and continuous adaptations that are applied as training needs increase and diversify. At the National Defense University, gaming and simulation have been combined to create learning environments which foster analytic skills and enable the process of concept validation leading to doctrine development. (Joint Forces Quarterly, 2009). To do so, one must consider that, "useful analytical environment in which to identify and weigh policy options and needs is the goal of good game design. (McCown, 2005). Flexibility and adaptability can be found in projects such as the development of various leadership games noted in the work of Iuppa and Borst (2007). During these projects, developers experimented with the balance of computer modeling for simulation and the interplay of human actors with virtual avatars to achieve training objectives. Over time, they found what worked and did not work was based on its appropriateness toward implementing the training objective.

Challenges with games and simulations are most exemplified in selection of the appropriate instructional delivery to meet the training objective. Choosing an advanced technological tool simply because it is available does not guarantee effective training. Investigations into simulators (computer generated environments to replicate the actual skill which the learner must perform) supports this; as Yardley (2003) states that in training, one must consider if the technology is, "... appropriate for increasing the use of simulation and strategies for purchasing and implementing simulators." This finding emerged as he studied the Navy's desire to balance training which normally occurred at sea with the possibilities of what could be done while ships are in port.

DARWARS and America's Army are motivating examples of the diverse goals which can be achieved through games and simulation. The military continues to lead the way in developing the possibilities both within training goals and

outside of the goals, such as analytical analysis, recruiting, and doctrine development. However, more research is needed to determine what learning outcomes can be systematically achieved by the use of individual and multiplayer games to train adult participants in acquiring knowledge and skills while sustaining the ability of games to provide intense and engaging experiences (O'Neil & Perez, 2009).

Serious Games

When applied in a non-entertainment realm, gaming and simulation technology results in serious games (Zyda, 2005). According to Susi, Johansson, and Backlund (2007), the term serious games have been defined, but no true definition of what it actually is exists. Taken as a whole, Susi, Johansson, and Backlund's (2007) interpretation of serious games from present research is defined as "digital games used for purposes other than mere entertainment" (p. 2). Serious games emerged from research within the military training field. Observing great potential for other occupational training, the Woodrow Wilson Foundation funded the Serious Games Initiative (www.seriousgames.com). Serious Games "...are characterized by their specificity and applicability for particular work-related purposes." (Klopfer, Osterweil, & Salen, 2009, p.21).

The 1980's decade marked the time when serious games, which often take the form of simulations and games in electronic formats, were used throughout the military (BinSubaih, Maddock & Romano, 2009). As described earlier, these electronic wargaming formats would use computer modeling and data capabilities to create simulation centers where soldiers would gather to analyze and fight wars against the computer. The goal was a performance oriented outcome where the decisions were analyzed and evaluated rather than simply trying to "beat" the computer. As computing ability grew, so did the complex-

ity and effectiveness of these serious games to achieve training.

Not until 2002 were serious games recognized by other organizations. The Serious Games Initiative furthered interest in serious games beyond the military. This form of gaming was distinguished by its purpose “to train people for tasks in particular job”. (Klopfer, Osterweil, & Salen, 2009) The serious game industry, described as flexible and adaptable, has developed into a \$20 million dollar market (Van Eck, 2006). The military invests most heavily in the serious games market. (BinSubaih, Maddock & Romano, 2009).

Serious games cover a wide range of training opportunities for the military. These include: tactical experience, ambush, rifle range, foreign language and culture, leadership, post traumatic stress disorder and obstacle courses (BinSubaih, Maddock & Romano, 2009). Sawyer and Smith (2008) created a taxonomy to capture the range and application of current serious games development efforts. Within the taxonomy, military training is identified as “defense” and examples such as games for health (rehabilitation and wellness) and games for training (soldier support) are recognized.

One example of a serious game endeavor by the military that models the type of electronic games commercial and civilian entities are interested in is that of games developed for dismounted infantry leaders. (Beal, 2006). The project included three games to teach leadership skills at different organizational levels experienced by infantry leaders. Successes of these serious games included the ability to represent realism and fidelity to the actual combat environment due in large part to the involvement of subject matter experts early on and throughout the development of the games. The learners also valued the opportunity to learn desired leadership skills; the findings found this factor to be more important than ensuring the games were fun and entertaining.

Challenges in implementing these serious games involved capturing feedback for a high level of required cognitive skills in an artificial

intelligence model. The participants expressed the need for feedback from a human instructor vital to their learning. Continuing to improve models and consolidative representation, especially in such a dynamic combat situation, is one goal of the Modeling and Simulation Center Information Analysis Center (Henninger, 2009).

Also of interest was the finding that although the participants were of the digital native generation, not all found the technology to be intuitive or familiar. (Beal, 2006). Ensuring a serious game is navigable without interfering with learning is an important task of the developer. As pointed out throughout this chapter, stating clear training objectives for the games was critical.

Given the high cost of creating in-person training to address the skills at the center of serious games objectives, makes this genre of game a center piece for further research and investigation. As computing ability allows the fidelity of the experience to increase, it cannot be considered a panacea for all training. However, its effectiveness and potential justify development to continue, especially as training budgets are high visible targets both in military and corporate budget scenarios. The military’s contribution to serious games is significant; yet the influence of the military within body of research for serious games and training must be acknowledged and addressed. National education and workforce development goals may differ, generating more varied requirements from research. (Federation of American Scientists, 2006).

Commercial-Off-The-Shelf (COTS) Games

Current markets of COTS games include a plethora of titles that carry a military theme. A small sample of these games include: *Call of Duty*, *Close Combat: First to Fight*, and *Full Spectrum Warrior*. Because these titles are COTS, it is safe to assume the primary purpose of their development was not training but rather entertainment. However,

the military's National Simulation Center at Fort Leavenworth, Kansas, endorses the use of these games as training tools, validating their potential in preparing soldiers for combat situations. In their publication, *Commander's Guide to Games for Training*, (2006), it is noted, "Games can provide an alternative training environment at a lower cost. The tradeoff is a reduction in fidelity." (p.5).

The success of COTS development can be partially attributed to the investment of the entertainment industry in the wargame genre. As noted by Macedonia (2000), "The military cannot afford to ignore advances in industry, where the graphics systems for game consoles and personal computers have nearly doubled their performance every nine months for the last five years." While the fidelity, which is the ability of training to recreate the actual environment where the task must be performed such as the war zone for the military, is decreased by moving from a realistic environment to a virtual world, the savings in terms of both fiscal and time cannot be ignored.

Another element contributing to the success of COTS in military training is that of providing a training environment familiar to the target audience. (Ford, Barlow & Lewis, n.d.). Many soldiers today grew up alongside the internet and are quite comfortable using the technology for the purpose of learning. COTS provide a motivating environment through its natural design of engagement. If soldiers are aware of the training purposes with COTS, they may overcome the outcome based orientation (play to win) and focus on the feedback given by the game to grow in understanding of their personal skill development.

The primary challenge in using COTS as a training tool is achieving the goals of training. "COTS gaming systems do not generally have the assessment components that are critical for effective training." Hussain and Ferguson, (2005). This finding is shared by O'Neill and Perez (2009), "There is general consensus in our community that learning with interactive environments, such as games and simulations, is not effective when

no effective instructional measure or support is added." The communities these authors refer to are the developers of games and simulation for training and adult education purposes. While few would dispute that learning occurs while gaming, the challenge for adapting COTS for military training is in achieving the specificity of the learning goal and the requirement to measure training effects to justify critical resources. Other challenges such as licensing fees and use of appropriate technologies to achieve training also exist.

To balance the evident worthiness of COTS for training with the need to ensure the targeted learning is achieved within training, it would be helpful for future training developers to provide policy and guidelines in this area, "Subject to the evaluation and trialing of games, the policies and practices for the effective use of games must be produced." (Ford, Barlow & Lewis, n.d.)

Massive Multiplayer Online Games (MMOGs)

Massive multiplayer online games (MMOGs) are another type of gaming medium the military is exploring. MMOGs offer collaboration and sharing of knowledge, skills, and values with other players both inside and outside of the game (Gee, 2003). MMOGs encourage individuals to think as a team and "make soldiers to think critically about their surroundings and enhance their situational awareness" (Curtis, Thomas & Ritter, 2008).

In their attempt to create elements of military training that address changing tactics of asymmetric threats, Fu and et.al (2007) investigated the use of MMOGs in developing and distributing training demonstrations. While training demonstrations exist in many forms to address different objectives, Fu, et.al, focused on 2-D animated representations with the intent to achieve procedural knowledge objectives. They used MMOG in the development of the demonstration, seeking synchronous feedback from soldiers currently implementing tactics in the war zone who pro-

vided current and relative data. The format of a 2-D animated representation provided a familiar training format for the target audience of soldiers. While the training demonstration did not attempt to achieve all training requirements, it proved worthy of development to provide one type of training tool within a toolkit of training sources.

Challenges with MMOGs and use in military training include security, cost, synchronous participation and connectivity of the technology. Because applications of MMOGs involve real time interactions between avatars driven by actual soldiers, knowledge exchanged should be shielded from possible enemy actors. This requires similar security measures used with existing military networks; the unique requirement of 2-D virtual world representations further implicates current challenges in this area. (Axe, 2008). While significant cost savings can be realized with MMOGs by reducing the logistical requirements of bringing soldiers and equipment together to train, the cost to develop realistic virtual representations must be carefully managed. The success of using MMOGs in the development of the training demonstration relied on synchronous participation of soldiers. Saving logistical costs in moving soldiers to a central place to train and away from the war zone is one advantage of MMOGs application; however, bandwidth and connectivity have persisted throughout the current decade as challenges for the military. The advantage of MMOGs may be lost to the lack of connectivity and bandwidth required.

Despite these challenges, the benefits of MMOGs and the possibilities in developing future training remain worthwhile. As noted in a research study of wargaming and distributed learning (Van der Hulst, Muller, & Roos, 2008), "...decision making can only be mastered by repeating the task as many times as possible in a controlled yet relevant reality, combined with intensive reflection upon one's own performance." MMOGs demonstrate promise in providing training avenues of relevant reality and the ability to access reflection and feedback.

Key Factors when Implementing Games as Training

Objectives

The first task in designing games for training is to ask, "What task(s) do I want the learner to perform after completing this training?" This is especially relevant for military training: "Clearly defined training objectives are critical to training effectiveness. Training game developers should define specific training objectives before software development begins." (Beal, 2006).

In their study of military training, Fletcher and Chatalier (2000) clarify the role of objectives:

"Training objectives are most often expressed in terms of what students can do (skills), what they must know (knowledge), and/or the attitudes they must possess after they finish the instruction. In training, the objectives can be derived directly from the skills and knowledge required to perform a job. In the absence of these objectives, relevant, systematic design, development, implementation, and evaluation of the instruction is unlikely". (p.14).

By nature, objectives must be measurable. Within a gaming context, determining if low level cognitive skills such as knowledge or comprehension are achieved is a simple task. Multiple gaming elements have been created to move game play along by requiring the measurement of learning and provide designers many options. While developed for game play, these elements prove useful in evaluating learning. Simulation training designers have developed strategies allowing the measurement of higher level cognitive skills such as analysis and synthesis.

However, measuring affective skills such as motivation and attitudinal change is much more difficult. One strategy is to integrate decision points within the training and record the action of the learner. Choices are aligned to objectives and measure whether the desired outcome is met. Yet, this is only one strategy; if more games are

to be developed for training purposes, designers will need multiple approaches to achieve any affective behavioral goals. Writing measurable, sound objectives to attain affective performance learning goals continues to be a significant factor to creating successful training tools.

Game Play

A key characteristic of games is often referred to as “game play”. Rollings and Adams (2003) define game play as, “one or more causally linked series of challenges in a simulated environment.” Associated with this description are terms such as: competition, story, and reward. Game play provides a strong link between games and learning. “The promise of games is that we can harness the spirit of play to enable players to build new cognitive structures and ideas of substance.” (Klopfer, Osterweil,& Salen, 2009).

Yet, the goal to build cognitive structures is not always the game developer’s goal. This is where design goals for games that are to be used in military training differ from those of commercial game developers. Commercial games are primarily concerned with game play and interweave learning and game play to motivate the user to continue. A fine balance between failure, which is expected, and advancing forward, which is desired, is often described as key to a successful commercial game:

“The secret of a videogame as a teaching machine isn’t its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the player’s abilities, seeking at every point to be hard enough to be just doable. In cognitive science, this is referred to as the regime of competence principle, which results in a feeling of simultaneous pleasure and frustration--a sensation as familiar to gamers as sore thumbs.” Gee (2008, p.67).

Games designed for military training may engage in the interweaving of learning and game play, however, the primary purpose of training drives design not game play. As mentioned with

serious games, most applications of games and simulations within the military motivate the user by providing the expected training within the experience of playing the game. While studying cadets who played a COTS game for training purposes, researchers reported that, “We found that leaders who are serious about using games for training want to use them to learn leader tasks and skills; they are less motivated to use them for fun.” (Beal, 2006, p.8).

The challenge for developers of military training games becomes in implementing game play within instructional design of a game whose purpose is training. If successfully accomplished, this can increase learner motivation with a positive effect in meeting performance outcomes. The developer’s challenge is to work with instructional designers to integrate elements of game play that create desired effects of motivation without interfering or distracting from the training goals of the game.

Iuppa and Borst (2007), in developing story based simulation for the military, identified elements of game play that can assist in achieving training goals. These include: navigation (allowing the learner to move around within the game and create a “sense of agency”); purpose (if the learner understands purpose of game play then becomes motivated to participate in the simulation); and competition (which can be with other people or factors such as a clock). The authors also state that narratives “afford the opportunity for learners to acquire tacit knowledge and leadership skills through anecdotes.” (p.60)

Feedback

In order to achieve the balance of game play (failure and success); the game design must be able to prevent the player from experiencing too much failure. Various types of feedback exist for this function, the most predominant tool being game hints or clues. While these tools occur in a subtle manner (between scene transitions or as an

optional navigational button), they become critical in assisting the player to advance within the game. The player thus learns through feedback.

Instructional design principles for adults state the importance of feedback within effective training. Lieb (1991) noted that adult learners often require specific knowledge, or feedback, regarding their learning to meet training objectives. The most common form of feedback is to provide correct answers to exam questions. Other techniques include visual clues that represent the correct information and compare against the information the learner generated. In analyzing the feedback, the learner comes to understand the knowledge and can apply it within the training task.

Many leaders in the military find that a key to the success of military training is the inclusion of feedback to the soldiers during and after a training event. The feedback is provided in a formal process known as the After Action Review (AAR). Unique to this process is that the soldiers generate the critique of the learning themselves, facilitated by the instructor or observer as opposed to the instructor or observer solely providing comments. Research has documented the difficulty in integrating feedback, “Modeling the human cognitive skills required for effective feedback during mission execution and critical thinking during after-action reviews has proven very difficult...to incorporate into stand-alone training games.” (Beal, 2006, p.8)

Since many games and simulations are implemented without instructors or facilitators, it is important design the game or simulation to include AARs. According to software developers, Virtual Heroes (2008):

“These data points (AAR) accomplish several critical goals. First, they ensure congruity between instructional and game design; learning objectives are now measurable outcomes. Second, AARs translates to clear return on investment for organizations who select learning based game products. Third and arguably most importantly, in

this virtual world, objectives translate to behavioral goals.” (p.5).

To link these critical elements of objectives and feedback, a variety of game play tools have been created to target specific aspects of learning. Developers at Virtual Heroes are focusing on integrating biofeedback data to learners while they engage in a simulation (2008). This technique is similar to an athlete that might monitor their heart rate while exercising, adjusting their actions in accordance with their goals. Another technique found in the simulations that Iuppa and Borst (2007) describe simply provides text based feedback to the player based on the decision they made during the game play. The feedback includes whether the decision was correct or not, a review of the decision made, and an explanation of how the decision is related to the desired training objective. These examples model the spectrum of technology within games that can be implemented to provide feedback, an essential element of effective training.

Emerging Technologies and Military Training

As the military continues to develop the use of games and simulations to meet their training mission, challenges continue to arise. Two specific challenges that appear to persist are: (1) achieving affective domain objectives and (2) portability. In searching for solutions, an examination of emerging technologies is useful.

Achieving Affective Domain Objectives

One key to effective training mentioned in this chapter is to identify measurable objectives, to include those for the affective domain. Traditionally these objectives would measure learners’ motivation, attitude, values, and other affective descriptors with instruments such as questionnaires, surveys, or indicator instruments. Training that centers around affective domain objectives may rely on intangible actions such as the informal

learning that occurs when learners communicate with each other regarding the training content. To achieve these objectives can be challenging; emerging technologies may offer some solutions.

While emerging technologies encompasses hardware and software products, this discussion of affective domain objectives is focused on specific Web 2.0 tools. Web 2.0 internet technologies, such as social networking tools, blogging and virtual worlds are emerging as parallel opportunities for learning in addition to serious games and simulations. Moreover, the technologies are proving to be particularly effective training tools for the military.

Social networking sites, such as *MySpace*, *Facebook* and *LinkedIn* provide a location on the web where people can interact with each other to form and support relationships. These sites include e-mail and instant messaging and encourage the user to generate their own content to display and share. The U.S. Army has incorporated this concept to some extent with its *Army Knowledge Online* (AKO) program. AKO is a central location on the World Wide Web for soldiers to utilize many services, among them the ability to dialogue with each other through the use of discussion forums. Topics on these discussion forums are generated by soldiers and by moderators, chosen for their subject matter expertise.

Considering social networks for integration with games in designing training programs reveals much potential. "Social networks themselves may also be powerful learning tools. . . . social networking application supports the game, but is not a game itself." (Klopfer, Osterweil, & Salen, 2009, p.14). Utilizing a social networking tool within a training program with affective domain objectives has many advantages, including the ability to support soldiers with communication tools that are familiar and appealing, especially when they are isolated by their mission or location. Social networking tools can also facilitate the dialogue required for successful implementation of this type of training.

The challenges of implementing such a social network include the ability to mitigate the risk of soldiers' confidentiality and maintaining high quality moderators who facilitate dialogue and ensure program integrity. Developer's must also consider how to create game play that calls for social networking tools while remaining focused on learning objectives. However, the ability of social networking tools to assist in achieving affective domain objectives cause them to be worthy of further investigation and experimentation within training programs.

Blogs are web-based platforms for hosting discussions around specific topics. These types of dialogues have long existed in electronic platforms, primarily within e-mail exchanges or on discussion forum boards. However, the structure of blogs has emerged as the preferred form by users of electronic communication methods (Brogan, 2008). Blogs often adapt guidelines such as e-mail policies to avoid abuse of the tool. Among the many advantages of blogs are that they increase trust while building a collaborative environment. Since blog postings are permanent, they build a wealth of collective knowledge. Participants tend to avoid posting information that is false because of the audience's ability to question and hold authors accountable. Promoting blogs may send a message to soldiers that they are trusted to share; censorship becomes the exception rather than the rule.

The military has had mixed experience with blogs. Many soldiers have posted their own experiences within a blog format for the world to read. Due to concerns of compromised information unintentionally reaching the enemy, policies were established to mitigate the risk. Soldiers continue to share their stories online in blogs; however, content must be screened by leadership to ensure that sensitive information is not being compromised. The military as an enterprise hosts public affairs (PA) sponsored blogs which are considered a tool in the PA mission. Discussion

forums continue to be the primary dialogue tool within training realms.

By adding blogs as a tool within a training program that is primarily dealing with affective domain objectives, developers expand the program's ability to reach a variety of learners. Also, learners' can gain a sense of ownership not only of their learning, but as part of the training program itself. Combining these aspects with a gaming format may prove to be powerful strategies to achieve challenging training goals.

Virtual world is a term often used to describe a 3-D computer simulated environment where people interact via an avatar. The extent to which content is mostly generated by the users is unique to virtual worlds. (Rezed.org, 2008). Virtual worlds are an example of a term described by Dede (2007) as a MUE, an acronym for Multiuser Virtual Environment. In his research, Dede explores MUEs as a possible format for schools in the future. Virtual worlds and MUEs are relatively new (*Second Life* began in 2003). They share many attributes of serious gaming formats, yet little data exists regarding these formats as a viable training tool. Many large corporations and universities are exploring the potential of MUEs and virtual worlds for educational purposes.

The military is exploring the use of virtual worlds. The U.S. Army teamed with commercial entities to launch five pilot projects in 2008. (U.S. Army, 2008) The pilots focus on various training venues to include information models for wounded soldiers, collaboration between representatives of several different federal agencies, and preparation of new recruits with virtual drill sergeants and recruiters. Forterra Inc., a commercial creator of virtual worlds, supported the U.S. Army in an endeavor to fill training gaps existing for deploying units (McCaskill, 2005). Testing of a prototype demonstrated that virtual worlds can support a wide range of military training audiences with relevant experiences based upon current combat conditions at multiple levels of warfare.

For the military, virtual worlds can enable those soldiers who share a common interest in the subject matter of the training to dialogue and extend learning beyond the training content presented in a standalone version. Osmotic conversation is that information which flows in the background hearing of members so that they may pick up relevant bits as though by osmosis. (Merriam-Webster, 2008). It is a tool that may assist in achieving affect domain objectives. In *Second Life*, members have the ability to be in a large group, yet eaves drop on the conversations which are occurring in the background. The informal nature of osmotic communication can be realized within the virtual world format. *Second Life* uses a tool called "spatial audio" defined as the moving of an avatar away from another avatar that allows side conversations, which is impossible within traditional telephone conferences. While the military is exploring the use of virtual worlds in many aspects such as recruiting, conferencing and training based on primarily cognitive domains, it may also consider expanding exploration of virtual technology to affective domain centered training.

A model for utilizing gaming as an integrator of formal and informal learning emerged during an attempt to create a conceptual plan to deliver an alcohol and substance abuse prevention training model grounded in persuasion theories for the military. The current face-to-face training relies on the instructor's ability to manage active resistance by the students, facilitate respectful collaboration and move students toward personal behavioral change. The model is structured around a series of activities that provide formal learning (dissemination of information) and informal learning (students sharing their personal experiences, views and perceptions). Often it is interactions and conversations that occur between the students participating in the training that becomes the most influential component in moving students toward change.

Traditional models of e-learning typically begin with an underlying structure for disseminat-

ing information. Layers of interactivity are added throughout the training to engage and motivate the learner thus improving their retention, comprehension and ability to apply the information presented. Elements of the alcohol and substance abuse prevention training easily converted to this format; however, lost in the translation were the affective elements, such as the student interactions and conversations which are necessary in applying persuasion theories. Web 2.0 internet technologies demonstrate the potential to achieve the affective elements. The challenge is how to integrate e-learning and Web 2.0 technologies to create an effective training model; and a possible solution may be gaming. Through gaming, the core element of the training model is able to deliver information while simultaneously engaging the affective domains with Web 2.0 internet technology components.

Current efforts in the realms of military training reveal a model shift from traditional instructor-led training to more diverse, multiple-delivery type systems centered on the student. Included in these systems are gaming platforms such as simulations and scenario-based gaming. By positioning the game as a central platform for the alcohol and substance abuse prevention training, the student is afforded the opportunity to control the learning situation and become motivated to achieve the objectives set forth in the training tasks. The model described is currently in development; it remains to be seen whether developers will create a training program with the ability to achieve affective domain objectives.

Portability

The military approach to training is to define objectives for student outcomes and the requirements for the training program, then devise alternative approaches to satisfy them. (Fletcher & Chatelier, 2000). The military's focus on distributed learning evolved from multiple goals; however, a significant factor is the ability to deliver individual

training that is effective, yet saves money and time – limited resources of the military.

Emerging technologies such as streaming video, virtual worlds, file compression, and various communication tools advance the ability of the military in meeting its distributed learning goals. Most games retain the trait of portability; they can be delivered to the learner in almost any location via electronic methods. This feature has become critical as the military continues long-term combat operations in remote locations.

Web 2.0 applications provide the military with scalable and sustainable tools that are adaptable when delivering the program anywhere, anytime, for anyone. A technological advantage of current virtual worlds such as *Second Life*, is the small memory space on a computer that is needed; most of the program is streamed via internet to avoid cumbersome updates and large data requirements.

Designing training that combines gaming and simulation with emerging technologies takes advantage of tools to meet affective domain objectives and utilizes applications that meet distributed learning goals of portability while possibly reducing costs and time requirements. Reflected in research is the ability of distributed learning to conserve resources (Prensky, 2001). Future investigations should focus on the ability to measure effectiveness of these programs with learners and ensure that training design focuses on its primary purpose to assist the learner in building and developing skills.

CONCLUSION

“Games can play a number of roles in learning, but they are most effective as learning environments when they have well-integrated instructional guidance and/or instructional support.” (Munro, 2009) This is a fact the military not only recognizes but embraces as they attempt to expand their ability to deliver training anywhere, anytime for anyone. The varieties of games that exist provide multiple

opportunities for learning, but it is important to identify what the games were designed for (learning versus entertainment) before establishing expectations for the game player. Developers of military training must understand the desired outcomes and ensure that sound instructional design is incorporated. The key factor for selecting training tools should focus on appropriateness rather than technological features or efficiently priced deliveries. Emerging technologies appear promising when creating games that require a blend of informal and formal learning and are primarily focused on affective domain objectives. Technological issues such as portability become more significant to a military engaged in persistent high operational tempos.

Fletcher (2003) suggests that those concerned with military training change the paradigm within current development arenas; "We should start building -- design drives science more than science drives design." Designing training environments that may employ technologies yet to be developed may inform the direction and future of distributed learning, both for the military and the fields of training and education.

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Chapter 4.18

Leveraging the Affordances of an Electronic Game to Meet Instructional Goals

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ABSTRACT

Electronic games have the potential to support learning by doing and enhance student motivation. However, there is little guidance in the literature on how to leverage the affordances of electronic games to design effective instruction. This chapter is our effort to start to accumulate knowledge to guide the design of electronic educational games. We present a case study describing how the unique components of electronic games enabled the design of Conquest of Coastlands, a learning environment delivered as an electronic game. We describe how our team synthesized two sets of

design principles from the literature on electronic games, instructional design, and intrinsic motivation and how these principles informed the design of Conquest of Coastlands. The principles and the related case study may inform the design of future electronic educational games and generate research questions to be investigated in empirical research.

INTRODUCTION

The Federation of American Scientists (FAS) released a report in October 2006, proposing digital games as a solution to reshape education (2006). The report lists a series of research and

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development challenges. One main area of challenges focuses on the design of games for learning. How can we design games that contribute to instructional goals? To answer this question, we need to understand the affordances (Gibson, 1977) of the electronic games, the potential and possibilities that the media may offer to enable effective learning.

Electronic games have two affordances for impacting learning: the promise to support learning by doing (Kirriemuir & McFarlane, 2003) and the motivational effects of games. Supporters of electronic educational games emphasize the potential of electronic games in providing simulated real world experiences. Squire (2006) considers game playing as designed experience, in which students learn through participating and performing in the game world. Gee (2007) states that the games that he is interested in “are digital simulations of worlds that are ‘played’ in the sense that a player has a surrogate or surrogates through which the player can act within and on the simulation” (p. 1). These are epistemic games (Shaffer & Gee, in press) in which learners play the role of professionals such as engineers, urban planners, journalists, or lawyers in authentic simulations of a society. It is argued that these games help learners develop ways of thinking and knowing valued by respective professions.

Advocates of electronic educational games often cite the work on intrinsic motivation to support the use of games in education. Psychologists (Lepper & Malone, 1987; Malone, 1981) analyzed computer games and identified a list of elements that are motivating, including challenge, curiosity, fantasy, and control. Flow (Csikszentmihalyi, 1991) is another theory related to motivation. It describes a sense of control, deep engagement, and exhilaration when one is involved in an optimal experience. Research shows that intrinsic motivation and flow positively contribute to learning (Cordova & Lepper, 1996; Csikszentmihalyi, 1991; Hektner & Csikszentmihalyi, 1996).

These views provide valuable insights on the effective dimensions of electronic games in education. However, how do instructional designers transform the two affordances of electronic games to enhance motivation and simulated experience into effective design of instruction? How should elements of electronic games be designed to meet instructional goals? This chapter explores these questions by presenting a case study of how the unique components of electronic games enabled the design of *Conquest of Coastlands*, a learning environment delivered as an electronic game.

This chapter starts with a theoretical framework that identifies the components of electronic games and describes two instructional design models and a motivation theory, all of which are guiding the design of our learning environment. Then, it presents an overview of the game and the quest that we are developing. Next, it describes the instructional elements identified for the quest and discusses how we leverage two affordances of the game to support effective instructional design.

THEORETICAL FRAMEWORK

Components of Electronic Games

Electronic games usually have two components: story and game play. Although some game designers argue that story is not a necessary element in all games, we consider it a key element in electronic educational games (Williams, Ma, Prejean, & Richard, in press). A story in an electronic game consists of characters, settings (context), and events (plots) (Stapleton & Hughes, 2006). Characters act to pursue the object of their desire or motivation. This action constitutes the plot. In the course of their pursuit or quest, characters encounter obstacles or problems that interfere with their achieving of the goal. This is the source of conflict, which is the essence of drama. Characters seek solutions to problems and take action to overcome obstacles. The drama consists of the ongoing friction between the characters’ motives,

the obstacles they confront, and the choices they make in confronting them.

Game play describes “what the player does” in the game. It can be broken down into the constituent game mechanics, including goals, rules, tools, cause, effect, and consequence (Stapleton & Hughes, 2006). It describes how the player follows the rules and uses the tools and resources to achieve the goals of the game and how the game responds to the player’s action based on certain cause-effect-consequence rules.

Four-Component Instructional Design (4C/ID) Model

The four-component instructional design (4C/ID) model (van Merriënboer, 1997) is a model for teaching an integrated set of knowledge and skills required for solving complex problems and completing complex tasks. There are four inter-related components in the 4C/ID model: learning tasks, supportive information, part-task practice, and just-in-time (JIT) information.

Learning tasks. Learning tasks are the concrete, authentic whole-task experiences similar to complex real-world problems. Repeated practice of learning tasks allows learners to generate abstract schemata from concrete experiences. Learning tasks are categorized into simple-to-complex classes. The order of the task classes and the specific instances of the tasks define the overall sequencing of the instructional content.

Supportive information. Supportive information is provided to assist with the non-recurrent aspects of the learning tasks. It includes mental models, cognitive strategies, and cognitive feedback related to reasoning and problem solving. Inductive-inquisitory and inductive-expository strategies are appropriate for teaching supportive information.

Part-task practice. Although learning tasks may provide enough practice for the recurrent skills, part-task practice may be needed to reach a high level of automaticity for these skills. Part-

task practice is a “divide-and-conquer” approach in which the learner practices constituent skills required to complete the whole task. The 4C/ID model advocates teaching the whole task at the beginning of the instructional program and embedding part-task practice in the context of the whole task.

Just-in-time (JIT) information. JIT information provides the step-by-step knowledge needed for part-task practice. JIT information is offered when it is relevant; it fades away when the learner acquires more expertise.

The strengths of the 4C/ID-model lie in its strong theoretical base. We concur with Merrill (1999) that this model has synthesized the best from existing instructional design models and incorporated theories derived from current cognitive psychology research. The 4C/ID model is not only influenced by the classic works on instructional design (Gagne, 1985; Merrill, 1983; Reigeluth, 1983), which are based on behavioral and cognitive psychology; it has also integrated components from more recent constructivist instructional design theories and models (Collins, Brown, & Holum, 1991; Spiro, Feltovich, & Jacobson, 1991). The integration of instructivist and constructivist approaches are made possible in this model because of the influence of cognitive load theory (Sweller, van Merriënboer, & Pass, 1998). The impact of the cognitive load theory is best reflected in the concept of “reflective expertise” (van Merriënboer, 1997) discussed in the model. Reflective expertise is the ability of a learner to generalize learning using two transfer mechanisms: domain-specific automated process to address familiar aspects of problems; and heuristics operating on cognitive schemata to solve unfamiliar aspects of problems. With such expertise, when presented with a problem, a learner can quickly solve the familiar aspects of the problem by automatically applying the rules, thus freeing up working memory to deal with unfamiliar aspects of the problem using heuristics and cognitive schemata induced from previous experiences

and examples. The learning tasks and supportive information are primarily designed to promote schema-based transfer. Constructivist strategies such as cognitive apprenticeship (Collins et al., 1991) play an important role in achieving this transfer. Part-task practice and JIT information may enable rule-based transfer. Instructivist strategies (Gagne, 1985) that take a “divide-and-conquer” and “drill-and-practice” approaches can be of value to facilitate rule-based transfer.

The 4C/ID-model not only has a solid theoretical foundation, but also features a strong research base. Empirical evidence of the model has been demonstrated in a series of studies. Research has been conducted with regard to the training of fault management (Jelsma & Bijlstra, 1990; Morris & Rouse, 1985), computer programming (van Merriënboer & De Croock, 1992), and statistical analysis (Pass & van Merriënboer, cited in van Merriënboer, 1997). The studies demonstrate that strategies based on the 4C/ID-model tend to provide better transfer than the conventional strategies (van Merriënboer, 1992). The 4C/ID-model informed the design of ADAPT^{IT}, a computer-based training design tool that helps professionals to design training courses for complex cognitive skills (The ADAPT^{IT} Consortium, 2003). Analysis of evaluation data indicates that this tool has met the expectations for efficiency and effectiveness.

Cognitive Apprenticeship

Cognitive apprenticeship (Collins et al., 1991) is an instructional design model built on traditional apprenticeship. In traditional apprenticeship adults teach children skills such as speaking, farming, and sewing by showing them how to complete the tasks and helping them when it is their turn to try. In cognitive apprenticeship teachers help learners acquire transferrable cognitive skills by demonstrating the thought process for completing certain tasks and guiding the learners as they work on the tasks themselves.

Cognitive apprenticeship advocates six instructional strategies: modeling, coaching, scaffolding, articulation, reflection, and exploration. Modeling, coaching, and scaffolding strategies help students acquire knowledge and skills through observation and guided practice.

Modeling. Cognitive apprenticeship typically starts with modeling, which provides students with an opportunity to observe expert performance of a task in order to build a conceptual model of the processes for completing the task. Jonassen (1999) categorizes modeling into two types, including “behavioral modeling of the overt performance and cognitive modeling of the covert cognitive processes” (p. 231). After students observe the expert performance, they are engaged in the completion of the task themselves.

Coaching and scaffolding. Coaching and scaffolding strategies provide the support students need to accomplish the task and to bring students’ performance closer to expert performance. Coaching involves observing students’ performance and providing hints, feedback, further modeling, reminders, and new tasks to address specific issues in students’ performance. Scaffolding can be provided by offering suggestions, help, cue cards; the teacher can even perform parts of the task that are beyond students’ ability. Coaching and scaffolding should gradually fade as students become more competent in performing the tasks.

Articulation and reflection. Articulation and reflection strategies enable students to gain access to and control over their own thinking. Articulation refers to requiring students to articulate their knowledge, reasoning, and problem-solving processes. Teachers can encourage students to articulate their thinking by asking for explanations and elaborations, or requiring them to explain their ideas to peers in cooperative groups. Reflection involves helping students compare their own problem-solving processes with those of the experts, thus making it possible for them to modify their processes. Techniques to enhance reflection focus on reproducing or replaying both expert

and students' performance to offer opportunities for comparison.

Exploration. After students become competent in solving the problems with no support, exploration should occur. Exploration involves pushing students to find and solve problems on their own. Students may be given general goals (e.g., exploring why the stock market crashed in 1929) and they can focus on specific sub-goals of interest to them. The purpose of exploration is to encourage students to become automatic in setting problem goals and solving the problems.

The 4C/ID model and cognitive apprenticeship are the two main instructional design models that inform the design of Conquest of the Coastlands. To conceptualize the complementary role of these two models, we identified two categories of instructional elements: problem and support (Table 1). These are the main elements in instructional design models that emphasize the role of authentic experience in learning (e.g., Hannafin, Land, & Oliver, 1999; Jonassen, 1999; Schank, 1999). In these learning environments, the student is presented with a problem, a project, or a task in a rich context. A variety of resources and tools are available to support the learner. From the perspective of this framework, the learning task in the 4C/ID model is the problem to be solved. Supportive information, JIT information, and part-task practice offer support for accomplishing the whole task. Cognitive apprenticeship offers additional support to guide student learning through observation and guided practice.

Table 1. Instructional elements based on 4C/ID and cognitive apprenticeship

Instructional Elements	
Problem/Project/Task	Learning task
Support	Supportive information
	JIT information
	Part-task practice
	Cognitive apprenticeship strategies

Intrinsic Motivation

Malone and Lepper (Lepper & Malone, 1987; Malone, 1981) developed a theory of intrinsic motivation after analyzing related literature and conducting experiments on electronic games. They identified four categories of design features that enhance intrinsic motivation, including challenge, curiosity, fantasy, and control. The first category of features focuses on developing an optimal level of challenge for the learner. Performance goals should be personally meaningful and the attainment of the goals should be uncertain. However, the sense of uncertainty should not be to the extent that it damages the learner's self-esteem; instead, the completion of the challenging goals should contribute to enhanced feelings of self esteem. To achieve this, there should be goals of varying difficulty so that the learner can work at a level appropriate for their ability. Hidden information and randomness may also enhance the uncertainty of the goals.

The purpose of the second category of design features is to enhance curiosity, including sensory curiosity and cognitive curiosity. Sensory curiosity can be facilitated with the use of perceptual stimuli such as light, music, animation, graphics, and video and audio effects. However, the enhancement of sensory curiosity should not distract the learner from instructional tasks. "Cognitive curiosity is evoked by the prospect of modifying higher level cognitive structures" (Malone, 1981, p. 363). It is the desire of the learner to better organize one's knowledge. The key to evoke the desire is to create a cognitive dissonance (Festinger & Carlsmith, 1959) by highlighting the incompleteness, inconsistency, or a lack of parsimony in the learner's understanding.

The third category of design features is concerned with giving the learner a sense of personal control by providing choices and personalization opportunities. For example, the learner can be given the choices concerning the characters, names, fantasies, icons, and other bells and

whistles irrelevant to the instructional aspects of the activities. Information and feedback is personalized based on these choices.

The last category of design features relates to fantasy. Malone defines fantasy-inducing environments as those that evoke “mental images of things not present to the senses or within the actual experience of the person involved” (American Heritage Dictionary, cited in Malone, 1981). Fantasy is appealing because of its cognitive and emotional impact. The cognitive benefits of fantasies lie in that fantasies provide analogies and metaphors that enable the learner to use existing knowledge to make sense of the new information. Fantasies have emotional appeal in that they arouse strong emotions through stories related to conflict and war, competition, and interpersonal relationships. There are two types of fantasies: endogenous and exogenous. In endogenous fantasies, there are inherent connections between the fantasy and the content and the goals of the fantasies match the instructional goals. For example, *Civilization* is an endogenous game for teaching history. In this game, the player builds civilizations and ensures its growth by balancing issues related to infrastructure, resources, diplomacy and trading, technological advancement, city management, and military. The fantasy advances as the civilizations evolve. Social studies can be taught by using this game. On one hand, the player needs the historical knowledge to succeed in the fantasy. On the other hand, the player needs the fantasy as a context to understand historical knowledge. In exogenous fantasies, the connections between the fantasy and the content are superficial; the same fantasy can be used as “sugar-coating” for a variety of content. For example, a *Speedway* game in which the students’ race cars move at the same speed as they correctly answer arithmetic questions is considered an exogenous game. In reality, arithmetic skills are not required for car racing; it is an artificial connection. The same game can be attached to any other content. Researchers argue that endogenous games are more interesting and

more instructionally effective than exogenous fantasies because of the inherent relationship between the fantasy and the content.

CONQUEST OF THE COASTLANDS AND THE GLIM QUEST

Conquest of the Coastlands is a role-playing electronic educational game with a science fiction/fantasy setting. Pursuing larger strategic objectives, the player character will be challenged with a variety of problem solving “quests,” which form the main plotlines of the interactive narrative and will provide the immediate motivations for player-character activities in the game. Each quest is designed to achieve specific learning goals.

The game takes place amid an ancient conflict between two sentient species and their struggle for dominance on a planet in another solar system. While not technologically sophisticated, the planet’s two rival sentient species have reached a turning point in their evolutionary history where it is likely that one—the Mruk-ma—will likely drive the other—the Sheft-ma—into extinction.

The Mruk-ma are aggressive, sea-faring species, while the Sheft-ma are city-builders who make their home in “The Coastlands,” along the marshy seashores and river valleys of Mertis’ lone continent. For the vulnerable Sheft-ma, the strategic key to their self-defense is a deteriorating system of fortifications built in the coastal wetlands surrounding their cities. But these wetlands are mysteriously disappearing at an alarming rate, and the threat of invasion by Mruk-ma fleets is growing.

A decisive change comes when the survey ship of an advanced alien race crash-lands in the oceans of Mertis. Arriving in escape pods from their doomed spaceship, the strangers, called Cilati, are scattered around the planet. Now hopelessly stranded on Mertis, some of the alien crew manages to make their way to The Coastlands, where they are warmly welcomed by the Sheft-ma. The Cilati survey team brings with them precious

scientific knowledge, technology, and methods that could dramatically shift the balance of power in the conflict between the two rival species. The survival of the Sheft-ma will depend on whether they can effectively utilize the science and tools of the Cilati to rebuild their crumbling forts and defend their disappearing coastlines.

The Cilatis are a highly advanced race of space-faring explorers. Extremely long-lived, they traverse the galaxy in pursuit of knowledge about other planets and other life forms. Cilati ships have visited countless worlds, quietly observing the species that inhabit them. Generally, they never interfere in the cultures they study, and they seldom even make their presence known.

However, it quickly becomes apparent that the Mruk-ma have adopted a radically new strategy in their struggle with the Sheft-ma: ecological warfare. By attacking the delicate environment on which their peaceful rivals depend, the Mruk-ma hope to wreck the Sheft-ma civilization and eliminate their species.

Our team is currently developing the *glim* quest in Conquest of the Coastlands. It is a four-week life science and environmental science curriculum for children ages 11-13. The curriculum consists of approximately 10 hours of electronic-game activities followed by approximately 10 class periods of hands-on, classroom-based activities. The primary goal of this curriculum is to teach an integrated set of knowledge and skills that allow students to address environmental issues. For professionals, such expertise may take years of education and experience to develop. Our four-week curriculum will focus on relatively simple but still complex and authentic problems.

INSTRUCTIONAL COMPONENTS OF THE GLIM QUEST

The 4C/ID model provides an overall framework to structure the instructional aspect of the game. This section describes the four instructional components of the *glim* quest: learning tasks,

supportive information, part-task practice, and just-in-time information.

Learning Tasks

In this curriculum, the learning tasks involve addressing environmental issues similar to those found in the real world. The tasks are organized in a simple-to-complex order. The electronic game addresses problems that have less variables/factors at play, followed by classroom activities which present more complex problems. Much support is provided in the game because students have little experience dealing with these issues. Performance constraints and modeling examples are offered to reduce the cognitive load.

The central problem presented in the *glim* quest focuses on exploring a drastic reduction on the harvesting of *glim*, a fish found in the coastal regions, which is a key staple of the Sheft-ma diet. The game provides an opportunity for the learner to explore an ecosystem that has been disturbed by an invasive species and other biotic and abiotic factors. Performance constraints are provided; learners are required to follow a set of scientific inquiry heuristics to approach the problem. At the beginning of the inquiry process, they are asked to create a data collection plan; during the process, they write a progress report from time to time; toward the end of the process, they develop a final report in order to draw conclusions and discuss findings. A modeling example is available to illustrate how scientists follow the inquiry process and develop various plans and reports to solve an environmental problem related to acid rain.

Supportive Information

Supportive information, including the mental model of the balance of the ecosystem, scientific inquiry skills, and cognitive feedback, is provided to assist with the non-recurrent aspects of the learning tasks. They are related to two primary learning outcomes: scientific inquiry and the bal-

ance of the ecosystem. Students are expected to acquire knowledge and skills needed to understand and conduct scientific inquiry, including “asking questions, planning and conducting investigations, using appropriate tools and techniques to gather data, thinking critically and logically about relationships between evidence and explanations, constructing and analyzing alternative explanations, and communicating scientific arguments” (National Research Council, 1996, p. 105). Students should also obtain an improved mental model of the interdependence and balance of the ecosystem components.

We employ both inductive-inquisitory and inductive-expository strategies to design the instruction for supportive information. For example, the inductive-expository strategy is used to help the learner understand how various factors lead to the imbalance of the ecosystem and related consequences. We present several case studies of coastal issues and then draw out the relationship among various factors such as farm run-off, construction of levees, and the introduction of invasive species. We use the inductive-inquisitory strategy to teach complex relationships among organisms as well as between organisms and the environment. For example, a principle that we want the students to learn is that an invasive species can disrupt the balance of an ecosystem; the change in the ecosystem caused by the invasive species may impact a native species directly or indirectly. To teach this principle using the inductive-inquisitory strategy, we provide an analogical encoding (Gentner & Markman, 1997) tool, which presents two examples illustrating the impact of invasive species and the learner is guided to identify the common principle underlying both examples. Research shows that analogical encoding is more effective than the pure discovery approach. For more information on the analogical encoding tool, see the work of Williams, Ma, Feist, Richard, and Prejean (2007).

Part-Task Practice

The learning task of the game involves recurrent skills such as interpreting graphs of fish catch data and water quality data. These are the secondary learning outcomes of the curriculum. Part-task practice provides opportunities for the learner to acquire these skills. To give the learner a sense of context, part-task practice should be embedded in the game rather than as a prerequisite for playing the game. More part-task practice is available in the associated classroom activities.

JIT Information

JIT information provides the step-by-step knowledge needed for the learner to perform the recurrent aspects of the learning tasks. For example, for the learner to practice reading and interpreting graphs, a tutorial is available to teach the knowledge and skills necessary for the practice. The tutorial presents concepts and principles related to graph interpretation, gives examples, and provides corrective feedback to the practice.

LEVERAGING THE AFFORDANCES OF THE GAME To Promote Learning By Doing

Components of electronic games can be leveraged to support the instructional elements. Table 2 shows how the instructional elements in Table 1 are mapped with the components of the electronic game to guide the design of instruction. For example, two components of electronic games, story and game play may serve as devices to situate the problem and the context. The story describes the characters, the settings, and the events related to the problem. The game play presents the goals for the learner and defines the rules and tools for achieving the goals. To provide support to the learner, characters in the story and tools in the game play may deliver supportive and JIT information

Table 2. Instructional elements and components of the electronic game

Instructional Elements		Components of the Electronic Game
Problem/Project/Task	Learning task	Designing the story and the gameplay to present the learning task
Support	Supportive information	Delivering supportive information, part-task practice, and JIT information by characters in the story and tools in the game
	JIT information	
	Part-task practice	
	Cognitive apprenticeship strategies	Implementing cognitive apprenticeship strategies via characters in the story and/or tools in the game

as well as facilitate part-task practice and enable cognitive apprenticeship strategies.

Designing the Story and the Gameplay to Present the Learning Task

Presenting the learning task in the context of story and game play may enhance a sense of authentic experience. In contrast with traditional methods of knowledge representation, games provide a rich description of situations and tasks which are more meaningful to students. They allow the players to identify fully with a character, act on the plot, and experience the cause-and-effect of their actions. This is important because contemporary learning and instructional theories (Jonassen, 1999; Schank, 1999; Spiro et al., 1991), including the 4C/ID model (van Merriënboer, 1997), all emphasizes the role of an authentic context in facilitating learning by doing.

Presentation of the *glim quest* learning task is primarily through three elements: the game cinematic that introduces the back-story of the entire game, an interactive cut scene that focuses on the specific challenge in the quest, and several interactions between the learner and non-player characters. The following aspects of story and game play design have a critical role in developing a rich context for the learning task.

Setting. A compelling story begins with a rich setting. In our game, the opening cinematic introduces the learner to the setting: a fictitious planet where two opposing species are in conflict. Each

quest has its own detailed setting that contributes to the overall game story.

Characters. Characters add to the richness and authenticity of the learning task. For example, the learners first come to know details about their own character's motivations and other key figures in the opening cinematic. The player character's main motivation in the game is to preserve and restore the Sheft-ma's fragile coastal ecosystem. The cinematic also provides a glimpse of the dreaded Mruk-ma scouts who are spying on the Sheft-ma coastlands. As the player character begins each quest, characters facilitate presenting the goals and details of each learning task. For example, in the interactive cut scene for the *glim quest*, the learner takes on the role of the player character, a talented and courageous young apprentice who is given a task to investigate a fish depletion problem that is threatening the survival of the Sheft-ma.

Events/plots. The opening cinematic and the interactive cut scenes depict the back-story of the game and quests and provide a context for each learning task. During the interactions with non-player characters, task goals are clarified and needed details are provided. As the plot unfolds, the player character encounters obstacles such as determining what data to gather and how to interpret the data.

Goal. Providing the player with clear goals, consistent with those in the game narrative, is essential to effective game play and further facilitates presentation of the learning task. The goal of the *glim quest* matches the player character's

motivation to preserve and restore the coastlands, and is clearly presented to the player character.

Rules. Rules help clarify the end goal of the learning tasks. There are two sets of rules that define the winning of the *glim quest*. The first set of rules concerns whether the player character follows the instructions of the mentors to successfully complete the scientific inquiry process. The second set of rules is related to Sheft-ma values, including knowledge, stewardship, practice, and critical thinking. The player character may gain more points if s/he adheres to these values. These rules are presented during the interactions between the player character and the non-player characters.

Tools. The presentation of the learning task is coupled by an introduction of tools that the player character has available to complete the task. During the interaction between the Cilati mentor and the player character prior to his/her departure on the quest, the mentor provides the player character with a personal digital assistant (PDA), a versatile device based on the Cilati's advanced technology. This serves as the primary tool for the player character to complete the quest. Other tools common to electronic games, such as a map tool and an inventory, are also available to the player character.

Delivering Supportive Information, Part-Task Practice, and JIT Information by Characters and Tools

Providing support by characters and tools as the story and game play unfold adds to the authenticity of the experience. As the plots evolve, the opportunities for providing support naturally occur when the player character encounters obstacles. In the pursuit of the goal, the player character confronts the problems with the support provided by characters and tools in the game.

In the *glim quest*, the learner is mentored by two non-player characters, a Cilati and a learned Sheft-ma elder. The Cilati provides support and guidance to the player in conducting research. The

Sheft-ma elder is learned in many disciplines possessing a folk understanding of the forces at play in the natural world. To help the learner with the quest, the Sheft-ma elder discusses his hypotheses based on his own experience and folk knowledge. The Cilati mentor guides the learner through the scientific inquiry process, introducing conceptual information needed to complete the inquiry and taking into consideration of the Sheft-ma elder's folk understanding.

The PDA is a main tool that provides support to the learner. It facilitates communication between the learner and the Cilati mentor, allows data collection and analysis, and enables presentation of case studies and related information. Case studies are used extensively to provide the supportive information. The cases are stored in the case library in the PDA and the analogical encoding scaffold is also embedded in the case library. Part-task practice and JIT information on how to interpret graphs is facilitated by a tutorial embedded in the PDA.

Implementing Cognitive Apprenticeship Strategies via Characters and Tools

The story elements in the electronic games can easily support cognitive apprenticeship strategies. In stories, the hero usually has a mentor (Campbell, 1949) who provides tools and advice to support the adventure. Meeting with the mentor not only advances the plot in the story but also offers an opportunity to use cognitive apprenticeship strategies.

A more interesting example of how the characters and tools in this game support cognitive apprenticeship strategies involves the interaction supported in the PDA *sketch tool*. The tool allows the learner to work as a forensic sketch artist to determine the key characteristics and classification of the invasive species. Near the start of the quest, a non-player character shares a strange skull with the player character. The skull is not

of any creature with which the local Sheft-ma are familiar. In order to determine what the organism is, the Cilati asks a series of questions concerning the organism's characteristics. For example, the Cilati begins by discussing the teeth embedded in the skull, explaining that examining these can provide hints on the types of food they eat, which is a key factor for determining where the organism fits in the classification taxonomy. The *sketch tool*, appearing to be under the control of the Cilati, displays teeth of herbivores, carnivores, and omnivores found on Earth, and asks the learner to select the ones that most closely resemble those found in the skull. The Cilati confirms or rejects the learner's selection, eventually guiding the learner to understand that the invasive species is an herbivore, and concludes the interaction by drawing the teeth in the *sketch tool*. The Cilati goes on to guide the player through examining the other features of the skull. The *sketch tool* interaction allows the Cilati to model the cognitive processes involved in identifying the features of an organism.

The next two cognitive apprenticeship strategies, coaching and scaffolding, are facilitated through the interaction between the learner and the Cilati. For example, the Cilati asks the learner to follow the scientific inquiry process to investigate the fish depletion problem. Scaffolding is provided by requiring the learner to use a set of scientific inquiry heuristics. A particular noteworthy aspect of the game is its affordance to facilitate coaching via the non-player characters and within the context of the story. The learner develops and submits a progress report to the Cilati, who reviews the report and provides individualized feedback. In reality, it is the teacher who provides the feedback. However, the game allows the teacher to deliver the feedback assuming the role of the Cilati, thus maintaining the authenticity of the story and keeping the learner immersed in the context.

The game also enables the implementation of articulation and reflection. The learners are encouraged to articulate and reflect on their scientific

inquiry process in several communication reports they submit to the Cilati: the data collection plan, the progress report, and the final report. These reports are supported by the PDA.

The final strategy of cognitive apprenticeship, exploration, is not implemented in this version of the game. However, it is supported by the classroom activities. The learners are given open-ended, broad research issues, and they work in teams to generate research question and conduct investigations to answer the questions.

LEVERAGING THE AFFORDANCES OF THE GAME TO ENHANCE MOTIVATION

From the theory on intrinsic motivation, we identified four principles to inform the design of the *glim quest*. The following describes how our effort in applying these principles.

Developing a Meaningful Challenge with Optimal Levels of Difficulty

Our first effort to enhance intrinsic motivation (Lepper & Malone, 1987; Malone, 1981) focuses on developing a meaningful challenge with an optimal level of difficulty. In our game, the challenge is for the learner to identify why fish catches decline dramatically for Sheft-ma fishermen. This challenge is meaningful because: (a) it is a problem in a rich context with a potentially devastating impact on the well-being of the Sheft-ma, and (b) it resembles authentic environmental problems on Earth. To ensure that the performance goals are challenging but attainable, we provide various types of support described earlier in the chapter. We have not implemented other strategies that may provide the optimal level of difficulty, such as designing performance goals at variable difficulty levels and adding hidden information and increasing randomness. We will explore these strategies in the future development of the game.

Enhancing Sensory and Cognitive Curiosity

Commercial electronic games enhance sensory curiosity with the design of three dimensional (3-D) environments, cinematics, as well as stirring audio effects and music. Styled after the commercial games in terms of the interface design, Conquest of Coastlands integrates these state-of-the-art media with the design of the story, the game play, and the instruction. The game is also designed to augment cognitive curiosity by evoking cognitive dissonance in the learner. We adopted Socratic method (Collins & Stevens, cited in Malone & Lepper, 1987) as a means to trigger a sense of cognitive dissonance through dialogs between the Cilati mentor and the learner. The mentor asks questions and provides feedback in order to reveal problems in the learner's thinking and therefore to generate interests in learning.

Providing Choices and Personalization Opportunities

In Conquest of Coastlands, we give the learner a sense of control by providing opportunities for choosing names and gender, customizing the clothing, and selecting a secret code. These elements are irrelevant to the instruction, but they provide a sense of control that is motivating to the learner. In addition, we also personalize some of the feedback. The teacher, responding in character as the Cilati, provides personalized feedback on the reports submitted by the learner. We expect this feature to be both motivating and instructionally valuable. It is costly to design elements for personalization and choices, so we have limited these features in the current quest. We will further explore and evaluate these strategies in the future.

Developing an Endogenous Fantasy that is Emotionally Appealing

To develop an endogenous fantasy, we align the goals of the story and the game with instructional goals. In Conquest of Coastlands, the goal of the story and the game is to address an environmental issue. This goal also serves as the instructional goal.

Different fantasy context appeals to different people because learners have different emotional needs and different fantasies address different needs. To attract diverse learners, we try to address a variety of human emotional needs such as fear, love, hope, trust, faith, and fortitude. For example, in Conquest of Coastlands, we use vivid 3-D and 2-D arts as well as cinematics to depict Mruk-ma as dreadful creatures that perform deadly attacks on Sheft-ma villages. Drastically declining fish catches may soon lead to famine in the Sheft-ma city state; the learner is driven by the love for his or her country to investigate the problem.

CONCLUSIONS AND IMPLICATIONS

In spite of the growing interest in developing electronic educational games, there is little guidance in the literature on how to design effective electronic educational games. Educators have little experience in designing electronic educational games and the computer game industry lacks expertise in integrating effective pedagogy into game design. This chapter is an effort to start to accumulate knowledge to guide the design of electronic educational games. It presents a case study of our experience in leveraging the affordances of the electronic game to design a learning environment delivered as an electronic game. It describes how we synthesized two sets of principles from the electronic games, instructional design, and intrinsic motivation literature and how these principles informed the design of Conquest of Coastlands. The first set of principles describes how we align components of the electronic game

with instructional elements to meet instructional goals. The second set of principles presents our effort to leverage the affordances of Conquest of Coastlands to enhance motivation.

This chapter may be beneficial to both game developers and researchers. For developers of electronic educational games, the principles and related examples presented in the chapter may inform the design of their games. Although some of the principles are specifically related to the 4C/ID model and cognitive apprenticeship model, they should be relevant to developers who choose any design models that emphasize student-centered learning and learning by doing, because these design models (e.g., Hannafin et al., 1999; Jonassen, 1999; Schank, 1999) all underscore the roles of authentic problems, supporting resources, and scaffolds in learning. These models share similar instructional strategies with the 4C/ID model and cognitive apprenticeship.

For researchers, this chapter presents a list of theory-based principles that need to be examined in empirical research. Research questions may be generated from these principles. For example, one principle concerns implementing cognitive apprenticeship strategies through characters or tools in the game. Coaching and scaffolding require the mentor to provide individualized feedback and customize the learner's tasks on the fly. Currently, we are building a Web interface for the teacher to access the documents that the learner submits and to facilitate providing feedback, in character as the Cilati. We are yet to evaluate the effectiveness of this strategy. The main drawback of this approach is that feedback from teachers may be time-consuming; students may not be able to continue to play the game until feedback is provided. Research is needed to evaluate and develop technologies that facilitate more efficient and effective coaching and scaffolding. For example, natural language processing technologies such as latent semantic analysis (LSA) (Landauer & Dumais, 1997) may be promising technologies for implementing coaching and scaffolding strategies.

Another example relates to design principles that may enhance motivation. The implementation of these principles (e.g., the enhancement of sensory curiosity) with the cutting-edge technology is expensive. Although theoretically these strategies may enhance motivation, the motivational gains may not be significant enough to justify the cost. Future research is needed to address this issue.

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KEY TERMS AND DEFINITIONS

Affordances of Instructional Media: The potential and possibilities that instructional media offer to enable effective learning

Endogenous Fantasy: In endogenous fantasies, there are inherent connections between the fantasy and the content and the goals of the fantasies match the instructional goals.

Flow: Flow is a theory on motivation (Csikszentmihalyi, 1991). It describes a sense of control, deep engagement, and exhilaration when one is involved in an optimal experience.

Game Play: It describes “what the player does” in the game. It can be broken down into the constituent game mechanics, including goals, rules, tools, cause, effect, and consequence (Stapleton & Hughes, 2006). It describes how the player fol-

lows the rules and uses the tools and resources to achieve the goals of the game and how the game responds to the player's action based on certain cause-effect-consequence rules.

Just-In-Time (JIT) Information: JIT information provides the step-by-step knowledge needed for the learner to perform the recurrent aspects of the learning tasks.

Learning Task: Learning tasks are the concrete, authentic whole-task experiences similar to complex real-world problems.

Part-Task Practice: Part-task practice is a “divide-and-conquer” approach to teach one or a limited number of constituent skills at a time in order for the learner to reach a high level of automaticity for these skills.

Supportive Information: Supportive information includes mental models, cognitive strategies, and cognitive feedback related to reasoning and problem solving. It is provided to assist with the non-recurrent aspects of the learning tasks.

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Chapter 4.19

A Video Game, a Chinese Otaku, and Her Deep Learning of a Language

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ABSTRACT

It is a buyer's market for employers in today's global village, where having another language under your belt could make the difference at an interview between employment or the dole queue (unemployment line). Learning additional languages rapidly has been the goal of immersion schools, and their approaches are effective in many respects because they make use of situated learning experiences in communities of practice. Such experiences present their own challenges however, as living in the country of the chosen language for a considerable period of time may not be possible. Migrant workers too may be shunned by native speakers, particularly if they have little or no knowledge of the native language, reducing learning opportunities to en-

gage in discourse. Video games may be one way to address these challenges. In order to do this, however, more must be understood about the ways in which games support these theories, the way individuals learning a second language interact with them, and what researchers and developers of serious games must know to support this use of games. This chapter will outline the relevant theories for second language learning, describe how they operate in games, and present guidelines for research and development of serious games and second language acquisition.

INTRODUCTION

*Tell Me and I Will Forget
 Show Me and I May Remember
 Involve Me and I Will Understand
 - Confucius 430BC*

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This is a longitudinal qualitative study of how a ‘virtual world’ of commercial off-the-shelf (COTS) video games was providing a safe space for an intermediate-level second language learner. The study investigates her ability to develop *deep learning* of English by engaging in extensive video game-play in the target language. Drawing on Vygotskian principles of research, which focus on the process and not the outcome of development, this small-scale research project explored, through interview, the process of learning to play *Deus Ex*TM.

I chose the title of this project having read Tobin’s (1999) experiences with his son entitled *An American Otaku*. As the computer miniaturizes into ‘must-have’ fashion accessories such as mobile phones and handheld gaming devices, a new generation is buying into the cyber age. Tobin (1999) used it to describe his son’s fanaticism with the role-playing game *Warhammer*TM and his immersion into cyberculture at the beginning of the millennium. As a father of a teenager, he asks himself pertinent questions about the possible ramifications of using this new technology—such questions as whether a life on the Net can be satisfying, and whether his son’s self-confidence and the interpersonal skills he is developing through e-mail communications can translate into real life? Will he have ‘real’ (face-to-face) friends? Do otaku grow up to be happy, normal adults? The fixation on new technology that stigmatized otaku a decade ago is now in common use among teenagers growing up in technologically advanced societies that are rapidly being changed by the technology of the integrated circuit and the Internet. The title reflects how the subject, Zoe, a mainland-Chinese English Language student, was drawn in to extensive video game-play by effective game design despite the barrier of the second language. Like an otaku, she would spend many hours alone playing the video game *Deus Ex* on her laptop in the host family bedroom.

The Research

For the sake of brevity, the background to how the research was initially set up has not been included; the details of how the subject Zoe was found, the year-long platonic relationship of the author with the subject as a support tutor in her curriculum studies, and how, through many conversations about learning styles, she agreed to participate in this study have also been left out. Similarly, the ethical considerations that were taken into account prior to, during, and after the study have been edited, only including those areas which may impact on future research.

The Subject

‘Zoe’ is from China and in her early twenties. She has been studying in England for nearly three years. She remained with the same host family for this time. She came to the UK having completed her Chinese (full board) high school studies with the intention of improving her English sufficiently, so as to enter a UK university. She was preparing applications to universities during the time of this study. She proudly announced her Communist roots to me—that her father was a prominent member of the Party in her city and that she would need to undergo a re-education program on her return to China (in order to reintegrate with Chinese society), having completed her studies in the West. She was keen to study Japanese culture on her degree course (citing that “you should know your enemy better than your closest friend”) and looked forward to living as an exchange student with a Japanese host family for a year.

Preparatory Measures

Participant exposure to gore, violence, and death through the playing of *Deus Ex* was addressed and procedures put in place whereby the subject could contact the researcher directly should any concerns arise from video game-play. Also, an

agreement was reached whereby the researcher could terminate the study if evidence of video game-play was having detrimental effects on the subject's health, her studies, or her social life. Communication lines to the subject's course tutors and host family were established and maintained throughout the study and for some time afterwards. Despite these safeguards, Zoe decided not to play *Deus Ex* for at least three weeks of her own volition before informing me or asking me for help with the game for the first time. The first interview starts at this point, after Zoe had had possession of the game for six weeks. I told Zoe she could keep the games until she intended to return to China (in six months time) so that she did not feel the study had disrupted our relationship, as I felt that if I had removed the games after the interviews, she may have felt rejected and used by the research process. Addiction such as befits the title otaku is well documented, and many gamers would admit to spending more time playing video games than watching television. Zoe clearly fits into this category. I also presented her with a good bilingual dictionary as a present which she was very pleased to receive, explaining that she could tell her parents she had been given the dictionary "in order to help in research" and that it would act as a lessening blow if she admitted to having played hours of video games. She indicated during the second interview that her mother did not object to her playing *Civilization III* (another game I lent her) if it was helping her with her studies.

594: Zoe: yeah, in the last few minutes...also last week I told my Mum I play this game and I say how useful it is...(Kim: *What does she say?*) She say "Alright, if you think it's useful." (Kim: *So she was quite happy to...*) because I tell her this game just helped me to understand more and understand well during my Maths, Religious Studies, and World Development...nearly every single subject so this is very helpful.

This piece of information was most reassuring as I had concerns about parental approval despite Zoe's maturity. Zoe's concerns about causing upset

or disappointment to her parents by her actions surfaced during tutor support on a number of occasions throughout my year as her personal tutor.

Research Material

The video game focused on in this chapter is the first-person shooter/role-play game *Deus Ex* made by Eidos Interactive (n.d.). The reasons for using *Deus Ex* are pedagogic in that it provides a thorough training session at the start of play in order to develop the player's skills. Additionally, the vast narrative script is dual-coded, with all dialogue subtitled and a copy of all conversations stored and easily accessed in *Denton's* (your character's name) databank, giving another form of backup to aid the learner. The game-play is paused and is not jeopardized while accessing the databank for facts or while reviewing a conversation. The game is designed to stretch the player into new *zones of proximal development*, not in a hack and slash way often used in inferior video game design, but in a thought-provoking way, demanding the player/learner step beyond their *regime of competence* (Gee, 2003, p. 71) in order to advance skills ready for more challenges later in the game. *Deus Ex* makes you question allegiance and commitment to government agencies fighting terrorism, develops leadership skills, and hones survival skills in hostile environments. It cannot be played half-heartedly, demanding weeks of regular play in order to reach its natural conclusion. The commitment is rewarded through a virtual world that is both compelling and, as Gee (2003, p. 5) described it, "life-enhancing."

SOCIOCULTURAL THEORIES OF LEARNING

The Zone of Proximal Development

How we learn language, and particularly how we learn a second or other language, has been

researched by many disciplines. Second Language Acquisition (SLA) is a relatively new field of investigation and as such has generated numerous theories. Pica (1998) comments on the theory-less but theory-laden field of SLA:

Theory-less in that, as most major textbooks remind us, there has yet to emerge a single, coherent theory that can describe, explain and predict second-language learning. Yet it is theory-laden in that there are at least forty claims, arguments, theories, and perspectives that attempt to describe and explain the learning process and predict its outcomes. (Pica, 1998, p. 9, cited in Beatty, 2003, p. 79)

SLA research is informed by the psychological research into behaviorism and cognitive theories of memory and learning (Bartlett, 1932; Skinner, 1957; Chomsky, 1965; Krashen & Terrell 1983; Swain, 1983; Gass, 1988; Skehan, 1989; Schmidt, 1994; Gupta & MacWhinney, 1997; Shimizu, Tang, Rampon, & Tsien, 2000; Churchland, 2002; Fauconnier & Turner, 2002), theories of human and child development (Bruner, Goodnow, & Austin, 1957; Subrahmanyam, Greenfield, Kraut, & Gross, 2001), first language acquisition and socialization studies (Slobin, 1985; Watson-Gegeo 2001), and cognitive anthropology (Lave & Wenger, 1991; Chaiklin & Lave, 1996). More recently the field of sociocultural theory, based on research by Vygotsky (1978), Bakhtin (1981), and Luria (1982) among others, has been included in the SLA research arsenal.

The theory of the zone of proximal development is part of the Social Development Theory proposed by Vygotsky (1978).

Aljaafreh and Lantolf (1994, cited in Dunn & Lantolf, 1998) describe the zone of proximal development as:

...the framework, par excellence, which brings all of the pieces of the learning setting together—the teacher, the learner, their social and cultural

history, their goals and motives, as well as the resources available to them, including those that are dialogically constructed together. (cited in Dunn & Lantolf, 1998, p. 415)

Research by Aljaafreh and Lantolf (1994) revealed that the potential level of development of the learner could be ascertained by the degree of assistance required in order to carry out an activity and also “the visible ability of the learner to utilize forms of external assistance” (Lantolf & Thorne, 2006, p. 277). That assistance could be supplied by a teacher or more knowledgeable peer, from a book such as a dictionary definition or from contextual clues provided by the environment such as learning to say “bless you” when someone sneezes, for example.

Aljaafreh and Lantolf (1994) define development in the language acquisition context as:

the study of how mediational means are appropriated by the individual as a result of dialogic interaction with other individuals.... The potential level of development of the learner is suggested by the kinds of assistance needed to carry out the activity and the visible ability of the learner to utilise forms of external assistance... assistance should be graduated—with no more help provided than is necessary, for the assumption is that over-assistance decreases the student's agentive capacity. At the same time, a minimum level of guidance must be given so that the novice can successfully carry out the action at hand. Related to this is that help should be contingent on actual need and similarly removed when the person demonstrates the capacity to function independently. Graduation and contingency are critical elements of developmentally productive joint activity. This process is dialogic and entails continuous assessment of the learner's ZPD and subsequent tailoring of help to best facilitate progression from other-regulation to self-regulation. (Lantolf & Thorne, 2006, p. 277)

Vygotsky's research showed that at a given time, an individual's development was afforded and constrained by his or her ZPD. The individual's capacity to respond to and benefit from certain kinds of interaction such as prompts, body language, or verbal remarks that would allow him or her to carry out an activity he or she would otherwise be unable to perform provided Vygotsky not with a *capacity of ability* as so many tests reveal, but the *potential growth* or proximal development to be expected from the subject. This 'provoked development' he referred to as the *experimental-development method* and at other times the *instrumental method*. Vygotsky elaborates thus:

The [ZPD] defines those functions that have not yet matured but are in the process of maturation, functions that will mature tomorrow but are currently in an embryonic state. These functions could be termed 'buds' or 'flowers' of development rather than the 'fruits' of development. The actual developmental level characterizes mental development retrospectively, while the [ZPD] characterizes mental development prospectively... the [ZPD] permits us to delineate the child's immediate future and his dynamic developmental state, allowing not only for what already has been achieved developmentally but also for what is in the course of maturing. (Vygotsky, 1978, cited in Lantolf & Thorne, 2006, p, 267; author's emphasis)

Vygotsky had already formed the key principle of the ZPD concept—the difference between the actual level of development already obtained and the cognitive functions comprising the proximal next stage. It was this that is attractive to educators, as it gives a yardstick to understanding aspects of students' emerging capacities and could be used for effective diagnosis of future development. Over the period of time Zoe was playing *Deus Ex*, observable changes had occurred. These changes would signal maturation of her ability to process

the gaming environment—to be in control of the various elements—and therefore demonstrate learning within her own ZPD. The additional factor of having to play in an L_2 environment suggests that in order to make these advances in game-play, Zoe would have had to decode the language along the way. This would be indicative of language learning. Transformation over time is at the heart of this method. The process of decoding and reusing the language as 'one's own' demonstrates the use of higher-order skills and L_2 development within the ZPD. This would demonstrate *deep learning* had occurred.

Deep Learning

Deep learning is important in this study because it shows that the language has been acquired and can be used as an instrument or artifact of language rather than a memorized semiotic 'out-of-context' symbol. An example of the latter would be testing student memory by showing the students a set of flash cards of target language, waiting a few minutes, and then asking them to write down as many as they could remember. Although some of the target language may be part of the subject's own lexical set, the test does not impinge on the subject's understanding of meaning. They could memorize the letter shapes for example and have no relationship to the semiotic association with the words presented. Just as a toddler blurts out an expletive (if exposed to them) without understanding the semiotic meaning but relishing the reaction it generates, learning can be a veneer on the surface without any engagement with meaning. Deep learning involves the learner in complete understanding. Weigel (2001) defines deep learning succinctly:

Deep learning leads to understanding and long-term retention of information through the critical analysis of new ideas and may be defined as 'learning that promotes the development of condi-

tionalized knowledge and metacognition through communities of inquiry’. (Weigel, 2001, p. 5)

Conditionalized knowledge here is defined as knowledge that specifies the contexts in which it can be useful. This requires the learner to think about how the knowledge can be applied in a particular circumstance. It requires engagement with the meaning to provide some form of concrete example in order to create an artifact that can be used in the mind of the learner. The interviews revealed some of the above characteristics of Zoe’s development of conditionalized knowledge within her ZPD, as the excerpts from the interview demonstrate.

Flow

Regular video game players will engage with a well-crafted video game for a number of hours at a time. I wondered if this intense focus of attention was the same as ‘flow’, as posited by Csikszentmihalyi (1988, cited in Arnold, 1999, p. 15). Arnold describes flow as “a state of optimal experience—effortless movement of psychic energy.” Goleman (1995) emphasizes the importance of the presence of this state for learning to take place:

Flow represents perhaps the ultimate in harnessing the emotions in the service of performance and learning. In flow the emotions are not just contained and channeled, but positive, energized and aligned with the task at hand. (Goleman, 1995, cited in Arnold, 1999, p. 15)

A gamer may experience the sensation of flow as they become more adept at a game. We could liken it to spectating a professional sports event where we almost feel the movements of the players which can be observed as the involuntary muscle twitches in the leg as a goal is scored because we are so in tune with the event. Perhaps it is the way we are sometimes so engrossed by a

musical performance that we lose our sense of our surroundings. Gamers twitch or involuntarily jerk as something happens in the game environment for example. Goleman adds:

Because flow feels so good, it is intrinsically rewarding. It is a state in which people become utterly absorbed in what they are doing, paying undivided attention to the task, their awareness merged with their actions. (Goleman, 1995, pp. 90-91)

Although flow has been cited in a number of research articles, there is little empirical research into what flow actually is. Csikszentmihalyi defined the flow response as a “holistic response” or an “optimal state of experience in which there is order in consciousness... This happens when psychic energy, or attention, is invested in realistic goals, and when skills match the opportunity for action” (1990 cited in Marr, 2000). Marr (2000) highlights the fact that there has been no experimental investigation into the nature of the somatic states that parallel flow; specifically, the “visceral and musculoskeletal concomitants to flow have never been examined.” Whether flow is self-generated by increased dopamine levels in preparation for the anticipated task as Marr suggests, or a form of meditative state is reached where certain perception channels are elevated causing others to be diminished has yet to be fully researched. Nevertheless, good video games do produce a state of flow where attention is fully directed at the task presented. I chose the video game *Deus Ex* because of its compelling storyline and almost flawless linking of game-play and feedback mechanisms, such as *Denton’s databank*, which make it not only an exciting game to play but also a thought-provoking one.

We start the interview evaluation with Zoe’s experiences playing the first-person shooter *Deus Ex*, a dystopian, cyberpunk world set in the 2050s where a mysterious pandemic is rapidly spreading across the globe. Terrorist organizations flourish

as government agencies attempt to maintain order and stability. You, the player, are about to be trained as a special agent, and all that you know is you are ‘nano-augmented’ and the second agent to be so endowed. Nanotechnology by this time has become sufficiently advanced that ‘nanites’, small robotic organisms the size of a human cell, can be injected into the body and give the player superhuman powers. In *Deus Ex* you and your brother *Paul*, who is already working as an agent in the field, are nano-augmented. There are 11 skills used by *JC* as a special agent: computers, electronics, environmental training, lock picking, medicine, swimming, and skills with weapons from low-tech, melee weapons such as knives and mini-crossbow, pistols and rifles, to heavy weapons such as rocket launchers and explosive devices. Each of these skills has four levels of mastery (untrained, trained, advanced, and master) that can be increased by earning additional points as you play the game. You start the game with a nominal set of points, which you can use to develop your character skills. Deciding how to upgrade your skills creates a unique character every time you play the game, and overdeveloping one skill at the expense of another could leave you with fewer choices of how to solve problems or puzzles within the game or may enhance a particular style of play you favor. Wise decisions need to be made because once made they cannot be undone. You may be a player who avoids confrontations and decide to develop your character’s spy skills—lockpicking, hacking, and bypassing security systems for example. *Deus Ex* is said to be among one of the few role-play games (RPGs) on the market that can be played without resorting to violence (except for one unavoidable confrontation), which makes it unique in providing many alternative styles of game-play to reach the same objective.

The Interview

The interview was conducted at Zoe’s host family home, upon her request for assistance to proceed

with the game. She called me first of all to let me know she had stopped playing *Deus Ex* as she did not want to “kill any more *Chinese policemen* in the game.” She sounded a little upset and I was concerned because my experience of game-play did not involve having to attack these characters. We start the interview with Zoe describing her initial reactions to playing *Deus Ex*.¹

131. Zoe: (*sitting in front of her laptop*) the lucky thing is...when I show some medicine or kind of weapon I can see the shape...I can know what exactly it is...this is the only thing...I know.

Zoe is using visual clues to find out what items in the virtual environment are used for. In the next utterance she indicates the game is difficult to understand. She has not accessed the databank to find out her mission objectives, but is awaiting aural instruction (from the very effective game prompts acting as a form of *other-regulation* when the player strays away from the game’s mission objectives). She has accessed the map provided and may have used the compass provided by the HUD (heads-up display) to work out directions within the environment. Zoe is finding out about the design of the game, which Gee (2003) calls the design principle.²

133. Zoe: when I’m playing this *Deus Ex* because...but I’m quite understand because they give me map...that will tell me where you should go...when they go there...actually I don’t know what I need to do...so when I face to the enemy I just know I got to shoot them to protect myself and I just walk anywhere until the ‘contactor’ just tell me...‘ah’...you need to do something else...which means I arrive to the right place so I need to carry on next mission.

It took her two weeks of play to begin to feel confident within the environment, where she was able to develop strategies in order to survive. This is not dissimilar to the orientation of a tourist arriving in a foreign city. Also, the ‘contactor’ Zoe refers to is a character at the *UNATCO headquarters* who has access to *Denton* via a *neural infolink*—the game design effectively has a coach guiding you

around the first level. The explicit information on-demand and just-in-time principle ensures the player is given relevant help just when it is needed. As the player becomes more competent, the guidance offered is reduced until it is no longer necessary. This reflects the other-regulation to self-regulation used in Vygotsky's (1978) genetic method stated earlier.

135. Zoe: Yes! Really funny but...yes the first week...I'm just like this kind of confused...and in the second week I'm just improved...I can understand more...play more martially.

She has developed a "save-game" strategy in order to replay unsuccessful parts in order to "get them right." This reflects Erickson's (1956) moratorium principle and Gee's (2003) *practice principle*. The psychosocial moratorium principle (Gee, 2003, p. 67) enables learners to take risks in the game environment because real-world consequences are lowered. Freedom to experiment without direct real-world consequences permits the learner to develop game (and laterally, real-world) concepts about life through trial and error. Begg, Dewhurst, and Macleod (2005) comment on the value of this principle in the training of medical doctors, who can make mistakes with their *virtual patients* without real-world consequences, meanwhile learning and improving their performance. Good COTS video games constantly juxtapose real and virtual realities so that your *projected identity* (i.e., the character you portray in the game—see Tripartite identities and knowing yourself) is forever being questioned and molded throughout the game. The concept of *play* has been at the center of many theories of learning, as it could easily be observed in action through children's daily activities as they learned about their environment and their social and emotional world with peers and adults. Piaget (1962), Bruner (1983), Vygotsky (1978), and Luria (1982), among others, sought to identify how play functioned in the cognitive processes of child development, and later as maturation takes place. Sociocultural theories of play have identified the

many ways in which play may affect children's cognitive development, but also their social and emotional development. Vygotsky (1978, cited in Lantolf & Thorne, 2006, p. 185) believed that play embodied imagination and that it contained all the developmental levels in a condensed form. Through make-believe play, children were able to extend themselves beyond their own cognitive abilities and therefore present themselves with the next appropriate ZPD through a process of self-reflection and metacognitive thinking. Gee (2003, p. 67) refers to the self-knowledge principle, which states that the virtual world is constructed in such a way as to make learners think about themselves and their current and potential capacities as well as the game domain they are playing in. The game environment acts upon the player by provoking development within their ZPD. The somewhat hostile environment of *Deus Ex* forced Zoe to make numerous game-saves or lose the progress she had made if her character suddenly died.

137. **Zoe:** I save many times...because sometimes I will make a mistake.

Kim: you go back and play a different part of the game 🐼

Zoe: Yes.

Kim: so you could actually be at the beginning of the game playing it at one time and then you could be later, playing a different part of the mission 🐼

Zoe: actually, I don't do that...I just continuing... but I'm worry about I will done something wrong so I always save.

Good COTS video games tap into our innate sense of survival and self-preservation, and encourage us to project this onto the character we are becoming in the game. Zoe had become emotionally involved with her virtual identity as *JC Denton, UNATCO agent*. Her desire to show me the part of the game where she dispatched *Anna Navarre*, another top agent at *UNATCO*, would demonstrate her competence as a player.

Anna's augmentation utilized older robotics technology, and her destruction brought about by *Denton* may be symbolic of the technological race for supremacy where outmoded ways must make way for the new. *Anna Navarre* is one of the few game characters that has to be 'terminated' in order to progress through the game—stealth and avoiding conflict both work effectively as strategies otherwise. However, at line 193 Zoe remarks that *Anna* just "explode herself." The reason is based on Zoe having found two parts of a code word that act as a 'killswitch' or detonation device when spoken to *Anna Navarre*, a way for the *government agencies* to ultimately control their creations should they get out of hand. Zoe had accessed this code through hacking computers in the *UNATCO headquarters*. Once the two clues had been found, it was only a matter of repeating them in sequence during a conversation with *Anna* for the kill switch to take effect. Zoe was taken by surprise (193: *I just be injured*) as the blast from *Anna's* mechanized body detonating caused her to lose health points.

194: **Kim:** She...you didn't have to do anything... you attacked her or?

Zoe: No just talking to me and suddenly she explode herself.

Kim: Oh, that's interesting, how did that happen? Have you got that saved?

Zoe: I don't think so because I don't like that part...perhaps I delete already (*pause*)... Yes I delete it.

Kim: Are you deleting it because...I mean...why are you deleting parts of games that you've saved before?

Zoe: something I think is not that important because I can save some (*tape ends*).

It appears that Zoe unwittingly terminated *Anna* without fully realizing what she was doing. She also erased games that she claims were unimportant or because she required space for her college work (523). It made no sense to me that

Zoe would want to delete the record of achievement of destroying a powerful enemy, and so perhaps this particular scene was too shocking to Zoe and deleting it may have been cathartic for her. However, she remembers all the details quite clearly.

145. **Zoe:** (*showing Kim earlier save where Anna is still alive*) this lady...I kill her...you tell me I've got several chance to kill her....

Kim: there's different ways actually...yeah.

Zoe: but I kill her in aeroplane.

Kim: you did?

Zoe: Yes.

Kim: alright...erm...interestingly if you do that the game immediately presumes that you're the enemy...is that right?

151. **Zoe:** No, no yet! I'm very lucky because that communicator, the contactor, and then he says 'oh you shouldn't kill her' but he say you did anyway...he says...because at this time only me and you know you kill her so I will help you to cover up this thing.

Zoe returns to her *boss's office* and has to select a response—which she does (emboldened below). She, as the projected identity *JC Denton*, has now effectively lied to *her boss*. Zoe has already started to form a *virtual identity*, which she is prepared to protect in the game environment by fabricating the truth.

Excerpt from *Deus Ex Script*³

JC DENTON: I have some bad news about Agent Navarre.

MANDERLEY: No shit. What the hell happened in there?

JC DENTON: Lebedev. A surprise attack.

MANDERLEY: I find that hard to believe. You're digging your own grave if you cover up for your brother.

JC DENTON: Yes, sir. I'm not covering up for Paul, sir.

MANDERLEY: Because he's gone, JC. I hope you'll understand this. The Coalition has shut down his augmentations and activated the killswitch.

JC DENTON: Activated...what?

MANDERLEY: Some very important officials have become nervous, nervous about Paul but also about you.

JC DENTON: I think I've proved myself. Can they really kill him—by pressing a button?

MANDERLEY: Yes—and you, too. So take these orders seriously. They're sending you to Hong Kong.

The above dialogue highlights the threat of a *killswitch* implanted in all nano-augmented *UNATCO* agents, which Zoe did not quite grasp as a concept. She had some concept of her own character exploding uncontrollably once she was in *Hong Kong* (248). She may have spent considerable time playing the game with it ending abruptly because she had not addressed the need to deactivate the *killswitch*.

The earlier comment on game deletion is interesting to note because in line 202, Zoe is recalling the scene where she gets arrested and imprisoned at the *UNATCO headquarters*, having been on the run from *UNATCO* for *Anna Navarre's* murder.

202: **Zoe:** Yes, very...what can I say...just the whole situation been changed...because before I'm the member of *UNATCO* and suddenly I'm be arrest and they will take all my weapons and medicine and any kind of things and they throw me into a kind of little room.

...

208: **Zoe:** because before I never played this game and you never told me he will face this situation and suddenly (*Kim: (laughing) sorry...*) and all the people...because...can you remember...at the first few missions when I complete them I back to *UNATCO* center I see many many soldiers and they

say '*Oh yeah great...you're such a hero and you done many many things*' something like that and '*I wish I can go with you to carry on this mission*' something like that...and I just think...they just like my brother or er, we have very good partnership...I have very good relationship with all these soldiers...feel very comfortable and I'm be free to go into the *UNATCO* or go out...I'm very free to go around that location...but suddenly...I'm being arrest and I'm thrown into security prison and all these people...they're not my friends at all...suddenly I feel it's a trap...just like trap and....

Kim: so you needed to delete that part of the game? yeah?

210: **Zoe:** Yeah, such a very erm...depress memories...it's not a good memory which depress me.

What is apparent from the above quotes is that deleting the game saves from the computer has not deleted the emotional trauma associated with the loss of status, position, power, and camaraderie she had initially with the *UNATCO* characters in the game. More noteworthy are how the comments made by the AI (artificial intelligence—non-player characters that respond to your character to create the illusion of reality) are memorized almost verbatim by Zoe, expressions that to a native-speaker playing the game would be considered 'throw-away' lines in the game-play scenario. Zoe has adopted a strategy of clicking on every AI character until no more useful information is forthcoming and the phrases presented are superfluous to the plot. Here is an example:

GUARD 1

If you need help, talk to one of the receptionists. You do not require a security pass to visit the first three levels of offices.

Late night....

My feet are killing me.

Hope you find who you are looking for.

The last three phrases are padding, but for a language learner they can be informative colloquial expressions in the L_2 . Zoe has been accessing these (for each and every character) throughout the game. More significantly, she is able to recall the expressions easily from their embodiment within the video game storyline. *Deus Ex* provides the player with a “memory bank” of past conversations, written word-for-word. This gives the learner an opportunity to access the language both aurally and visually. This reflects the dual-coding theory research of Paivio (1990, 1991) and Clark and Paivio (1991, cited in Rieber et al., 1996, p. 2). Within *Deus Ex*, *referential processing* opportunities occur at cinematic cuts or when a player clicks on an in-game character in order to obtain information. Referential processing is particularly important because dual coding theory predicts that learning will be enhanced when information is encoded in both systems (i.e., dually coded). Information that is dually coded has twice the chance to be retrieved and used (Kobayashi, 1986). There is no limit to the number of times a learner accesses this information, which enables them to repeat and create representational structures undisturbed by other elements of the game. Although there is no appropriate grading of the language in COTS games, given the opportunity to employ study skills, a learner can access a much richer use of the L_2 than may be possible within immersion classrooms for example, where pedagogic principles of “comprehensible input” and “caretaker talk” (Ellis, 1994, pp. 248-267) limit teachers’ use of the language as they guard learners against unnecessary exposure to certain (grammatical and pragmatic) forms of language and monitor the quantity of content delivered so as to avoid cognitive overload. COTS video games were never designed with language learners in mind, so none of the above restraints are present during game-play. In fact, they have been created to be richly immersive environments for a *native* speaker. The language learner receives exposure to the L_2 as it was originally intended. Clearly,

Zoe had made associations in order to understand the context of her character *JC Denton* within the gaming environment and was also able to emotionally identify closely with the character as *Denton* becomes hunted as an enemy of *UNATCO*. Gee (2003, p. 209) makes reference to three more key principles that enabled Zoe to learn within the game’s environment. The first two are the situated meaning principle and the text principle, where signs and signifiers are understood because of their embodiment in the context of the game, and where moving back and forth between text and embodied experience permits growth within this learner’s own ZPD:

To understand or produce any word, symbol, image or artifact in a given semiotic domain, a person must be able to situate the meaning of that word, symbol, image or artifact within embodied experiences of action, interaction, or dialogue in or about the domain. (Gee, 2003, p. 24)

A language learner must have access to the situation where that word or symbol, image or artifact was taken from in order to create meaning—an embodied experience of action, interaction, or dialogue. This is defined as *active learning* or *situated learning*. The richly immersive world of video games can supply highly detailed embodied experiences. Gee (2003) highlights the need for the player to be able to participate in ‘affinity groups’ or ‘groups’ within the semiotic domain. This is the third principle alluded to above, the semiotic domains principle. Zoe was clearly proud to be a part of *UNATCO*, but her *affinity group* no longer regarded her as a friend. Zoe has trouble accepting this loss and creating a new affinity group in *Hong Kong*. The metalevel thinking about semiotic domains principle focuses on the ability of the learner to apply critical thinking (i.e., not passive thinking) about the relationships of semiotic domains being learned to other semiotic domains. Zoe’s awareness of her *imminent death* by activation of the *killswitch* clearly worried her,

having seen its effect on *Anna Navarre*. Now she is on the receiving end. Her inability to locate *Tracer Tong* in *Hong Kong* may have led her to seek external assistance from this researcher in order to preserve her *virtual self as successful agent*, although as you will see later, other events were preventing Zoe from forming her new identity with the affinity group in *Hong Kong*.

Zoe had put in many hours of game-play in order to develop *Denton's* skills—the achievement principle states that there must be sufficient rewards offered at each level of the game to allow the learner to continue towards mastery and sufficient signposting given for the learner to recognize when he or she has been rewarded. In *Deus Ex* those rewards are improvements to your core skills or your weapon accuracy or upgrading of your augmentations. However, Zoe appears more taken by the AI comments of her being an effective agent in the field (see 208 above).

The intertextual principle could be seen as having a more global understanding of certain categories of text, through exposure to a number of embodied experiences within a number of domains. Zoe travels to *Hong Kong* where she will meet a 'terrorist leader' that was supporting *Paul*, her character's brother, another nano-augmented agent who has been terminated by *UNATCO* for his involvement with *Tong* and his cohorts. Zoe will have no choice but to drop the identity she created at *UNATCO* and start to build a new one using the embodied experiences the game presents her with. Her ability to cast off the old and adopt the new will also be a guide as to her ability to recognize the intertextual 'genre' of building a personal identity and will be a measure of how she has developed within her ZPD as the game provokes her towards this goal. Sadly, Zoe is reluctant to identify herself with *Chinese terrorists*, although *UNATCO* regards her as a common criminal now and the memories of this depress her (210). Despite this, she continued to play—in game-play terms she would have had to play for a considerable time in order to exit the *UNATCO*

headquarters and find *Tracer Tong* in *Hong Kong* which reinforces Gee's (2003, p. 67) committed learning principle, concerning commitment to the virtual character within a compelling virtual world.

Tripartite Identities

Gee (2003) argues from a sociocultural perspective that learning as deep, critical learning will come about only if the learner has made the commitment to take on the *identity* of "a person who can learn, use and value the new semiotic domain" (Gee, 2003, p. 59). In other words, unless the learner has decided that the new domain is accessible to them as a *member of this new community*, they cannot participate in it because they do not consider themselves eligible or even capable members of this new group. Zoe's reluctance to associate with the *terrorists in Hong Kong* may have hindered her ability to progress any further or resolve the pressing issue of the *killswitch*, the *terrorists* being the only ones with the technology to deactivate it. Perhaps the semiotic label 'terrorist' had powerful, negative associations for Zoe to the extent that she did not want to associate with them. To develop her *virtual identity*, Zoe must perceive herself as "a person who can learn, use and value the new semiotic domain" (Gee, 2003, p. 59). Zoe would need to forge links from her primary *real-world identity* (the multitude of identities she portrays to others in society) to her secondary *virtual identity* (the way she perceives herself as a character in this game). Our *real-world identity* is what helps us understand who we are, and includes our moral, cultural, and political viewpoints too. In the third identity, the *projected identity*, the learner builds through projecting their own wishes, goals, aspirations, and personality onto the *virtual identity* and is a combination of the other two. It is through this process of juxtaposition of real-world and virtual world identities that we achieve deep learning via our projected identities (Gee, 2003, p. 66).

There is nothing to stop Zoe from restarting the game or mission and playing the character *JC*

Denton in quite a different way. This is a common strategy among gamers as they learn from the experience of failure in the game as to what works and what does not within the confines of the game. It also enables you as the player to direct your game-play according to the desired combination of real-world and virtual-world identities (the multiple routes principle). If Zoe had simply played the game without participating in the game domain—that is, as an external observer—her description of *her arrest* would be vague and non-committal. However, she was highly emotionally charged, even after not having played for three weeks. She was also not happy to enter the game environment again during the interview, describing it as scary.

Interview Continued: Provoking Zoe's ZPD

The emotional bonds Zoe had created demonstrated a strong virtual identity had been developed, along with her projected identity as a good team player within the *UNATCO* staff and soldiers. Losing this bond was quite painful for her. I would argue that Zoe's projected identity as an important member of the group within the game was formed by her virtual self becoming an integral part of the community of practice (Lave & Wenger, 1991) that consisted of agents working for *UNATCO*. Zoe had put herself on the virtual payroll at *UN-ATCO*! Once she had lost this identity (through the intentional game design of terminating *agent Navarre*), the loss may have been such that her motivation to continue had all but stopped. Nevertheless, she found the game so compelling she eventually asked for my help. At this stage in the game-play, Zoe, as *JC Denton*, is unsure of her character's *real identity and background*, though she has some certainties.

218: **Zoe:** yeah, I think so...but at the time I'm definitely sure that *UNATCO* is my enemy... because I know that they are the organization

who killed my *parents* and caused...I lost my *brother*...and I'm going to find out the truth in *Hong Kong* and I need to find out the people who is called...strange Chinese name...*Tang Sing Tong* or something like this.

As a player Zoe appears more confident and aware of the goals she needs to achieve at this stage of the game now that I have provoked her ZPD, and she starts to self-regulate her thoughts again.

242: **Zoe:** I feel quite weird because...when I arrived *Hong Kong*...I got so many thing I need to do...first...and then second.

Kim: (*laughs*) can you remember them...after 3 weeks?

244: **Zoe:** I remember he said I need to find this guy...what's his name?

Kim: *Tracer Tong*.

246: **Zoe:** yeah, *Tracer Tong* (this guy).

Kim: yeah, why do you need to find *Tong*?

248: **Zoe:** because he said I need, I must to contact these people because he's a friend of my *brother* and then I can get more details from this guy. I think he's the leader of terrorists in *Hong Kong*. [So I have to.] And another thing is my *brother* and I...we are no natural people we are been...what can I say...our body is been modify...can I say that...with part of some...just like...robot...some systems which is in our body...my *brother* already die...this is why I need to...when I...in *UNATCO*, I need to send some details from his dead body and the people...I'm quite confused because they say something like...I'm quite special and quite unusual...I'm different compared with my *brother* because I didn't...(what can I say) very strange...I don't understand this part...just that...I didn't...oh! very strange but at least I am sure when I arrive in *Hong Kong* they said my body will be explode or something...over...my life will be over...

so I only got 12 hours to a life...I need to find out *Tracer Tong* to sort out this problem.

249: **Kim:** okay, so *Tracer Tong* knows the answer to stop your body exploding.

Zoe: yeah, something like that.

In line 248 Zoe is summarizing her goals on an ‘actions to do’ level, while on a metalevel she is recreating her *virtual identity* and her character’s reason for existence. She is aware that her *brother Paul* is dead and that *UNATCO* is to blame, is the enemy (218), and is also responsible for *JC’s parents’* death. Notice too how Zoe has resigned herself to accepting the need to associate with the affinity group of *terrorists* in *Hong Kong*, almost under her breath, as private speech (so I have to).

Zoe had called me to help her at this stage of the game as she seemed overwhelmed with the complexities that were unfolding within the game narrative. I decided to clarify the urgency of canceling the killswitch as a priority (249). I direct her to an important conversation with *Jock*, the helicopter pilot, an ally.

256: **Zoe:** Hmm (*reading*). Twelve hours. Killswitch.

Kim: yeah, I think that’s the keyword here.

Zoe: Yeah.

Kim: that they’re talking about the killswitch... in other words...

Zoe: so I will be...

261: **Kim:** dead (*Zoe: dead*) so that’s what happened to your *brother*...so *UNATCO* can switch this thing on...(Zoe: off) well basically, once they start the switch...it’s like they press the switch, 12 hours later you’re dead.

262: **Zoe:** yeah, I remember this...oh yes...when I stay in *UNATCO* center...when I met my former boss...when he talk with that guy (*Kim: Walter Simons*) yeah...and then the guy who in the *Walter Simon* he saw me and he said ‘*We will kill you. You won’t alive in next 24 hours*’...something like this...

but I’m still alive...but the thing is...in my *brother* and I...inside of our bodies there is something what *UNATCO* gave us...and something like killswitch...I think it is a kind of explosion system.

Kim: it’s a time bomb.

264: **Zoe:** yeah, which will...when they are turn... switch on the key and then we will explode ourselves...something like that.

In line 261 Zoe hesitates to say ‘dead’—perhaps she still does not accept that her character will die soon, without any enemy confrontation occurring, if she does not act fast. By line 264 I have provoked understanding of certainty of death unless she takes action to locate *Tong*. I locate the *Primary Goals* screen and ensure Zoe understands these (265) and the location of *Max Chen*, another potential ally and link to *Tong’s* whereabouts. She recalls a scene vividly from inside *Chen’s Lucky Money Club* (282), which she used as a refuge from *MJ12 commando units* (*super-robots that are created to up the stakes of the in-game demands on the player*).

282: **Zoe:** because I get some details from *Max Chen* I think...and another strange thing is, when I get into *Lucky Money* and that *Max Chen* and then somebody follow me, actually...they get into the *Lucky Money* and shoot us...and *Max Chen* has lots and lots of bodyguards that in battle with these guys...and then the both of them...many people die...when the battle finish...and then I just go to the...what can I say...go to the front room of *Lucky Money*...many many people lay on the ground...I saw the people who follow me...they are like kind of policemen but I don’t think they are... they looks quite...they not natural people because they’re wearing kind of machines, something...

Kim: do they move like people, or you haven’t seen them move yet...they’re just dead.

284: **Zoe:** I think I saw one...they are very very powerful...really hard to kill. Yeah. So I didn't join the battle! Too hard!...I thought 'Oh my God!' (*Kim: (laughs) okay...probably wise!*) Yeah, when I saw they are follow me I just ran into the *Max Chen's room* and I closed the door...when they finish I open and go out.

This rich description of a massacre and the power these new characters wield appear to have frightened Zoe into a state of inaction. I decided to investigate her use of augmentations, as she would need these to survive the next stages of the game. I discovered she was poorly equipped as a player in this department (289) and that she considered the augmentations practically useless.

292: **Zoe:** I don't use that actually...I think they're useless! Perhaps because I didn't upgrade them...so they only comes out very slightly...result...so they are not that helpful.

Kim: but you upgraded your strength, yeah?↗

294: **Zoe:** it's not that helpful...i think if I can up to four...level four then might be very useful.

295: **Kim:** so your actual augmentations...you don't really switch them on then when you go into a battle or...(Zoe: no) when you're trying to avoid people or...

296: **Zoe:** I even try once but...it's not that helpful.

Interestingly she seems reluctant to experiment with using the augmentations in any aspect of the game. Even the built-in augmentation of a light is not used. There appear to be technical reasons.

393: **Kim:** do you ever use your light?↘

394: **Zoe:** this is why I'm want to talk about with you...I don't know why this game...they...it takes a long time to...when I press F12 and then it switch on the light but you have to wait a long time to start to move.

395: **Kim:**(to start to move?) show me...right you've got a light.

396: **Zoe:** I can go into here, but when I...strange...I don't know...(giggles) perhaps because you're here!

Kim: because I'm sitting here it suddenly works! (*laughs*)

398: **Zoe:** you're lying, you're cheating!

Kim: what was happening before?↘

400: **Zoe:** before when I press this kind of keys (*the F keys along the top of the keyboard*) the game would suddenly just be...stopped.

Nevertheless, they worked when I used them, which Zoe was pleased to observe. Returning to (300) indicates why there may have been problems with the augmentations.

Kim: let's take a look at your health now.

300: **Zoe:** I'm always being very healthy...and I already...

Kim: you've got 253 (*normal game supply is four or five per mission!*)...now is that from picking them up in the game↗ or (Zoe: No↗) have you used 'cheats'↘?

302: **Zoe:** of course used 'cheats'.

Kim: okay↘ tell me.

304: **Zoe:** because in the game.

Kim: tell me about using 'cheats'...how many 'cheats' have you used↘?

306: **Zoe:** erm, just several times...one I changed this medicine number...number of this medicine box and er, number of ammos...I had lots and lots of weapons but...most useful one I think is this one...(points to *sniper rifle*) 2006 ammo because it's very...you can see the details with this one...first the maxi range is very good and you have silencer...very very quiet...I think 'maxi' range is the most important thing...it's very high...I can shoot very far away and then...without people knowing.

Zoe has resorted to using cheats to gain unlimited health, unlimited ammunition, and advance all her physical skills. She was also distancing herself

from potential enemies and picking them off like a sniper—an effective strategy. Her off-hand manner with regard to the use of cheats (302) indicates she considers this to be an expected compromise by gamers and not at all unusual. She either decided that augmentation is not helping her achieve her goals or she felt the need to supplant the dearth of *augmentation canisters* with other (unlimited) options. Two questions come to mind: Is augmentation considered to be akin to ‘defiling the body’, which is considered unacceptable in some cultures, and does that hold true for the Chinese culture; and is Zoe using cheats to compensate for her unwillingness to use the augmentations? Using cheats is certainly an accepted part of gamer strategy to continue playing, despite the real-world inabilities of the gamer (Gee, 2003, p. 187). Good COTS video games allow for degrees of autism among its players, and cheat codes permit players to overcome particular weaknesses that would otherwise prevent their continuing or participating in the game. Despite giving herself endless *health kits* and unlimited *ammunition*, Zoe came to realize she is no match for the demands being made on her character in the virtual world and so retired from play for three weeks. Nevertheless, the game was so compelling that Zoe was unwilling to return the CD-ROM to me even though I had offered to take it back during one tutorial session; instead she was determined to solve the issues that were still vividly active in her mind three weeks later. She had already discussed the lack of strategies (41) at the beginning of the game and was now confronted by the need to provide another set of strategies at a much higher level. She had advanced-level skills using the cheats so she was effectively playing as a ‘grand master’, but without augmentation, she was mortal. Augmentation leads to possession of god-like powers, as the initial cinematic introduction and the title of the game itself indicates. Zoe had reached the limits of her ZPD. Her strategies were now useless to her. In fact, she was still using a *New York UNATCO* ‘shoot on sight’ strategy in *Hong Kong*

which was inappropriate because there were no threats initially, as the *military police* were friendly towards her character *JC Denton*. However, Zoe decided she needed to get some information from the *police headquarters* in the *marketplace*. The character *Maggie Chow* offers to help *JC*, but she is merely using him as a pawn in her own game to incite a feud between the two *triad* gangs. She gives the code for a secret vault in the *police HQ* to *JC*, but the answers he is looking for are not there—the first double cross the player experiences in the game. This action resulted in Zoe shooting at least one *Chinese military policeman*. (There may have been two more in the station—I decided not to look as I believed Zoe was deeply embarrassed at committing such acts, and this may have been the reason for such a long delay before informing me of the difficulties she was experiencing). A number of possible solutions could have been available to her, but she did not seem to have considered them—using a *riot prod* to render AI unconscious or wearing a *camo suit* (345 below) were not being considered by Zoe, neither to avoid detection when snooping around nor as a strategy to escape when under attack—both very effective strategies. What was more surprising was the disdain she held for the objects discarded as rubbish (*Zoe: I’ve already threw them over 5 already*). I decided to provoke her ZPD on this issue.

340: **Zoe:** (reading from *Denton’s databank*) computing system...they can render an agent invincible to...

Kim: is that ‘invincible’? 🐢?

342: **Zoe:** ‘invisible’ (Kim: Ohh! 🐢🐢; Zoe laughs) to both humans or bots by dynamically...

Kim: etcetera etcetera yeah...a bit of technical English there...(reading) dynamically refracting light and radar waves...so, basically it makes you *invisible*.

344: **Zoe:** but they are not very 🐢useful 🐢.

There is still reluctance to use this equipment for some reason. I decide to provoke another area altogether—her culture.

345: **Kim:** it's like a magic cloak (*Zoe: hmm→*). well, you've got one so let's see how you could possibly use it... (*Zoe: I've already threw them over 5 already.*) I'm sure you could find some more. What's interesting about this is that at the moment you are saying you can't play any further because you keep getting shot by Chinese police.

Zoe 'complained' to me that she could not play *Deus Ex* any further without "having to shoot *Chinese military police*." I now discover she has disposed of at least five opportunities to become invisible while investigating situations and places, thereby remaining undetected and avoiding bloodshed.

346: **Zoe:** ㊦ it's not only like that... I'm not pleased to play foreign game which (*inaudible* 'when they travel?') China because I think Western people they always misunderstand Chinese culture and people and life... they always criticize them, they always blame something which they don't agree.

347: **Kim:** I'm sorry... who disagrees ㊦?

348: **Zoe:** Western people.

There seems to be considerable bottled-up emotion. I persist.

349: **Kim:** about what? ㊦

350: **Zoe:** about anything I think because for Western people China is too foreign, too foreign and many cultures can blame many issues... can bring up many issues and many things people don't accept and they disagree with.

351: **Kim:** but my issue here is that you're playing the game, you're in China, your Chinese, naturally by birth... so...

352: **Zoe:** yeah, it's Chinese people's fault... I think until today, Chinese people's minds haven't been independent, haven't been... (*pause*) rescued... you can say... we are still in limited opinion... just like can you remember why, the past hundred years why China been ruined by Western people... because the last Chinese dynasty we closed our market... we closed Chinese land... we don't allow our residents go out to trade with another country. (*Kim: right.*) We are no interest in outside world.

Zoe has been reflecting deeply on Western and Chinese cultural differences and is heavy with emotion about Chinese people being misunderstood in the West. Her comments about Chinese people's minds not having been independent, and not having been rescued provokes questions in my own mind about whether they are independent and rescued now. Does Zoe consider they are? I provoke further.

353: **Kim:** okay, so how does that...

354: **Zoe:** We're proud of our civilization. So until today is same thing happen. Even we open our market we are pleased people to... foreign people trade with us... to do some commercial thing.

355: **Kim:** my point is, here you are in this game but you won't go any further... why is that? ㊦

356: **Zoe:** This is what I'm talking about.

357: **Kim:** okay, explain again 'cos I can't.

358: **Zoe:** my feeling!

I understand her argument to be that Western minds do not understand Chinese culture because China has been "closed to the West for so long." What I don't understand is how a Chinese player, playing an American secret agent, still finds it okay to kill a *Chinese military policeman* without any justification (other than needing to get into the *police station* in order to continue her mission).

The proof must be in the game itself, so I decide to investigate.

359: **Kim:** just go into the game, show me where you are in the *market*.

Zoe: (looking at *Saved Games*) *Lucky Money*... no I get out from there.

Kim: so what's happened...have you met *Max Chen* at this point (*Zoe: yes*) and have you been into the *Versalife* building? 🗡

Zoe: no yet because I cannot.

Kim: okay, so it's locked to you.

Zoe: (perhaps I will meet some enemy) I'm just scared play this game sometimes!

Zoe claims to be quite frightened by the game environment, but retains her composure while we look around the market.

371: **Kim:** okay, so you've looked at *data cubes* and what do you do when you read that? If you just click on it...that's the free *map*, okay...so you've picked up the *map*...erm, so have you been involved in any gun fights or anything in the *market* at all...or are you just walking through the *market*...you're not actually shooting anybody in the *market*.

Zoe: I'm not, because when I arrived there at first time...I think the *policemen* they move by themselves...but before there's another *policeman* sitting...standing in there...he was standing there and I talking to him and he said '*no one can show their gun in this market*' so I always just take my empty hand go into there. If I pick up any weapons from my pockets and then I think the policemen will start to shoot me...something like this because when this *residents* saw me take a gun people will terrified and will run away.

Kim: what, you've done that? 🗡

Zoe: I didn't 🗡 (*Kim: oh you haven't then*) but I suggest it will happened and there is a warning bell..(*Kim: yeah yeah*) yeah, if I

pick up something people will run there to rung bell. (*Kim: sure.*)

Zoe has not experimented or if she has, she has forgotten as it is quite possible to walk around the *market* with a drawn weapon without encountering any opposition. It is the discharging of weapons that causes the alarms to activate. She has taken the word of a *Chinese policeman* AI character as 'law to be obeyed' and she obeyed it. Interestingly, the real-world law (within Zoe's domain as a Chinese national) appears to be stronger than the *virtual game law* at this stage. The real-world semiotics have powerful representations in the virtual world until such time as the player wishes to break those codes, as Zoe does by shooting a *policeman*, protected by the psychosocial moratorium principle. Zoe may have spent many hours of game-play trying to find answers to *Tong's* whereabouts, fully knowing her *virtual life* was coming towards an end. In an act of desperation, I believe she resorted to violence against the *military police* in an effort to try to uncover mission-critical facts, unaware that this was a 'red herring' in the game design. The game does not just spoon-feed the player with facts and information—the player must tease it out of the game environment, which is hard work. Gee (2003, p. 90) calls this the probing principle. For example Zoe:

1. Probes the virtual world to gather data,
2. Creates some hypothesis based on this data,
3. Reprobes the world by applying the hypothesis to see the effects, and
4. Responds to the feedback.

This principle could be seen as cyclic for every independent action the player carries out in the game, and a player may need to juggle a number of these separate cycles depending on the complexity of the storyline. Gee (2003, p. 90) comments that without this strategy in place, a player would not get very far in a video game. Clearly, Zoe had tried everything in her power to progress through the

game. She had reached the limits of her ZPD as far as the game domain was concerned. I provoke her development at this critical stage, but first notice something strange about the way she holds her fingers over the keyboard of her laptop. I ‘drive’ for a moment to see what the problem is.

375: **Kim:** let’s just go down this road...how do you...(keyboard configuration to control character movement does not work for Kim)...oh, you use different patterns altogether to go forward...(Zoe: *there’s a robot in there*) and the robot’s ‘green’ (*friendly*) at the moment, okay.

Zoe has changed the key bindings, which control movement and bring up information screens and call up weapons and other devices from her inventory. I did not clarify what changes she had made so as not to interrupt the flow of her description of the current situation. Watching the contortions she had to put her fingers through to carry out simple movements was revealing as she had positioned many keys in close proximity—nevertheless she still seemed unsure of which keys did what. This could have been what was causing her such difficulties in fending off opponents earlier in the game and now presented a problem of control at a higher level of play. Additionally, laptop keyboards are much more compact and do not offer the raked profile of a large keyboard, but lie flat, which could be presenting Zoe with more physical control issues. I return the laptop control to Zoe.

376: **Zoe:** (*aside: you see this, I kill this*).

Kim: who’s that?

378: **Zoe:** *Chinese Military Police (smiles)*.

Kim: so you did shoot him?☹

380: **Zoe:** ☹☹ yes.

Kim: okay→ um...why did you shoot him?☹

382: **Zoe:** because I need to get into there (*indicates police station*) yeah...when I picked this, opened this (*Kim: that’s the police station is it?*) Yes. When I get into there but I’m no allow in.

Kim: okay, so you feel you need to go in there for some reason?☹

384: **Zoe:** because inside have first a *TV control system* I can, when I go there I can switch off. Then I can go to many place.

Kim: why do you need to switch that off?→

386: **Zoe:** I dunno—sometimes I think it’s important (*giggles*).

In 376 Zoe refers to a *Chinese policeman* who she has shot dead. She mentions the act but refers to the character as *this* (not him). Unless she means to utter the phrase “I kill(ed) this man,” but in her next breath she identifies him by using the job title ‘*Chinese military police*’ but does not add gender (*policeman*). I wondered if this was a strategy to lessen the act and divorce herself from it by remaining gender-neutral or genderless. Her argument for having to enter the *police HQ* using violence demonstrates her overarching aim to meet the game goals even if it meant killing a *Chinese authority* figure. In contrast to her concerned voice on the phone when she called to tell me about not wanting to kill any more Chinese characters in the game, Zoe seems quite calm now. It is as if, having shown me the deed, she has been absolved of the crime. I decide to retrace my steps and ensure she understands all the basic elements of the storyline.

405: **Kim:** how do you feel about the two games...i mean...do you think you’ll carry on with *Deus Ex*?

Zoe: perhaps not...really...if I will play again...perhaps I will start in the middle or from the beginning start because...as now I’m in Hong Kong...I feel is...the story of this game is getting deeper and more complex.

Kim: it gets even more complex...i assure you.

Zoe: Yes, of course...because in the beginning I’m a member of *UNATCO*...and at the end I’m joined to terrorism group...and then become enemy of *UNATCO*...and *UNATCO* is a fake...is not right...is work

for money...is no work for government...
no work for the residents...this is...which is
disappoint me...a lot and shock me...and...
on the other hand....

She seems keen to start over with the new information, although there is reluctance too and she has not come to terms with the concept of working outside of a government framework in the *Hong Kong* environment, which I suggest is to do with her Communist Party upbringing and her unwillingness to associate with *terrorists*, even in a virtual world. I check her comprehension of the plot.

409: Kim: did you understand the plot with the Grey Death...this sort of plague and the vaccine that you're trying to find...did you understand that part of the story...you know you had to find those big green canisters...sort of bubbling liquid?

Zoe: Yes.

411: Kim: do you know what they were...part of the story?

Zoe: before I don't know...because I remember the contactor he always tell me 'you need to find these...there is three bottles of this green water, or something...green liquid...i don't know what's it for but anyway I found this...these three bottles.

413: Kim: can I tell you what they are?↗

I started to go into an explanation of the plot instead of 'concept checking'. I was starting to feel tired after nearly three hours of interview. Zoe stopped me and wanted to explain her understanding, which seemed a better idea. She seems to be very alert still—perhaps because she can sense that solutions to her game-play will be provided soon.

414: Zoe: no...before you tell me I tell you...and then when they said 'good you've found out these three bottles and then we will send a group of military to cover up...to find out...

to take these things away'...and I think it's alright...but...the second time...i mean...after I achieve this goal...after I complete this mission...the next time when I see this thing is...they are just next to *my brother's* dead body...well...i dunno...i think something wrong about those things...which is not right.

Kim: but you'd learnt to recover them...what and then *UNATCO* own them...*UNATCO* have them.

416: Zoe: I think they have them just for...it's an important element to support their secret testing...or something...do you think so?↗

I was surprised that Zoe had not grasped the special significance of these objects. She had a photo and description of one in her data files and had risked *her virtual life* on a number of dangerous missions in order to secure them for *UNATCO*. The whole narrative of *Deus Ex* is based on their very existence, but Zoe seems to have missed the point: *Ambrosia* is a vaccine against the *Grey Death*, is manufactured by *Versalife*, and is in short supply, hence the importance of *UNATCO* preventing it from getting into anyone else's hands. I explain a little more of the plot, and concept check vaccine and antidote with a dictionary. Zoe makes the association with Bird Flu and then corrects herself to mean the cure, not the disease. She realizes that *Ambrosia* is a positive thing, so must have thought that it was for negative uses, such as poison. I cannot see why she made this assumption at the beginning of the game, but decided not to ask her so as not to embarrass her. I refer to a bilingual dictionary to define 'vaccine'.

426. Zoe: its like this...(shows dictionary).

Kim: like an antidote...okay...is there another word that you know?↗ What does a doctor give you to stop you getting the disease?↘

428. Zoe: cure↗? Medicine.

Kim: yeah what sort of medicine...I'll give you another word...do you know the word 'vaccine'?↗

430. **Zoe:** hmm...oh yes...like bird flu!⁴

Kim: yes↗ okay.

432. **Zoe:** or another normal flus...so...hmm...to protect you before you get this thing.

Kim: so those green bottles you were looking for in *Deus Ex*...they are a vaccine.

434. **Zoe:** ahhh↗??? But it's a positive thing...i thought they are....

Kim: they're a positive thing, no, they're a good thing...but there is a limited supply of the vaccine...just like with the bird flu...they can only make so much of it...so who do they give it to?↘

436. **Zoe:** I think...of course...because the vaccine is limited we can't give every single person in the world so we...

Kim: so who decides who gets the vaccine?↘

438. **Zoe:** government.

Kim: hmmm↗...who does the government give the vaccine to?↗

440. **Zoe:** the most important people first...the wealthy people or like this country (Britain) it's the Royal Family first and another famous celebrity like...celebrity of sport...or singers...this kind of...businessmen...this kind of people...poor people especially...for example in America like black people like New Orleans...these⁵ people will be abandoned...because they are useless...they are no valuable to the government.

Kim: so that's really what the story of *Deus Ex* is about...you start off working for UNATCO and you start off getting this...the first raid you do...when you go up into the Statue of Liberty Island...you have to tell the NSF boss...you arrest him at the top of the building (*Zoe: yes yes*) and he has one of the canisters...or you were trying to stop them because they were taking the canisters...so really the NSF were stealing these vaccines from UNATCO...or from the government.

442. **Zoe:** they want to survive more people.

Kim: exactly...they're trying to protect their own people...so when you realize that that's why you join NSF...because you realize they're trying to protect the ordinary people.

444. **Zoe:** the government want to abandon useless people.

In 442 (*they want to survive more people*), Zoe now sees the reason the NSF wanted to capture the *Ambrosia* shipments from UNATCO—in order to save ordinary people. She may have a concept of the NSF as 'freedom fighters' now. Initially, *Denton* as a UNATCO agent is fighting the NSF, a supposedly *terrorist organization*. The plot of *Deus Ex* plays with the concept of "one man's terrorist is another man's freedom fighter"—a quote spoken by a character in the novel *Harry's Game* by Gerald Seymour, constantly making the player consider whose side he or she is on. Zoe's provoked ZPD leads to her self-regulating her mission goals and purposes as *Denton*:

444. **Zoe:** the government want to abandon useless people.

Kim: and let them die of this death...but it also turns out...the more you look at the story you find out that the Grey Death was created by...

Zoe: UNATCO...government!↘

Kim: well by...some government agency...to kill people so the government could take control...that's what happens in the next part...when you go into *Versalife* you'll find out a bit more information!↘

Zoe: so who I am!↘?

Kim: sorry...how do you end or who do you become...↗ well you'll have to find out! If you're interested enough.

Zoe: I don't understand!↘ If my parent's could die, which means they're nat(ural?)...normal person so why my *brother and I* we're half machine...we are half robots...we no not natural people any more... (*Kim: that's*

something you'll need to discover) ...ourselves have been modified...why?🔪👊 ... and why chose me?🔪👊

Kim: these are questions that the game will answer (*chuckles*).

Zoe: why they chose me...and no choose anybody else?🔪👊 how special I am.👊

Zoe seems excited to discover the answers to these questions now. I need to check whether she still feels unable to use the augmentations.

435: **Kim:** but I'd recommend that if you do want to play on and find those answers you also will find you need to start using those unnatural (*Zoe: super powers*) super powers in order to...well obviously progress through the game.

Zoe has used the word 'super powers', not in the sense of great nations, but as a noun phrase to describe what being augmented is like. This may have resonances in fantasy figures like Superman™, where god-like skills are used for good, not evil.

Zoe: I feel very slowly to update these skills... because I need to find that bottle (*upgrade canister* or *augmentation canister*).

Kim: yeah those...you will find once you get into *Versalife*...there's four more upgrades that you do in *Versalife*...probably you have to go in there a second time.

Zoe asks about *Versalife*—she is interested in finding out about this company as it is the next stage of the game.

456: **Zoe:** What does *Versalife* mean?

Kim: *Versalife* is a company in *Hong Kong*...and obviously you're going to go in there and find out what they're doing but you'll soon find out they're doing a lot more than what you think they're doing...(laughs).

Zoe: is it illegal thing? (*Kim: Oh yes! Laughs.*) Something bloody👊 ...something darkness👊...or it's something good for people...good for residents...

Kim: ummmm...

Zoe's final question still demands to know if the Chinese government is being slandered in any way, but I assure her that it is only the *American government* that receives criticism, but I play this down.

463: **Kim:** no🔪👊...there are no...there is no criticism of any known government in this game so as far as that game is concerned it's a politically correct game except for maybe a connection between the *American government* and who they're controlling.

Zoe: I think so because the first location is the *Liberous Island* so...

Kim: but I think that is just because there...obviously the number of people who will play the game are probably Americans...that's probably they're bigger.

Zoe: Yes, because George Bush everyday talking about anti...

Kim: ...terrorism.

The tape ended at this point. Although we started to have a discussion about terrorism and American and British policy, I cannot include this data as it was not recorded. Nevertheless, the interview process brought to mind many unanswered questions Zoe had about international terrorism and police states.

CONCLUSION

Despite not having grasped the global pandemic storyline initially, my attempts at provoking development of her ZPD provided Zoe with increased determinism to continue with the game from a more informed position.

Zoe was able to complete 12 missions, albeit using cheats, up to the interview. This is quite an achievement in itself, as Zoe did not demonstrate the skills of a seasoned first-person shooter gamer, and the game's virtual character, being male, may have been difficult for Zoe to relate to. Self-regulation to such a degree in an L_1 environment, without L_2 dialogic support—that is, relying on her own study skills to mediate for her without reference to communities of enquiry exterior to the game—clearly demonstrates the effectiveness of the gaming environment to supply this dialogue. Given that the project ran over a number of months, Zoe must have engaged in many hours of play to reach this level as an intermediate learner of English. This seems to indicate that she had fully identified with the virtual character *JC Denton*, and until the cultural issues arose about playing in *Hong Kong*, she was making good progress. This disturbance to her play/learning is indicative of her feelings towards the game's cultural stereotyping of Chinese and may have been sufficient to cause her to withdraw from the game. There is also the possibility that the complexity of the storyline was overreaching her ZPD so flow was disturbed and only sporadic learning was occurring. It would be interesting to discover how she acquired the cheat codes for the games, whether off the Internet or by asking friends at college. The study could not ascertain whether any external help was given to Zoe throughout the period of play and is a weakness of the study. I base my assumption of minimum peer/expert support based on reports from the host mother who commented that Zoe rarely left her bedroom after returning home from college (implying she did not have an active 'social life' with other students), and also my personal observations of her in the learning resources center at the college and seeing her walking home from college where she was always alone. She would have had to engage with the plot in *Deus Ex* to be able to give such detailed descriptions during the interview, and there are indications of deep learning with regard to this.

The strongest evidence is the emotional upset she displayed when describing her capture and imprisonment by *UNATCO*. Her ability to make the domain shift from the in-game conspiracy of a *government* destroying its own people in order to gain control over the population, to the reported appalling lack of government response given to the victims of Hurricane Katrina in August 2005, allegedly based on the victim's social class and race, demonstrates Zoe's understanding of real-world parallels within the semiotic devices of the game.

Understanding the processes that lie behind the metacognitive shifting of domains is under-researched partly because the processes are so immediate and therefore difficult to measure when they occur, and partly because they remain for the most part invisible and unconscious to the learner. I would argue that Zoe has made strong virtual identities within the video games that have demanded her to utilize the target language in order to reach a certain stage in the games she has been playing. She has not had opportunities to develop her "gaming skills" through communities of enquiry, but has provided evidence of her deep learning of real-world issues through exposure to the game and has demonstrated competence at shifting domains within her inter-language competences, which constitutes a higher-order skill. Zoe has certainly been provided with new ways of viewing such topics as conspiracy, terrorism, and allegiance, and it would be interesting to follow up the research to see if, one year later, she is able to recall any of the issues she discussed in detail as that would certainly demonstrate long-term retention of information, and more significantly, whether her ZPD had expanded in these topic areas. She could certainly recall in minute detail after her three-week abstention from playing the game, which supports the argument that video games can provide effective situated learning environments. What COTS video games often do not do is provide the pedagogic intervention required. As the researcher, and as a member of a community of enquiry, I had to engage in provok-

ing Zoe's ZPD in order for her to understand the detailed plot of *Deus Ex*. Whether this was due to her need for more refined study skills or more likely her need to be part of a real-world community of enquiry would be worth researching further. The question is, do COTS video games teach language as a standalone product, or does there need to be intervention and dialogic intercourse with an expert from a community of enquiry? There were sufficient affinity groups within the communities of practice in *Deus Ex* to enable Zoe to feel part of the game and to contribute to its 'development'. Further research will need to be carried out to ascertain how effective these communities are in providing the learner with language skills in the L_2 .

There is little doubt that good COTS video games are engaging and provide dynamic and compelling entertainment. What cutting-edge educators desire is for the rich virtual worlds within video games to be harnessed for the presentation of learning material.

Video Games in Educational Use

van Eck (2006) is clearly optimistic about "serious games" that are in development,⁶ where the lessons learned from manufacturers of COTS games have been applied to "edutainment" products so that the game-play element has not been overshadowed or lost through overzealous pedagogy. This particular process of production of digital game-based learning (DGBL) as "one-off edutainment" is expensive, as it is time consuming and requires a great deal of input in terms of man-hours, which companies are reluctant to invest in for fear of "revisiting their unprofitable past" (van Eck, 2006, p. 20). van Eck (2006, p. 18) reminds us of the dangers of "academizing" games and quotes Papert (1998) who refers to edutainment software of the last decade, which instead of harnessing the power of games for learning resulted in "shavian reversals"—the offspring that inherits the worst characteristics of both parents—where the game

element is boring and the learning is just "drill and kill." He argues that we must ensure we do not put too much emphasis in the other direction either, where games are fun to play but "hit and miss when it comes to educational goals and outcomes" (van Eck, 2006, p. 18). By finding the synergy between effective game-like engagement with the software and effective pedagogy, van Eck claims that COTS digital game-based learning is possible in the classroom.

There are a number of organizations that classify games according to guidelines agreed upon within the video games industry to inform parents and teachers of game content and suitability for young players. The Entertainment Software Rating Board (2007) and the Pan-European Game Information (n.d.) age rating system established in 2003 provide an informative censorship of game content by giving a range of suggested ages the games are suitable for, as well as iconic representations of game content, such as bad language, sex, drug use, violence, gambling, and fear, as well as racial and other forms of discrimination. This rating system is similar to that used by the film industry, but has a much lower threshold for age suitability, starting its ratings at 3+, then advancing to 7+, 12+, 16+, and 18+ for adult games. These ratings are a useful tool for teachers and educators when selecting material suitable for certain age groups and cultural backgrounds.

The data provided by this study for the use of COTS video games to teach second or other languages can be considered inconclusive. Nevertheless, further research into COTS video games should attempt to assess how much change is occurring within a learner's ZPD while accessing the L_2 environment. Studies that assess all four skills (listening, speaking, reading, and writing) through provoking the individual learner's ZPD would provide valuable data as to how rapidly the L_2 was being acquired. Access to diagnostic equipment used by games manufacturers on subjects for beta testing new games would provide a richer source of data about how the player accesses the

L₂ within the game environment. Attention could be given to where the game needs to supply the dialogic interaction, which would otherwise have been supplied by a teacher or more knowledgeable peer within a community of enquiry.

Video Games in Employment

Just as Zoe felt comfortable in the *UNATCO headquarters*, I suggest that video games themselves can create communities of enquiry within the game world where the domain knowledge of a field of enquiry is accessible, in stages appropriate for the learner on the periphery of his or her chosen subject. I do not envisage this as a static “body of knowledge,” but as an organic database of simulated experiences that accurately reflect the real-world domain as it is updated and renewed.

“In communities of practice, knowledge, skills, identities, and values are shaped by a particular way of thinking into a coherent epistemic frame” (Shaffer, Squire, Halverson, & Gee, 2004). This concept of providing epistemic frames is based on the epistemology of that domain, the working knowledge of how certain professional groups think. Doctors speak about medical issues in the language they all know, as do teachers, scientists, lawyers, and childminders. Within those frames lie the language and concepts of that domain’s culture and practice. Video games would be able to act as examples of good practice within these epistemic frames and provide that group with learning environments for future employees.

I am not suggesting either that *all* forms of learning should be accessible only as a video game. What video games do, and do well, is provide a rich immersive environment containing virtual identities that act as powerful learning tools, and this could be integrated into current e-learning programs where scenario-like engagement is required by the learner, for assessment purposes for example. This is already practiced in jobs where there is a high risk factor such as air-traffic control or training tactical military operations, or

where simulation is an effective substitute during training where equipment used has a high replacement cost such as fighter jets or oil rigs and where novices require specialized training before being presented with the real-world scenario.

Video Games in Life

When a player identifies with a character in a video game, he or she is projecting his or her own self into the game and giving birth to a new identity that they will eventually accept as a real-world identity. This may sound like fantastical science fiction, but the evidence is already available, as this powerful communication and learning device is being used for both good and evil. Gee (2003, p. 151) highlights the fact that racist organizations have produced their own video games in order to teach their perspectives on reality. He argues that video games are no more powerful than books or films in that we take from them what we choose to, but also suggests that playing such a game would inform the player of why such an organization hates the way that it does and makes the player want to “redouble their efforts to work for world peace, diversity and tolerance” (Gee, 2003, p. 199). I would argue that minds can be changed by dialogue, and that learning is dependent on what you bring to the video game as your real-world identity. There are a myriad of facets that make up each and every life. The games design for the language learner to experience deep learning of the target language includes the learning of that language’s culture and what binds it together as a society. Video games used as powerful learning devices would make it possible to create virtual identities that enable learners to share in the effective social practices, powerful identities, shared values, and ways of thinking of important communities of practice. Shaffer et al. (2005) direct us to the provision of epistemic frames for learners, where finding out about the ways of thinking, doing, and knowing within different communities of

practice, such as different professions, leads to a “thickly authentic” context in which to learn where

activities are simultaneously aligned with the interests of the learners, the structure of a domain of knowledge, valued practices in the world, and the modes of assessment used (Shaffer, 2005).

By engaging the language learner in virtual communities of practice that they desire to be part of, they are more able to acquire the target language while developing their projected identity as a member of that community. Video games are fun too:

In play, we participate in a simulation of a world we want to inhabit, and epistemic play is participation in a thickly authentic simulation that gives learners access to the epistemic frame of a community of practice. When it succeeds, it is fun, not because fun is the immediate goal, but because interest—linked to identity, understanding, and practice—is an essential part of an epistemic frame, and thus of an epistemic game. (Shaffer et al., 2004).

I do not call for the abandonment of hard-won effective practices in English Language Teaching (ELT), which have produced and will continue to produce results in providing learners with the opportunities and abilities that ownership of another language can bring them. I do call for the adoption of any and all technologies that will make the task easier to produce those results by engaging the learner. Prensky (2001) highlights the differences that these technologies are already having on the way young people think and act in the society (Prensky, 2001). Learning styles are changing and the pedagogic processes must adapt to address this change. The technology is now ripe for deploying into educational settings such as language learning. The idea is not new. Titles such as *Who is Oscar Lake?* (Language Publications Interactive) and the *Carmen San*

Diego series (Brøderbund) launched over a decade ago were brave pioneering examples of what was then considered cutting-edge language learning products. Perhaps the video game industry could take the “moral high ground” by spearheading the development of video games for learning in all communities of practice. Our schools and universities would greatly benefit from being able to provide our students with rich, deep learning environments. And as regards examining learners, just sit the examinee in front of the video game of their chosen domain and see how well they survive in it!

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KEY TERMS AND DEFINITIONS(FROM THE 36 LEARNING PRINCIPLES PROPOSED BY GEE, 2003)

Committed Learning Principle: Learners participate in an extended engagement (a lot of effort and practice) as extensions of their real-world identities in relation to a virtual identity to which they feel some commitment and a virtual world that they find compelling.

Design Principle: Learning about and coming to appreciate design and design principles is core to the learning experience.

Identity Principle: Learning involves taking on and playing with identities in such a way that the learner has real choices (in developing the virtual identity) and ample opportunity to meditate on the relationship between new identities and old ones. There is a tripartite play of identities as learners relate and reflect on their multiple real-world identities, a virtual identity, and a projective identity.

Intertextual Principle: The learner understands texts as a family (genre) of related texts and understands any one such text in relation to others in the family, but only after having achieved embodied understandings of some texts. Understanding a group of texts as a family (genre) of texts is a large part of what helps the learner make sense of such texts.

Multiple Routes Principle: There are multiple ways to make progress or move ahead. This allows learners to make choices, rely on their own strengths and styles of learning and problem solving, while also exploring alternative styles.

Practice Principle: Learners get a lot of practice in a context where the practice is not boring (i.e., in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success). They spend a lot of time on task.

Probing Principle: Learning is a cycle of probing the world (doing something); reflecting

in and on this action and, on this basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking the hypothesis.

Psychosocial Moratorium Principle: Learners can take risks in a space where real-world consequences are lowered.

Regime of Competence Principle: The learner gets ample opportunity to operate within, but at the outer edge of, his or her resources, so that at those points things are felt as challenging but not “undoable.”

Self-Knowledge Principle: The virtual world is constructed in such a way that learners learn not only about the domain, but about themselves and their current and potential capacities.

Semiotic Domains Principle: Learning involves active and critical thinking about the relationships of the semiotic domain being learned to other semiotic domains.

Semiotic Principle: Learning about and coming to appreciate interrelations within and across multiple sign systems (images, words, actions, symbols, artifacts, etc.), as a complex system is core to the learning experience.

Situated Meaning Principle: The meaning of signs (images, words, actions, symbols, artifacts, etc.) are situated in embodied experience. Meanings are not general or decontextualized. Whatever generality meanings come to have is discovered bottom up via embodied experiences.

Text Principle: Texts are not understood purely verbally (i.e., only in terms of the definitions of the words in the text and their text-internal relationships to each other), but are understood in terms of embodied experiences. Learners move back and forth between texts and embodied experiences. More purely verbal understanding (reading texts apart from embodied action) comes only when learners have had enough embodied experience in the domain and ample experiences with similar texts.

ENDNOTES

- ¹ The excerpts have been transcribed from audiotape recordings between Zoe and the researcher. Pronunciation, grammar, and syntax errors have been left unaltered and an indication of intonation direction given by arrows at the end of a line. Italics indicate characters, locations, or fictional places within the game environments, so *Hong Kong* indicates the city as represented in the game environment, not the real-world city. Where discussion involves real-world locations, these have been left in normal font. Where Zoe uses the first person singular to refer to herself as a character in the game, 'I' remains in normal font.
- ² Gee's excellent book on *What Video Games Have to Teach Us About Learning and Literacy* has been referenced throughout Zoe's interview to highlight the key principles built into good COTS video games.
- ³ Full © script for *Deus Ex* prepared by Luke Kowalski: http://db.gamefaqs.com/computer/doswin/file/deus_ex_script.txt. Description of the game *DeusEx* with hyperlinks are from Wikipedia: http://en.wikipedia.org/wiki/Deus_Ex
- ⁴ A topical subject for China—SARS and now Bird Flu (H5N1 avian influenza).
- ⁵ Zoe refers to the almost complete lack of response by the Federal Emergency Management Agency (FEMA) in the United States before, during, and after Hurricane Katrina hit New Orleans (taken from Wikipedia, September 5, 2005; available at http://en.wikinews.org/wiki/Federal_response_to_Katrina_a_%27National_Disgrace%27).
- ⁶ *Environmental Detectives* developed by Education Arcade, *Hazmat Hotzone* from Entertainment Technology Centre, *Virtual U* developed by Professor W.F. Massey, and *River City* by Professor C. Dede.

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Chapter 4.20

Narrative Development and Instructional Design

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ABSTRACT

This chapter explores the challenge of balancing narrative development and instructional design in the creation of an electronic game-based learning environment. Narrative is a key factor in successful commercial games. The hero's journey is explained and proposed as a model narrative structure for developing educational role-playing games and informing instructional design. Opportunities to embed various instructional strategies within the hero's journey structure are presented.

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INTRODUCTION

With annual proceeds that exceed the movie industry, the popularity of entertainment video games is stunning. In January 2007, Blizzard Entertainment announced that their massively multi-player online role-playing game (MMORPG), *World of Warcraft*, had more than 8 million subscribers (Blizzard Entertainment, 2007). The result has been a call by many, including the Federation of American Scientists (2006), to explore digital games as a viable approach for teaching in K-12 and higher education.

An increasing number of game-based learning environments are currently under development or have recently been released in which the learner is placed in virtual worlds and asked to engage in various tasks. For example, *River City*, for children ages 11-14, is a multi-player virtual environment emphasizing player tasks designed to develop higher order thinking skills and content knowledge in biology and ecology (Ketelhut, Dede, Clarke, & Nelson, 2006). *Quest Atlantis*, for children ages 9-12, immerses children in a virtual world with an emphasis on developing social responsibility (Barab, Thomas, Dodge, Carteaux, & Tuzun, 2005). *PeaceMaker* provides opportunities for a player to develop an understanding of the Israeli-Palestinian conflict through an engaging simulation (Impact Games, 2007). With this heightened interest in digital game-based learning, comes a need to explore methods and models for designing effective educational games.

One of the key issues in the design of electronic game-based learning environment involves aligning the requirements of multiple components of a game, such as narrative, gameplay, and instruction, to create a game that is both engaging from the narrative and gameplay perspectives and effective from the instructional design perspective. For many game genres, a compelling narrative context is essential to engage players fully and provide them with an appealing range of options and outcomes in creating their own stories. In developing electronic game-based learning environments, balancing the development of a compelling game narrative with instructional design needs can be challenging. There is little guidance in the literature on how to create stories that meet instructional goals and how to develop educational content in the context of stories. The purpose of this chapter is to share our own experience in aligning the demands of good interactive storytelling on the one hand with sound instructional design on the other, in the creation of a role-playing game for teaching life science and scientific inquiry for children ages 11-13. The

implications for design outlined in this chapter will likely inform instructional designers of how narrative can be effectively utilized in educational game-based learning environments.

LITERATURE REVIEW

The Art of Narrative

One only has to look into the face of a child as she listens to a story to realize the power of this medium to entertain and to educate. On a daily basis, we engage in storytelling with those around us. The use of stories to pass on knowledge is common in all cultures. Storytellers seek to expand one's conceptual understanding of a topic or share relevant experiences that others have had (Burke, 1993). Parents often share stories with their children in order to teach some lesson. Grandparents may pass on family knowledge in the form of stories. Stories, in some form, are an essential part of everyday life. Stories can provide a meaningful context for learning through the description in rich detail, engaging characters, and illustration of knowledge in context. In contrast with typical methods of knowledge representation, stories provide a rich description of situations which are more meaningful to students.

By and large, the conventions of Western narrative are founded on aesthetic principles advanced by Aristotle, who argued that, at its best, narrative has the capacity to be both entertaining and edifying. The most lasting influences of Aristotle's *Poetics* on Western narrative are found in the conventions of *character* and *plot* (Aristotle, trans. 1997). Character may be understood broadly to refer to the personal forces at work in a story, shaping—and shaped by—the plot. Plot is the unfolding of action and the arrangement of incident in the story. For the reader or audience, characters provide the point of access, so to speak, for understanding and appreciating that unfolding action.

Reduced to its most basic components, the Aristotelian model of narrative operates such that: characters have a given motivation or desire; characters pursue the object of their desire (i.e., often presented as a quest); they encounter antagonists or obstacles that interfere with attaining their goal, resulting in a source of conflict; characters seek solutions and take action to overcome these problems, resulting in a progress toward the object of desire or motivation. Ordinarily, these struggles create a sense of rising action, described as narrative tension, which leads to a climax or series of climaxes, resolving that tension. As much for us today as for Aristotle and the Greek dramas he analyzed, the appeal of any narrative is rooted in observing the relationship between the actions a character chooses and the problem he or she confronts.

Therefore, in one sense, narrative can be defined as a record of the choices and problem-solving efforts of characters in pursuit of their goals. The dynamic described previously can be easily identified at work in virtually any Western narrative, from the simplest of stories, like “Cinderella”, to the most complex of dramas, like *Hamlet* (Shakespeare, 2003).

The latter provides us with a familiar illustration. Hamlet’s moral code pre-disposes him to seek revenge when he was told that his father was murdered by his uncle. Thus the motivated Hamlet sets about to take action against his uncle. However, in the course of that pursuit, he is confronted by a series of obstacles—specifically, doubts about whether his uncle is actually guilty of the crime. Hamlet’s moral code also requires that, before he can act and carry out his plan, he must be absolutely certain that his uncle did indeed murder his father. Hamlet is therefore faced with difficult choices: Should he obey the commands of his father’s ghost and kill his uncle, despite his uncertainties? Or should he allow his uncle to live and therefore continue to suffer the haunting of the ghost? Hamlet chooses to investigate his father’s murder further and seek answers to his doubts, so

he devises a series of tests to determine whether his uncle is genuinely guilty of the crime. With each successive test comes renewed motivation as well as new doubts and new obstacles for Hamlet to overcome in his pursuit of the truth and of justice for his father’s murder. So it is that *Hamlet* is loved by audiences as a great detective drama as well as a probing psychological study.

From its most primitive beginnings, narrative dramas have served ritual and didactic roles in the societies that produce them. Plays were meant, in part at least, to instruct audiences and to edify them. Aristotle described the most desirable outcome for the dramas of his time as *catharsis*. Aristotle also observed that the instructive value of plays was organically bound to their capacity to entertain: Audiences sitting in the amphitheatre must be made to sympathize with King Oedipus and his motives, for example, in order to invest emotionally and cognitively in the problem-solving exercises of the characters on the stage below.

This touches the central problem for conventional narrative: audiences are simply spectators to the drama, passively observing the motives, decision-making, and actions of characters on-stage. Spectators are distinct from the characters they are observing. *So, traditionally, the chief challenge for narrative artists has been to find ways to distract the spectator from that distinction; to immerse their audiences ever more deeply in the characters they create and to engage them more fully in the action of the plot.* Addressing this challenge is the primary objective of interactive narrative.

Role of Interactive Drama in Electronic Games

For the most part, interactive drama emerges from the very same traditions as conventional drama and operates according to the same root principles. Interactive drama relies on fundamental assumptions about character, motivation, and plot; about characters’ will and capacity to act; about

obstacles, conflict, and the role of choice-making in pursuit of desired ends. What distinguishes interactive drama from conventional drama is erasing the distinction between spectator and character. In effective drama, the spectator will understand and even empathize with a character. But when the spectator identifies fully with a character, the narrative ceases to be a traditional *drama* and instead becomes an interactive drama (Crawford, 2004; Mates, 2004; Murray, 1997) or a *game*.

Murray (1997) suggests that interactive drama can be analyzed from three aspects: immersion, agency, and transformation. Immersion is the feeling of identification with the protagonist and being present in the place depicted in the drama. It is the goal of both traditional drama and interactive drama to provide the audience or player a willing suspension of disbelief. Agency is a sense of control and empowerment experienced by the players when they take actions based on their own intention and when their actions have an effect on the world where the interactive drama takes place. Transformation has three meanings. The first involves having the audience and the player take on the role of someone else. The second refers to transformation as variety, meaning that the interactive drama provides variations of game experiences to the player depending on the choices made and actions taken by the player. The third meaning is the personal transformation of the player in the game. Immersion and some aspects of transformation already exist in the traditional drama (Mates, 2004).

We argue that what distinguish the interactive drama from Aristotelian drama are two related elements identified by Murray (1997): agency and transformation as variety. In a conventional narrative drama, the audience passively observes the characters without the opportunity to act on their own motives. In interactive drama, however, the players have a sense of agency. They take action based on their own intentions. In conventional narrative drama, characters face a limited array of possible options when confronting a problem.

The plot then moves in linear fashion to trace the cause-and-effect outcomes of the single option that the character selects from that array. This can be termed a “fixed-structure” drama. In interactive drama or game, to enable player agency and to allow for the player’s free choice in pursuing his motives, all of the cause-and-effect outcomes for all of the options must be calculated to provide transformation as variety, that is, variations of experience on a theme. Therefore, unlike a conventional drama which follows a single, fixed-structure plot-line, an interactive drama or game must be structured for a large (but limited) number of possible plot-lines; that is, a “flexible-structure” story.

Although “flexible-structure” stories may allow player choices and provide a sense of agency, there has been a debate among two camps of players, developers, and scholars: those who favor narrative and those who focus on player agency and game interactivity. To the root of the debate is the conflict between player agency and narrative. Narrative is driven by the direction planned by the writer; whereas interactivity and learner agency depend on the motives of the players. In an effort to reconcile the conflict, Henry Jenkins develops a persuasive argument for viewing games “less as stories than as spaces ripe with narrative possibilities” (2004, p. 119). Game developers such as Will Wright strive to create a compelling space of narrative possibilities in which players can “define their own story arc” (Perlin, 2004, p. 13). For example, in his strategy games such as *SimCity* and *The Sims*, there are no specific goals or objectives. The players make decisions as to which cities or characters they wish to create and what goals they want to achieve.

Clearly, by allowing the spectator to become a participant in the fiction, computer games have the potential to engage audiences in the conventions of character and plot in much richer, deeper ways than conventional dramas. Aristotle would remind us, however, that there may be much more to this than just increased exhilaration for

audiences. If we attend to the Aristotelian premise that drama has the capacity to be both entertaining and edifying, then we must acknowledge that the interactive form of this medium has special virtues over its conventional antecedents. It is in the design of the narrative possibilities of the game space that one must also integrate the “educational possibilities”. The design of the narrative must be such to support player quests and tasks that provide opportunities for construction of desired knowledge and understanding.

Importance of Narrative in Game Genres

Narrative plays a role in most game genres, though its importance varies. Action games, such as platformers, shooters, and racing games, often have story elements, though story is less important than the play experience (Dickey, 2006). In platformers, such as *Super Mario Brothers*, the story is simplistic. The player takes on the role of Mario (or Luigi) avoiding obstacles, or King Bowser (the villain) and his henchmen in order to rescue Princess Peach. Story, in the form of text, is displayed at the beginning of each level. The story creates valuable context for the game, but, in of itself, is less important than other factors such as game play to the overall game experience. First-person shooters (FPS) and third-person shooters (TPS), such as *Halo* and *Doom*, often utilize brief cinematics to provide some measure of background information on the player character, setting, and overall goal. In these types of games, narrative plays a greater role than in platformers. But designers must approach this greater role

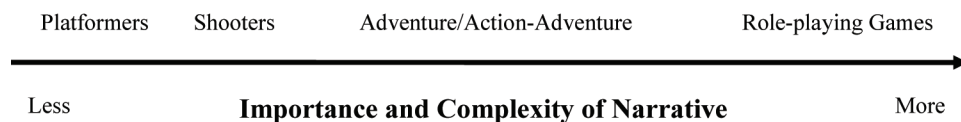
cautiously in shooters, never allowing narrative to get in the way of game play and its immediacy.

In adventure games (e.g., *Myst*) and action-adventure games (e.g., *Tomb Raider*), narrative is important in order to create a rich space for the player to explore. Often these games rely on intriguing story to propel the player to explore the world. Both of these genres provide rich worlds for exploration, conundrums, and obstacles that integrate with a compelling storyline.

Role-playing games (e.g., *World of Warcraft*, *Guild Wars*) provide rich worlds in which players can experience their own characters' growth in ability and strength as they seek to complete tasks. A richly developed narrative is essential to role-playing games because they are slower paced, providing more time for the player to experience and reflect on the story. Extensive back-story, varied non-player character types with complex motivations, and plot twists are critical to compelling role-playing games. The importance and complexity of narrative grows greater as we move through platformers, shooters, adventure, and role-playing games (see Figure 1).

Role-playing games (RPG) are a genre that may be well suited for the development of educational games that target higher order educational goals such as those that fall into the following categories in Bloom's cognitive learning domain: application, analysis, synthesis, and evaluation. Rich virtual worlds found in RPGs provide opportunities for students to be immersed in contexts that allow them to satisfy their curiosity and need to explore. Woven from narrative, audio, 3D graphics, and interactivity, these rich contexts are rife with educational possibilities.

Figure 1. Importance and complexity of narrative in game genres



Player characters are able to follow their own interests as they learn more of the world through experience. Many contemporary theories on learning environments emphasize the role of experience in a rich context (e.g., Barrows, 1996; Jonassen, 1999; Schank, Fano, Bell, & Jona, 1994; Spiro & Jehng, 1990). A second beneficial characteristic of RPGs is that they tend to be slower paced than platformers or FPSs. The emphasis in RPGs is *not* placed on high intensity action (e.g., killing and destroying as in FPS) but on reflective action driven by intellectual deliberation. The gradual uncovering of the story, the unfolding of a mystery, the increasing grasp of a problem—these complex narrative features of RPGs create fertile conditions for motivating students.

Another compelling characteristic of RPGs is the chance for players to experience the growth of their character over time. An educational RPG provides a means for students to experience their own intellectual growth, directly represented in their player character. The characteristics made explicit and emphasized in the player and non-player characters provide opportunities to model those characteristics we desire in our students.

Finally, the structure of role-playing games, a sequence of progressively more difficult challenges, is consistent with how instructional experiences are organized as a progression of increasingly difficult educational experiences (van Merriënboer, 1997). Table 1 summarizes role-playing game characteristics that may lend themselves to educational games.

Narrative Structure

In its simplest form, stories have three acts: beginning, middle, and end. At the beginning of the story we try to capture the attention of the audience and place the protagonist in a situation where they are faced with some challenge or problem. This creates an imbalance that compels the protagonist to take action in order to restore equilibrium. During the “middle” of the story, the protagonist continues to face obstacles, make choices, and experience the consequences of those choices. It is these experiences that result in the character growth needed to ultimately overcome the overarching problem. The story ends when the character’s “world” has been restored to balance by solving the problem and achieving the goal.

In his work, Joseph Campbell explored the power of myth through comparative analysis, drawing out certain universal truths that transcend culture and history. His work, *The Hero with a Thousand Faces*, draws forth a common story structure, which he calls a monomyth, which underlies many of the world’s most compelling myths and legends (Campbell, 1949). This “hero’s journey” is a model story structure that fits well with the development of role-playing games and has been used in cinema and commercial game development. For example, the structure of movies such as *Star Wars* (Burns, 2007) and the *Lion King* were openly derived from the hero’s journey structure outlined by Campbell. Indeed, with books like Christopher Vogler’s (1998) *The Writer’s Journey: Mythic Structure for Writers*, the

Table 1. Role-playing game characteristics that lend themselves to educational games

Role-Playing Game Characteristic	Benefit for Educational Game
Rich Worlds for Exploration	Compelling learning contexts
Slower Pace for Experiencing Story and Reflection	Facilitates reflective action driven by intellectual deliberation
Character Growth in Ability and Strength	Players can experience their own intellectual growth explicitly represented in their player character; game characters can model desirable characteristics
Series of Challenges	Supports progression of educational

monomyth has now become a virtual normative for writers working in popular entertainment media.

The hero's journey has three main stages that correspond with the three-act story structure: departure, initiation, and return (Campbell, 1949).

- **Departure:**
 - **Call to Adventure:** The story begins with the hero in their “ordinary” world. The hero receives a call to adventure; a call to leave the comfort of his or her everyday existence.
 - **Refusal of the Call:** Often times the hero refuses the call hoping the problem will go away or that another “more worthy” will take up the call. The resistance to accept the call is often based on a sentiment we all share in common; a fear of the unknown. Eventually the hero accepts the call, though with trepidation.
 - **Mentor:** A wise mentor provides encouragement, guidance and support to the hero as she prepares for the journey.
 - **Crossing the Threshold:** The hero embarks on the journey, crossing from the familiar to the unknown.
- **Initiation:**
 - **Road of Trials:** The hero is confronted by a series of obstacles; help is provided. These trials prepare the hero for the ultimate battle to come.
 - **Ultimate Trial:** The hero must face and defeat the ultimate evil. In myths highlighted by Campbell, these trials often involve reconciling a disconnect between truth and ones' own beliefs, or reconciling the good and bad characteristics of a father figure in order to better understand oneself.
 - **The Prize:** After passing through the trial, the hero is able to obtain the prize he sought; the object or understanding that will benefit the place she left behind.

- **Return:**
 - **The Journey Home:** The hero may initially refuse to return home having grown to love the new world and abilities. But eventually he is compelled to return home in order to help those that he left behind.
 - **Bestows the Prize:** At the conclusion of the journey, the hero arrives home with the object that was sought. The object or knowledge restores equilibrium to the world.

In addition to effective story structure, a number of storytelling devices can enhance the quality of a narrative. Noteworthy are character design, creation of conflict, and plot twists.

Character development is a crucial part of good story design. Compelling game-based narratives are often written from the player character's point of view. Action in the game narrative is driven by player character decisions as she faces obstacles and choices in pursuing a goal. The conflict the character experiences results in growth. Designers can bring to bear various character types commonly found in conventional storytelling. Vogler (1998) defined seven archetypes in his popularization of the hero's journey. The *hero* (protagonist) is the main character typically promoting the action in the story. The *shadow* is usually the main opponent often the cause of the hero's problems. *Mentor* characters play a larger role in helping the player along their journey. *Shapeshifters* are characters whose real intentions are hidden from the main character. *Guardian* characters are those that block the path of the hero. Some games employ guardian characters which the player must defeat to move to the next level. The *trickster* distracts the hero from his quest. The *herald* brings news to the hero.

Conflict is an essential ingredient to a compelling narrative. Conflict propels the narrative forward and facilitates effective game play. As in narrative development, we must infuse conflict

into the game in order to cause the character to act thereby propelling the story forward. One can create conflict through a *unity of opposites*: two characters desire to possess the same object. A *ticking clock*, or “time-lock,” is another example of a conventional narrative mechanism that can facilitate conflict.

Plot twists are yet another device that designers can employ to enhance the narrative. Plots twists include “red herrings” (i.e., providing clues in order to mislead the player character) and reversals (i.e., a story that moves predictably down a path suddenly turns in an unexpected direction).

CONQUEST OF THE COASTLANDS

Our team is currently developing a role-playing game that features intriguing storylines, immersive 3-D representation of context and quests (problems), simulations, tools and resources that support quest completion, choice of roles and tasks, levels of play, record keeping, as well as real time interaction and feedback. Quests in the virtual environment are supplemented by classroom-based activities, which address students’ knowledge gaps revealed during game play and extend problem solving from the virtual and fictitious world to similar problems in the local community.

Styled after highly successful commercial products like *World of Warcraft* and *Everquest*, the role-playing game features a science fiction/fantasy setting. Pursuing larger strategic objectives, the player character is challenged with a variety of “quests” that is, player-characters must pose questions and seek answers, investigate mysteries, formulate hypotheses, gather evidence and information, use appropriate tools and techniques, and ultimately take action to solve problems presented within quests. These quests form the main plotlines of the interactive narrative and provide the immediate motivations for player-character activities in the game. Each quest is designed to achieve specific learning goals.

The game takes place amid an ancient conflict between two sentient species and their struggle for dominance on a planet called *Mertis* in another solar system. It is a warm, wet world of stormy oceans, dotted with countless islands and a single small continental landmass. While not technologically sophisticated, the planet’s two rival sentient species have reached a turning point in their evolutionary history where it is likely that one—the *Mruk-ma*—will likely drive the other—the *Sheft-ma*—into extinction.

The Mruk-ma are an aggressive, sea-faring species, while the Sheft-ma are city-builders who make their home in “The Coastlands,” along the marshy seashores and river valleys of Mertis’ lone continent. For the vulnerable Sheft-ma, the strategic key to their self-defense is a deteriorating system of fortifications built in the coastal wetlands surrounding their cities. But these wetlands are mysteriously disappearing at an alarming rate, and the threat of invasion by Mruk-ma fleets is growing.

A decisive change comes when the survey ship of an advanced alien race crash-lands in the oceans of Mertis. Arriving in escape pods from their doomed spaceship, the strangers, called *Cilati*, are scattered around the planet. Now hopelessly stranded on Mertis, some of the alien crew manage to make their way to The Coastlands, where they are warmly welcomed by the Sheft-ma. The Cilati survey team brings with them precious scientific knowledge, technology, and methods that could dramatically shift the balance of power in the conflict between the two rival species. The survival of the Sheft-ma will depend on whether they can effectively utilize the science and tools of the Cilati to rebuild their crumbling forts and defend their disappearing coastlines.

The Cilati are a highly advanced race of space-faring explorers. Extremely long-lived, they traverse the galaxy in pursuit of knowledge about other planets and other life forms. Cilati ships have visited countless worlds, quietly observing the species that inhabit them. Generally,

they never interfere in the cultures they study, and they seldom even make their presence known.

It quickly becomes apparent that the Mruk-ma have adopted a radically new strategy in their struggle with the Sheft-ma: ecological warfare. By attacking the delicate environment on which their peaceful rivals depend, the Mruk-ma hope to wreck the Sheft-ma civilization and eliminate their species.

The future of their civilization now depends on whether the Sheft-ma will be able to master the mysterious science of their alien allies, the Cilati. To put it in the epic terms that are conventional to RPGs of this genre, it is only amid desperate circumstances like these that heroes emerge... Heroes who know that understanding the world around them is the first step in controlling it... Heroes who recognize that well-armed fleets and fortresses alone will not be enough... Heroes who foresee that the secrets of science will be the key to Conquest of the Coastlands.

INTEGRATION OF NARRATIVE DEVELOPMENT AND INSTRUCTIONAL DESIGN

In our development process we view story development and instructional design as intricately interdependent. We began our process by developing a story concept. Effective storytelling often relies on conventional story structure. We adopted the traditional three-act story structure and the “hero’s journey” as frameworks to guide our story development. The hero’s journey is a model framework for not only guiding the development of a compelling story, but an equally effective framework for thinking about instructional design.

Employing Episodes

In the development of *Conquest* we found it useful to think of the game narrative as a series of episodes (i.e., quests) with each having its own story with a beginning, middle, and end. These

quests have their own plot, usually utilizing the hero’s journey, which contributes to an overarching story for the entire game. In each quest the player completes some learning tasks. For example, in one *Coastlands* quest, the *glim quest*, the player character, the hero, is called upon to research a devastating threat to the Sheft-ma’s food supply: a more than 70% reduction in harvests of a fish, called the *glim*, which is a primary food source for the Sheft-ma. This quest begins with the player character being called to appear before the council and tasked with learning all they can. As the quest story unfolds, the player learns the cause of the fish depletion, but also gains valuable information about the overall plotline. That is, what are the root causes of the devastating deterioration of The Coastlands. The *glim quest* has a clear story arc with outcomes that not only satisfy its own story but also contribute important information to the overall story of the game.

Hero’s Journey: Call to Adventure/Refusal of the Call

The hero’s journey begins with a call to adventure. Just as the hero desires to escape the ordinary but often fears the unknown of the quest, we often desire to embark on adventure yet fear that we may not be up to the task. This theme is an integral part of human nature and one to which many students can relate. Students are naturally curious and desire to learn yet must be drawn into the adventure of learning. This aspect of the hero’s journey provides a way to dispel some of the inertia that may hold a student back from fully engaging in the learning process.

Gaining students attention and engaging them in an intellectually challenging task is a key aspect of many instructional models. For example, Robert Gagne’s “events of instruction” begins with gaining the learner’s attention (Gagne, 1985). Madeline Hunter (1982) argued for the anticipatory set in order to “hook” the learner. Keller (1983) advocated gaining attention

through perceptual arousal and inquiry arousal. In *Conquest of the Coastlands* we utilize an opening cinematic to gain the student's interest in the overarching game storyline in a call for the player to engage in the adventure. The game cinematic provides the player important back-story that will serve them later in the adventure. Similarly, as we present each quest, we utilize interactive cut scenes in order to set up the problem and gain the student's interest in accomplishing the goal. For example, in the *glim quest*, the cut scene opens with the player character being called before the High Council. As the scene unfolds, the player character expresses eagerness to help her species and an innate curiosity to know and understand. Yet she also shows fear in accepting the task. Ultimately, she overcomes the reluctance to take on the quest and commits fully to the adventure.

Hero's Journey: Mentor Provides Support

In the hero's journey, the mentor often motivates the character to accept the call and provides needed support for the journey. The development of the mentor concept in our game was not only informed by the hero's journey, but also the cognitive apprenticeship model, an instructional design model that emphasizes the role of mentors in supporting learning (Collins, Brown, & Holum, 1991). In our game, we provide mentors to aid the player character. The first mentor is Ikiru, the player character's elderly uncle, who is learned in many disciplines, possessing a folk understanding of the forces at play in the natural world. The player is first introduced to Ikiru in the opening cinematic where learned that Ikiru has a growing concern about the changes he sees in The Coastlands. As the player character prepares for the journey, Ikiru provides encouragement and help. For example, in the *glim quest*, Ikiru provides the player a list of potential hypothesis, based on his folk understanding, as to what may be causing the reduced catches. As the quest unfolds, the player meets

with the Cilati, the other mentor, who having unique expertise as an accomplished scientist, facilitates the recasting of the folk hypotheses into viable scientific hypotheses thereby scaffolding the player. The Cilati also provides technology, a personal digital assistant (PDA) that has tools and resources to aid the player in the investigation.

Hero's Journey: Crossing the Threshold

As in a hero's journey, we strive to create learning environments where the student is truly committed to the quest of "making the material their own". Just as the hero fears to accept the call to adventure, students have fears that prevent them from fully engaging in an activity. If we have done well in gaining their attention with a compelling adventure, we hope to see engagement. In *Conquest of the Coastlands*, the player character shows hesitancy to accept the call to explore the *glim quest* yet ultimately confronts her fears and commits to the task.

Hero's Journey: Road of Trials

In the hero's journey, the road of trials is a series of challenges, often placed by the antagonist, that help prepare the hero for the ultimate test to follow. These increasingly difficult challenges help the hero grow in strength and wisdom. Similarly, instructional models advocate a sequence of increasingly challenging problems and content. For example, the instructional design model adopted by our team, the four-component instructional design (4C/ID) model, advocates a sequencing of task classes from simple-to-complex (van Merriënboer, 1997). The 4C/ID model consists of four inter-related components: learning tasks, supportive information, part-task practice, and just-in-time (JIT) information. Learning tasks, most relevant to this discussion, are the concrete, authentic whole-task experiences similar to complex real-world problems. These learning tasks are categorized

into simple-to-complex classes. The order of the task classes and the specific instances of the tasks define the overall sequencing of the instructional content. In *Conquest of the Coastlands*, we follow a progression from simple-to-complex for the game (i.e., quests are progressively more challenging) and within each quest (i.e., tasks within each quest are progressively more challenging). For example, earlier quests in the game have the player engage in partial scientific inquiry whereby some of the inquiry task are already completed (e.g., problem statement defined, hypothesis developed). Later quests in the game will have students engaging in full inquiry and open inquiry. Similarly, a quest such as the *glim quest* begins with simple tasks (e.g., summarizing data provided by non-player) shifting to more complex tasks (e.g., analyzing and interpreting water quality data).

Hero's Journey: Ultimate Trial

The ultimate trial of the hero's journey is a climactic moment where the hero, after much personal growth as a result of confronting obstacles, faces, and overcomes a great challenge. In this stage of the journey, the emphasis is on the hero's transformation. Similarly, we strive for the design of educational experiences that are transformative. Many of us have experienced a master teacher or mentor who provided us a challenging task that truly transformed our thinking about a concept or topic resulting in a new found understanding. As in a story where the hero "faces death" in the ultimate trial and survives, the learner works at the edge of their ability to accomplish a challenging task and thereby is transformed. So too should this ultimate learning experience be for the player character. In our game, we are striving to provide a sequence of quests that culminates in an ultimate trial. For example, in earlier quests the player character engages in supported inquiry. As the player progresses, we increase the difficulty of the challenges presented and fade the scaffolding provided. At the conclusion of the game, the

player character engages in independent scientific inquiry; demonstrating, we hope, a new found depth and breadth of knowledge. Similarly, within a quest, the sequence of tasks can progress toward an ultimate trial.

Hero's Journey: The Prize

In this stage of the hero's journey, the hero is rewarded by gaining the object of their desire. This sort of narrative device provides a clear motivation for the character thereby driving the story forward. In the framework of the hero's journey, the prize is the object or elixir that initially propelled the hero to begin his or her journey. This plot device helps focus the player character on a clear goal. Similarly, from an educational perspective, the goal or prize should drive the educational activities. Wiggins and McTighe (2001) suggest we begin with the end in mind. In instructional approaches such as goal-based scenarios (Schank, Fano, Bell, & Jona, 1994) and problem-based learning (Barrows, 1996), the goal or problem becomes the organizing focus of the activity. The goal should be interesting and motivating to the player and should result in the development of knowledge and skills desired. In the development of *Conquest of the Coastlands*, we strived to create clear story goals in the game (e.g., learn why the *glim* are dying in order to avert famine) that corresponded to clear learning goals (e.g., with guidance, learners are able to articulate the question or problem at hand, design an investigation, gather data, draw conclusions, and communicate the results and research process, National Science Content Standard A).

Hero's Journey: The Journey Home

As the hero begins the journey home, there are still challenges to overcome. These challenges further motivate the player as they continue their quest.

Hero's Journey: Bestowing the Prize

At the conclusion of the hero's journey, the protagonist returns home triumphantly, and bestows the prize, elixir, or wisdom upon those that she left behind. This mechanism provides a way for the learner to synthesize the key aspects of what was accomplished and learned in the quest providing a beneficial learning activity for the player and a valuable artifact for evaluation. Two strategies from the cognitive apprenticeship model (Collins, Brown, & Holum, 1991), reflection and articulation, provide insight into the benefits of this final stage of the journey. Articulation refers to requiring students to articulate their knowledge, reasoning, and problem-solving processes. These explanations and elaborations require the student to make their thinking explicit providing opportunities for feedback from others and serving as a source for their own reflection. Reflection involves helping students compare their own problem-solving processes with those of experts, thus making it possible for them to modify their processes. This final stage of the journey provides an opportunity for players to articulate their thinking and then reflect upon it. In *Conquest of the Coastlands*, a key element of Sheft-ma culture is the manner in which the Sheft-ma preserves and communicates knowledge. At the conclusion of each quest, the player character returns to the Chief Cantor, a key figure whose role in this fictional society is to document what is learned in the hero's various adventures and provide a synthesis of the learning. These quest summaries are noted in scrolls, and the learning acquired through heroic questing is then shared with the rest of the society, delivered in song by the Chief Cantor in order to entertain and educate the populace. The hero's journey is thus completed with the bestowal of the prize.

Story Devices

In addition to effective story structure, a number of storytelling devices can enhance the quality

of a narrative and facilitate instructional design. Noteworthy are character design, creation of conflict, and plot twists.

Character development is a crucial part of good story design. Compelling game-based narratives are often written from the player character's point of view. Action in the game narrative is driven by player character decisions as she faces obstacles and choices in pursuing a goal. The conflict the character experiences results in growth. Designers can bring to bear various character types commonly found in conventional storytelling. The *hero* (protagonist) is the main character typically promoting the action in the story. The *shadow* is usually the main opponent often the cause of the hero's problems. *Mentor* characters play a larger role in helping the player along their journey. *Helpers* are characters that provide other types of support to the main character. *Guardian* characters are those that block the path of the hero. Some games employ guardian type characters the player must defeat to move to the next level. The *trickster* distracts the hero from his quest. The *herald* brings news to the hero. In our own development, we utilize various character types such as player character as hero, Murak-ma as shadow or antagonist, and mentor characters in the form of Uncle Ikiru and the Cilati.

Conflict is an essential ingredient to a compelling narrative. Conflict propels the narrative forward and facilitates effective gameplay. As in narrative development, we must infuse conflict into the game in order to cause the character to act thereby propelling the story forward. One can create conflict through a *unity of opposites*: two characters desire to possess the same object. For example, in *Conquest of the Coastlands*, a unity of opposites is created whereby the Sheft-ma (i.e., player character species) are directly competing with the Murak-ma non-player character species to locate and retrieve Cilati escape pods scattered about the planet. The escape pods have important technology that may help one species overcome the other. In this example, the task of

finding escape pods provides a clear goal for the player (facilitates gameplay) and creates conflict that is motivational. The escape pods provide a fun way to introduce technology that is needed for the student to achieve the curricular goals. A *ticking clock*, or “time-lock,” is another example of a conventional narrative mechanism that can facilitate conflict. In *Conquest of the Coastlands* the player character learns that the escape pods are made of a material that causes them to disintegrate within a limited time when exposed to the elements.

Plot twists are yet another device that designers can employ to enhance the narrative. Plots twists include “red herrings” (i.e., providing clues in order to mislead the player character) and reversals (i.e., a story that moves predictably down a path suddenly turns in an unexpected direction). For example, in our game, there is a rumor that fish depletion is caused by an alien monster, a ferocious predator that eats both fish and fishermen. In reality, the monster is an invasive herbivore. It disrupts the coastal environment by consuming a large amount of marsh grass. Fish depletion is caused by the environmental change triggered by the monster. The rumor serves as a “red herring” that not only enriches the story and but also provides an opportunity to challenge the player to think critically and to distinguish superstition from science.

IMPLICATIONS

The literature review and our experience in designing an educational role-playing game has led to the identification of several principles that may provide instructional designers guidance in the creation of educational role-playing games.

Conceptualize Game Narrative in Quests

Design the game narrative as a series of quests with each having its own story with a beginning,

middle, and end. These quests have their own plot, utilizing the hero’s journey, which contributes to an overarching story for the entire game. Additionally, each quest consists of a series of tasks that support quest learning goals and contribute to the overarching learning goals for the entire game.

Begin Quests with a Call to Adventure

The hero’s journey call to adventure provides a mechanism for gaining the students attention and engaging them in an intellectually challenging task. Children can relate to a character that has fear of embarking on an adventure, but ultimately commits to the task at hand. An opening cinematic or an in-game cut scene can facilitate gaining the students attention and facilitating full engagement in the learning task.

Develop Non-Player Characters that Act as Mentors

A common element of narratives that employ the hero’s journey is the mentor who motivates and supports the hero throughout the quest. Non-player characters can be modeled after the mentor figure in the hero’s journey and can also be informed by the cognitive apprenticeship model. These non-player characters can assist by assigning quests, providing needed clues, and implementing cognitive apprenticeship strategies (e.g., modeling, coaching, articulation, reflection).

Provide for a Series of Challenges/Ultimate Challenge

The hero’s journey and instructional design models advocate for a series of challenges that prepare the hero/learner for the ultimate test to follow. Provision of concrete authentic experiences of increasing difficulty provides for compelling learning opportunities. As the series of challenges

increase in difficulty and the player gains skill and confidence, scaffolding can be faded.

Utilize Plot Device to Drive Narrative Forward and Focus Player on Clear Goals

In the hero's journey, the protagonist's desire or need for an object provides a clear motivation for the character thereby driving the story forward. Utilizing this plot device helps focus the player character on a clear goal. Similarly, from an educational perspective, the goal or prize should drive the educational activities. The goal or problem becomes the organizing focus of the activity.

Design Narrative to Provide Opportunities for Reflection and Articulation

At the conclusion of the hero's journey, the protagonist returns home triumphantly, and bestows the prize upon those left behind in the hero's ordinary world. This narrative element can provide a way for engaging the learner in synthesizing the key aspects of what was accomplished and learned in the quest. This narrative element can facilitate opportunities for students to articulate their knowledge, reasoning, and problem-solving processes. Articulation provides a source for students to compare their own problem-solving processes with those of experts.

CONCLUSION

Electronic games provide unique opportunities for utilizing interactive narrative to create compelling learning environments where students are engaged in shaping a narrative; a narrative that is not only entertaining but also results in new knowledge and skills. This chapter shares our experience in balancing narrative development with instructional design. The hero's journey emerged as a model

narrative structure for developing interactive narrative and informing instructional design. It provides opportunities to embed various instructional strategies, such as gaining attention at the beginning of instruction, mentoring, sequencing learning tasks from simple to complex, clarifying the learning goal, and articulation and reflection of learning.

The hero's journal may serve as a narrative structure for game developers to align narrative development and instructional development in the process of creating effective electronic game-based learning environments. It is our hope that this chapter may guide developers of electronic game-based learning environments and will begin a dialog as to the importance and strategies for aligning interactive narrative development with educational game development.

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KEY TERMS AND DEFINITIONS

Backstory: The history of events that precedes the start of a narrative.

First-Person Shooter: A computer game genre where the player character has a first-person perspective.

Interactive Narrative: Narrative in which the spectator is able to make choices that guide the outcomes.

Monomyth: A common story structure which underlies many of the world's most compelling myths and legends.

Platformer: A genre of computer game where the player navigates among platforms while avoiding obstacles.

Role-Playing Game: A game where the player takes on the role of a character.

Unity of Opposites: A narrative device whereby two characters desire to possess the same object.

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Chapter 4.21

Teacher Gamers vs. Teacher Non-Gamers

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ABSTRACT

The purpose of this study was to identify secondary teachers with video game-play experience and determine if perceived levels of comfort in regard to completing job-related technology tasks, amounts of instructional technology usage, and amounts of participation in innovative teaching strategies are affected by experience or lack of experience with video games. Although significant differences were not found between teachers identified as gamers and those identified as non-gamers, researchers may choose to investigate specific areas where mean differences were found. For example, gamers were more comfortable using presentation software for demonstrating concepts in class, communicating electronically with colleagues and students, us-

ing the Internet for instructional purposes, and presenting information using various delivery modes. In comparison to gamers, non-gamers indicated a tendency to communicate electronically with parents more often, encourage students to use electronic tutorials outside of class more often, and allow students to use word processors to complete assignments more frequently. This study can be used as a reference point for future research into teachers and video game-play in regard to teaching practices and job-related tasks.

INTRODUCTION

Video games have become a part of the daily lives of many individuals, regardless of age or gender. In fact, the video game industry has grown to rival the motion picture industry and each of the major television networks in terms of revenues

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and profits. Despite the size of the industry, more research is needed on the potential benefits of video game-play and learning (Shaffer, Squire, Halverson, & Gee, 2004).

In an exert entitled, "From Video Games, Learning About Learning," from his book, *What Video Games Have to Teach Us About Learning and Literacy*, Gee (2003) describes video games as being long, hard, and challenging. Gee indicates if a game has good learning principles in its design, the learning can be translated in positive ways. In his opinion, the theory of learning behind good video games closely resembles learning theories from the cognitive sciences.

Cognitive science is the study of the mind and includes processes such as thinking, reasoning, language, perception, learning, and remembering. Cognitive science crosses several disciplines including computer science, linguistics, philosophy, and psychology (Rapaport, 1996). Research within this area suggests human interaction within an environment and perception are related in creating memory (Glenberg, 1997).

Video games create environments and allow interaction within these environments. According to cognitive science principles, this should create memory. Good games are challenging, give information in context, allow players to create, build problem-solving skills, are motivating, and offer opportunities for individuals to work together (Gee, 2003).

Characteristics of gamers, such as willingness to volunteer, creativity, and reading to gain knowledge, have been used to describe innovative teachers (Cumming & Owen, 2001; Thomas, 1993). Also, similar to video games, innovation requires creating, persistence, action, teamwork, and risk taking (Ballantyne, McLean, & Macpherson, 2003).

Based on the premise that learning takes place in video games and many characteristics of game players and innovators are similar, the researchers designed this study to determine the effects video game experience may or may not have on

perceptions of teachers and their comfort levels when completing job-related computing tasks, amount of instructional technology usage, and participation in innovative teaching practices. If video game experience allows individuals to gain certain knowledge and skills applicable to basic computing skills and instructional technology, teachers may have higher comfort and participation levels in each area. Also, many of the characteristics of game players reflect the same qualities found in innovative teachers.

This study is important to the field of education and gaming because certain aspects of gaming such as problem solving, teamwork, communication, and knowledge of technology may be increased by the playing of video games. Intuitively, if knowledge of technology is increased, comfort levels with various technologies may also be increased. Also, motivation (Rosas et al., 2003) and self-confidence (Carstens & Beck, 2005) have both been enhanced by video game-play. Each of these aspects or traits are important to the field of education as teachers are facing ever-increasing pressure to raise scores on various standardized tests and teachers are expected to perform at high levels in the classroom.

BACKGROUND

Computer games and video games are two terms that are often used synonymously to describe games played on personal computers, handheld systems, consoles, or arcade machines (Wikipedia, 2005). A game is a form of art that requires decision making, opposition, the management of resources, the attainment of tokens, and a sufficient amount of information. Games are often strengthened by diplomacy, simulation, variety, character identification, role-playing, and socialization (Costikyan, 1994). Games are complete systems with explicit rules, with fantasy playing a major role in various situations (Crawford, 1982). Gee described a game as a world in a box allowing a player to create an

identity they really want and the ability to gain experiences that were not available before (cited in Foreman, 2004).

Most people consider games to be for younger members of society or for males only, but the statistics within the industry tell a different story. In May 2005, the Entertainment Software Association released the results of a consumer survey that indicated game players were an average age of 30, with 35% under the age of 18 and 43% between the ages of 18 and 49. Nineteen percent of game players were over the age of 50, and 55% were male.

Previous research has shown gamers to enjoy such activities as exercising, sports, volunteering, religious activities, creative undertakings, and reading. In fact, the Entertainment Software Association (2005) reported that gamers spend over three times the amount of time on activities such as these when compared to playing video games. Also, characteristics of gamers, such as being risk takers (Beck & Wade, 2004), showing a willingness to volunteer, having creativity, and reading to gain knowledge, have been used to describe innovative teachers (Cumming & Owen, 2001; Thomas, 1993).

Research indicates girls prefer games that allow them to play with other players, have high-quality graphics and multimedia components, and allow for communication between participants during game-play (Agosto, 2004). Males tend to enjoy games with a lot of action and fighting with weapons, but both genders believe realism is an important aspect in game design (Media Analysis Laboratory, 1998).

Many educators and parents do not believe video games are a viable component of a curriculum and have issues with the educational software that is available (Virvou, Katsionis, & Manos, 2005). Leaders within the area of gaming and learning argue that video games may change the way we learn and can effectively engage learners (Squire & Jenkins, 2003). A vast amount of information and resources are available to individuals at the

click of a button, but classrooms have not adapted. While games are often complex and difficult, people work through them and the difficulty often provides motivation. Further, Shaffer et al. (2004) indicated that video games allow players to participate in communities and develop thinking and organization skills, but they also noted the field is absent of sufficient research concerning learning theory. One sign this may be changing occurred in March 2004, when the first Serious Games Summit was held at the Game Developers Conference. The summit brought together educational researchers, game developers, and trainers to share experiences in hopes of developing new markets and better products (Corbit, 2005). Another positive sign for the industry is the fact that more colleges and universities are offering courses, and in some instances, degrees related to video game design. Prestigious universities, such as The Massachusetts Institute of Technology, Stanford, Carnegie Mellon, and Southern California, are leading the way in this area (Mangan, 2005).

Until recently, little research existed concerning the potential benefits of video game-play even though many children and adults spent a large amount of time playing games. Now, more researchers are looking at possible benefits of game-play and have found that they may improve social skills, encourage teamwork, increase knowledge pertaining to technology, develop math and reading skills, and improve problem solving (Media Awareness Network, n.d.).

It is evident from the literature that video games have become a part of our culture and have gained a tremendous amount of popularity. For several years, the majority of research on video game-play focused solely on negative aspects, but the trend is beginning to change. Pillay, Brownlee, and Wilss (2003) indicated recreational game players engage in cognitive processing while playing, and many of these processes are very valuable in educational settings. Gamers display the ability to digest explicit and implicit information, reason inductively and deductively, make inferences,

and solve problems. Whether it be in the role of teacher or student, each of these processes lend themselves well to an environment implementing instructional technology.

Instructional technology is changing the way we learn. Exposure to different types of video games aids in developing schema that may be used in completing future tasks and solving problems in technology-rich settings (Pillay, 2003). Structural knowledge may be gained from games, allowing individuals to function in similar environments with instructional technology. According to Gros (2003), video games are often the first access young people have to the world of technology, and they help create a positive outlook towards technology. It is the hypothesis of Gros that children acquire digital literacy through play, and video games are the most interactive multimedia available today. Many games require players to reach some type of goal, and innovative teachers have been described as having a vision for the future and strategies for reaching this vision (Cumming & Owen, 2001).

Innovation is the introduction of something new—a new idea, method, or device (Merriam-Webster Online, 2005). While the formal definition of innovation is rather straightforward, defining innovative teaching practices is much more difficult. Several of the skills learned from video games mirror characteristics of innovative teachers identified by Cumming and Owen (2001), Thomas (1993), and Ballantyne et al. (2003). Each of these studies acknowledged innovative teachers as having the ability to work with others, possessing strong social skills, a sound knowledge base, and a desire to succeed.

After an exhaustive search, the researchers were unable to locate any previous research on teachers who play or once played video games. Rather, most studies focused on such areas as increased motivation, problem-solving skills, aggression, and addiction (Amory, Naicker, Vincent, & Adams, 1999; Bensley & van Eenwyk, 2001; Hauge & Gentile, 2003; Rosas et al., 2002).

Merriam-Webster Online (2006) defines experience as “the fact or state of having been affected by or gained knowledge through direct observation or participation.” If experience playing video games allows teachers to become more comfortable with job-related technology, more readily accept instructional technology, and more readily participate in innovative teaching practices, perhaps the educational community will adopt gaming as a viable component of effective teaching practices at both the postsecondary and K-12 levels. College education departments may add gaming to their pre-service teaching programs, and professional development content for teachers and administrators may be delivered through similar means.

The following research questions guided this study:

1. Who are the teachers with experience playing video games?
2. Are teachers with experience playing video games more comfortable completing job-related technology tasks?
3. Do teachers with experience playing video games use instructional technology more often than those without experience playing video games?
4. Do teachers with experience playing video games participate in more innovative teaching strategies?

METHODOLOGY

Population

The researchers designed this study to determine the effects video game experience may or may not have on perceptions of teachers and their comfort levels when completing job-related computing tasks, amount of instructional technology usage, and participation in innovative teaching practices. In determining the sample for this study, the

researchers had specific criteria for selecting the schools. Specifically, each school needed to be at a secondary level to obtain a better ratio of male to female teachers. The researchers also wanted the schools to include various socioeconomic levels, which were determined by the free or reduced lunch percentage. Based on these criteria, seven secondary schools in North Alabama were selected. For this study, all classroom teachers serving grades 6 through 12 were given the opportunity to complete the survey instrument. By including each classroom teacher, the researchers hoped to reduce the amount of bias when generalizing to the population.

The population was divided into two groups: those with video game-play experience and those without. For this study, a teacher is considered to have video game-play experience if he or she has enjoyed playing video games weekly as a hobby anytime in the past or present. Each respondent was questioned regarding their perceptions of comfort using technology to complete basic job-related tasks, amounts of instructional technology usage in the classroom, and amounts of participation in innovative instructional practices. The researchers then determined if a significant difference existed in comfort levels and amounts of usage between each group in relation to basic job-related computing tasks, instructional technology, and participative levels in innovative teaching methods.

A survey was designed by the researchers to collect information from respondents through a traditional paper option. Each classroom teacher received the paper survey, along with a cover letter, explaining the purpose of the study and directions for completing the survey.

Administrators at four schools chose to have the surveys completed in a faculty meeting and returned at the conclusion of the meeting resulting in return rates of 75%, 75%, 100%, and 94%, respectively. One school chose to distribute the surveys at a faculty meeting and have the surveys returned in a sealed envelope to a designated location, resulting in a return rate of 25.7%. Two

schools chose to have the surveys placed in teacher mailboxes and returned in a sealed envelope to a designated location, resulting in return rates of 70% and 78%. Overall, 258 faculty members were given the opportunity to complete the surveys and 184 surveys were submitted for analysis, resulting in a return rate of 71%.

Survey Design

The survey instrument (see Appendix) was developed by reviewing several instructional technology surveys administered in higher education and a video game survey administered by the Beckman Institute (n.d.), reviewing the National Education Technology Standards for Teachers (ISTE, 2000), focusing on the best practices for using instructional technology established by the University of Texas at Austin (n.d.), and researching a study on innovative teaching (Cumming & Owen, 2001). Questions related to gaming practices were developed by the researchers to garner specific statistics from the participants. The survey contained five sections to gather information regarding and to assess:

1. Demographic information from questions 1-6
2. Game-play experience from questions 7-11
3. Perceptions of teacher comfort levels when completing job-related computing tasks from questions 12-17
4. Amounts of instructional technology use by the teachers from questions 18-30
5. Amounts of implementation of innovative teaching practices from questions 31-41

A four-point Likert scale was used to rate each item from section three ('strongly agree', 'agree', 'disagree', 'strongly disagree'), section four ('frequently', 'sometimes', 'rarely', 'never'), and section five ('frequently', 'sometimes', 'rarely', 'never'). Validation of the survey was obtained by having the survey reviewed by a panel of experts.

Reliability was tested through a pilot application of the survey and testing the internal consistency of the questions using Cronbach's alpha. One question was removed from the original survey to reach an acceptable level of .894 for section three, .839 for section four, and .863 for section five.

Data Analysis

Descriptive statistics were used to analyze items on the survey. Three separate independent samples t-tests were conducted to determine if a significant difference existed between each group regarding comfort levels with job-related technology tasks, amounts of instructional technology usage, and implementations of innovative teaching practices.

Demographics

The first section of the survey instrument included six questions that gathered demographic information from the participants. Percentages were rounded to the nearest whole number for discussion. The first question asked the participants to choose a range in which their age fell. Table 1 displays the frequencies and percentages for this item. The data revealed that 17% of the population fell between the ages of 20 and 29, 26% fell between the ages of 30 and 39, 22% fell between the ages of 40, and 49 and the remaining 35% of the population was 50 or older.

The second question identified the gender of the respondents. The data in Table 2 indicate the participation of 58 males and 126 females in the study, resulting in percentage levels of 32 and 69 respectively.

Table 1. Age of participants

Age	Frequency	Percent
20-29	32	17
30-39	48	26
40-49	40	22
50+	64	35

Question 3 asked the participants to specify their highest level of education. Of the total population, 30% indicated a bachelor's degree as the highest degree earned, while 60% revealed having a master's degree. Also, 9% were identified as having an education specialist degree, and 1% had earned a doctoral degree. Table 3 displays the frequencies and percentages for this item.

Question 4 attempted to gather information regarding the years of teaching for each individual in the study. Frequencies and percents from each range of years are listed in Table 4. Out of the population, 23% identified themselves as having 6-10 years of teaching experience, followed closely by the 0-5 years experience group at 21%. Next was the 11-15 years group at 19%, followed by the group with 25 or more years at 16%. The smallest groups represented included the 16-20 years experience and the 20-25 years experience groups at 10%.

Table 2. Gender of participants

Gender	Frequency	Percent
Male	58	32
Female	126	68

Table 3. Highest level of education

Degree	Frequency	Percent
Bachelor's	55	30
Master's	111	60
Education Specialist	17	9
Doctoral	1	1

Table 4. Years of teaching experience

Years	Frequency	Percent
0-5	39	21
6-10	43	23
11-15	34	19
16-20	19	10
20-25	19	10
25+	30	16

Question 5 gathered data concerning the subject areas taught by the participants. The subject area of math was represented at the highest rate at 19%, followed by English at 17%, history at 16%, science at 12%, special education at 10%, other areas at 10%, vocational at 9%, and physical education at 7%. Frequencies and percents for this question are found in Table 5.

Gaming Experience

The second section of the survey collected participant data specific to video game experience. Question 6 identified each participant as a game player or non-game player during the present or any time in the past. Out of 184 respondents, 66 (36%) identified themselves as a gamer (as having game playing experience) and 64% classified themselves as not having game playing experience.

When asked about playing video games on personal computers, only 18% chose ‘frequently’. The majority, 41%, chose ‘seldom’. When asked about playing video games on consoles, 59% chose ‘seldom’. Within the game-playing population, 48% reported playing Web-based games ‘sometimes’ or ‘frequently’. In an average week, 64% of game players reported playing games less than one hour per week, 27% played from one to three hours per week, and 9% played from three to seven hours per week. No respondents reported playing more than seven hours per week.

Question 11 from the survey asked the participants to list an approximate age at which they

began playing video games. Almost 20% indicated they began playing games at the age of 10, and 17% indicated they began playing games at the age of 12.

Research Question 1

Who are the teachers with experience playing video games? When looking at the game players, 32% of the population was from the 30-39 age group. This percentage was followed closely by the 40-49 age group at 27%. While this study did not account for anyone under the age of 20, these percentages resembled statistics released from the Entertainment Software Association in 2005, where the mean age of game players was found to be around 30.

Among the total male population surveyed, 52% were labeled as a gamer, while only 29% of the total female population carried the same label. Even though the female population had a lower percentage within their own gender, they made up 55% of the game-playing population due to their higher total population in this study.

Each of the groups with years of experience from 0 to 5, 6 to 10, 11 to 15, and 16 to 20 had at least 35% of the group identified as gamers, with the 6 to 10 years experience group leading the way at almost 50%. History teachers and teachers from the group “other” classified themselves as gamers at a rate equal to or greater than 60%. Science, math, and English followed at percentage levels of 32%, 31%, and 41% respectively.

Research Question 2

Are teachers with experience playing video games more comfortable completing job-related technology tasks? Total scores for gamers and non-gamers were computed and analyzed by an independent samples t-test to explore this research question. The effect of video game-play experience was not significant, $t(182) = .983, p = .189$, at an alpha level of .05. Sufficient evidence existed to con-

Table 5. Subject area

Subject	Frequency	Percent
Math	35	19
English	32	17
Science	22	12
History	30	16
Physical Education	12	7
Vocational	16	9
Special Education	19	10
Other	18	10

clude that there is no significant difference among teacher gamers and teacher non-gamers in regard to comfort levels with job-related technology. The mean total score for game players in this section was 20.33 and the mean total score for non-game players was 19.99.

This section of the survey contained six questions. Even though no significant difference was found between the groups for total scores for these questions, the gamers had higher mean scores on five questions, and one question had equal means. Of the five questions with differing means, the question regarding the use of basic computer applications had a very small difference of .01, leaving four other questions with mean differences of at least .10.

The questions with mean differences of at least .10 between each group included perceived comfort levels of using software to demonstrate concepts in class, communicating electronically with colleagues and students, using the Internet for instructional purposes, and presenting information using a variety of delivery modes including audio, video, and text. These differences may be explained by studies such as Mitchell and Savill-Smith (2004), where computer games were found being used to teach a variety of basic and complex skills supporting several areas and disciplines. Also, video games are often times the first access individuals have to technology and may create a more positive outlook towards technology (Gros, 2003).

Each question reflected positive confidence levels for both groups, except in regard to comfort levels creating and updating Web pages. On a four-point Likert scale, this question had a mean score of 2.58 for each group. In fact, 44% of game players and 50% of non-game players chose 'strongly disagree' or 'disagree' in response to this item. In contrast, all of the other questions in this section had mean scores above 3.23, with most hovering around 3.50. Hopefully, each group will become more comfortable working with Web pages as technology advances and becomes more

user friendly, but each group will need sufficient professional development to see great improvement. For example, blogs can replace the often tedious and time-consuming class Web page, but many educators are skeptical in regard to new types of technology.

Research Question 3

Do teachers with experience playing video games use instructional technology more often than those without experience playing video games? After total scores were computed for each group for the survey questions related to this research question, an independent samples t-test was conducted to determine if a significant difference existed between the gamers and non-gamers in regard to their amounts of instructional technology usage. The effect of video game-play experience was not significant, $t(159.273) = -.318, p = .751$, between the two groups at an alpha level of .05. The mean total score for game players in this section was 31.38 and the mean total score for non-game players was 31.73.

There were 13 items answered by the respondents for this section. Six of the questions had more positive results for gamers, and six of the questions had more positive responses for non-gamers. One question had equal means from each group. Even though 12 questions had different means for each group, several questions had similar means, and only three of the questions had differences greater than .10. Of these three, all had higher mean scores for the non-gamers, indicating non-gamers communicate electronically with parents more frequently, encourage students to use electronic tutorials outside of class more frequently, and allow students to use word processors to complete assignments more frequently. In relation to communicating electronically with parents, gamers scoring at a slightly lower level resemble the results from Lawry et. al. (1995), where no clear relationship was found between anti-social behavior and gaming. Also, non-gamers allowing students to

use word processors and electronic tutorials more often may be attributed to computers becoming more prevalent in teacher education programs. Teacher education programs are offering more opportunities for students to learn with various types of instructional technology, and many are requiring introductory computer courses (Betrus & Molinda, 2002).

A few of the items in this section had mean scores below 2.0 on a four-point Likert scale. The choices on this section were 'never', 'rarely', 'sometimes', and 'frequently'. This would indicate an average result somewhere between 'never' and 'rarely' on these items. Neither group exhibited positive results in regard to allowing students to communicate with teachers, students, or experts via blogs. The negative results associated with blogs could be attributed to the new emergence of this type of communicative technology. Blogs are attractive because of their ease of use (Downes, 2004), but many teachers may not be familiar with them. Also, both groups reacted negatively to how often they allow students to use spreadsheets to complete assignments. Game players also had an average below 2.0 in response to allowing students to use databases to complete assignments.

Research Question 4

Do teachers with experience playing video games participate in more innovative teaching strategies?

An independent samples t-test was conducted to determine if a significant difference existed between the gamers and non-gamers in regard to their participation in innovative teaching strategies. The effect of video game-play experience was not significant, $t(182) = .336, p = .737$, between the two groups at an alpha level of .05. The mean total score for game players in this section was 35.71 and the mean total score for non-game players was 35.49.

There were 11 items on this section of the survey. The choices on this section were 'never', 'rarely', 'sometimes', and 'frequently'. When a

closer look is taken at each individual statement, the means are extremely close for each item for both groups, with differences less than .08 for all questions except one. The only item with a greater difference was in regard to how often the individual takes risks with instruction by trying something new. The game players group reported taking risks more often, but the difference between each group was only .10. The slight difference in the amounts of risks taken could be explained by Beck and Wade (2004) when they found gamers to have the ability to implement bold but measured risk-taking strategies in the business world. Beck and Wade (2004) also described gaming as a possible training ground for critical business skills.

Items reported with lower means from each group included using alternative assessments such as digital rubrics and portfolios, and incorporating creative writing activities into daily lessons. Each of the other items in this section represented more positive results, with both groups reporting very high means on reflecting upon and assessing their own teaching and ensuring that all students are experiencing some type of learning success in their classroom.

IMPLICATIONS

Implications of this research may prompt further study and also an evaluation of one's thoughts concerning the potential benefits of gaming. It is hoped that this study and other studies centered on gaming and education will further inform both policymakers and practitioners about the characteristics of game players and the potential benefits of gaming in education.

Is Education Willing to Keep Pace?

Even though this study did not find any significant differences between gamers and non-gamers concerning specific teaching behaviors, there is little doubt the field of education can learn from the gaming community (Gee, 2004). The youth

of today are growing up in technology-rich environments with almost daily advancements in the Internet, video games, and computer games.

Educators are facing a very tough challenge in keeping the attention of their students in a fast-paced, technology-rich society. Students have entertainment at the touch of a button whether it is via MP3 player, computer, cell phone, game console, or remote control. Many students are losing interest in the classroom because of the lack of engagement in this setting. While entertainment should never take the place of quality information within the classroom, student engagement should always be a high priority. Policymakers and practitioners have often been slow to adapt or to accept change. A balance might be beneficial. For example, most secondary students are familiar with podcasting; podcasting has tremendous potential in the classroom. Through a computer or a digital audio device, students can download audio/video broadcasts related to classroom topics, providing another alternative to content presentation other than the traditional classroom lecture and text.

Are College and Professional Development Programs Making Progress Preparing Teachers?

When the data were analyzed, all of the questions and statements received favorable results for both groups except for three questions. These three questions were related to advanced computing skills including updating Web pages, implementing blogs, and using databases. Since these were the only questions or statements receiving low scores, it may suggest that college programs and professional development activities are making progress preparing teachers to complete job-related computing tasks and implement instructional technology. Most colleges and universities are requiring students in the field of education to complete at least one class related to computing skills, and more emphasis is being placed on meaningful professional development at the school level.

CONCLUSION

This study was limited to public schools at the secondary level in North Alabama. With the increase in sales within the video game market and the continual growth of the video game player population, a similar study may benefit from a larger and more dispersed population.

Although significant differences were not found between gamers and non-gamers when t-tests were conducted for each research question, researchers may choose to investigate specific areas where mean differences were found. For example, gamers were more comfortable using presentation software for demonstrating concepts in class, communicating electronically with colleagues and students, using the Internet for instructional purposes, and presenting information using various delivery modes. In comparison to gamers, non-gamers indicated a tendency to communicate electronically with parents more often, encourage students to use electronic tutorials outside of class more often, and allow students to use word processors to complete assignments more frequently. Future research may address issues of experience with technologies such as online banking, scrapbooking, and online shopping. Some respondents may have experience with items such as these, but may not be gamers. This could be a clue why significant differences were not found in relation to job-related technology tasks. Also, researchers may choose to explore a possible link between teachers' private use of computer technology and their willingness to implement instructional technology into the classroom.

In this study, teachers were identified as gamers or non-gamers by age, gender, education level, years of experience, and subject area. Future studies could involve comparisons within gaming teachers concerning teaching behaviors. Factors that may contribute to specific behaviors include average hours of game-play per week, preferred types of game genre, and type of preferred platform. Also, another study may benefit

by exploring the attitudes of each group towards technology and the reasons they use or do not use certain types of technology.

Future researchers could develop a scale or matrix to rate levels of game-play-based on specific characteristics or set criteria. Some game players prefer online gaming in communities, others prefer playing alone on consoles or handheld devices, and some prefer playing simple games on personal computers. As far as time spent playing games, individuals play at all different levels. Some play for less than one hour per week and others may play for several hours in the same week. Also, multiple genres are readily available for free or at varying prices. When studying video game players, there are multiple characteristics and criteria that can be studied. Future studies on teacher gamers would benefit by taking these characteristics into account, and significant differences are more likely to be found in practice.

The video game industry continues to grow at a rapid pace, and more individuals are playing video games than ever before. Many people are spending significant time playing video games, and video games have become part of our culture. While this study did not find any significant differences between those teachers identified as gamers and those as non-gamers, specifically in perceived levels of comfort in regard to completing job-related technology tasks, amounts of instructional technology usage, and amounts of participation in innovative teaching strategies, the potential of video games in education should not and cannot be ignored. It is hoped that this study will be used as a reference point for further study with teachers and the effect of video game-play on teaching practices and job-related tasks.

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KEY TERMS AND DEFINITIONS

Blog: Short for Weblog; considered to be an online personal diary/journal that may be updated easily and quickly online.

Innovative Teaching: Demonstrating characteristics that include, but is not limited to, creativity, possessing problem-solving skills, having good social skills, using technology, and having a desire to succeed in teaching and learning.

Instructional Technology: Any type of technology implementation based on learning theories and that takes a systems approach to helping individuals solve problems.

Podcasting: The delivery of digital content over the Internet available for playback on a personal computer or portable media player.

Schema: A mental object, structure, or organizational pattern created by an individual to aid in future understanding.

Teacher Gamer: A teacher is considered to have video game-play experience if he or she has enjoyed playing video games weekly as a hobby anytime in the past or present.

Video Games: The terms ‘computer games’ and ‘video games’ were used interchangeably throughout this study. These games often require problem solving, teamwork, opposition, and character identification in order to attain a goal. These types of games are played on computers, consoles, arcade machines, and handheld devices.

APPENDIX

Survey

This instrument is designed to obtain information to aid in determining the impact playing video games may have on the use of instructional technology and participation in innovative teaching practices.

Please use the following definition in considering your response: A video game is considered to be any game that is played on a personal computer, handheld system, console, or in an arcade.

Directions: Please answer all items. There are no incorrect answers. Responses to the items will be coded and used in a statistical analysis. All answers will be confidential.

1. **Age:** 20-29 30-39 40-49 50+

2. **Gender:** Male Female

3. **Highest level of education:**

Bachelor's Degree Master's Degree Education Specialist Degree Doctoral Degree

4. **Years of teaching:** 0-5 6-10 11-15 16-20 20-25 25+

5. **Subject Area Taught (Majority of Day):**

Math

English

Science

History

Physical Education

Vocational

Special Education

Other: Please Specify _____

6. Do you consider yourself to be a full-time or part-time video game player now or any time in the past?

Yes

No

If you answered no to the previous question, skip to question #12. If you answered yes, proceed to the next question.

7. How often have you played a video game on a personal computer?

Never

Seldom

Sometimes

Frequently

8. How often have you played a video game on a console (e.g., PlayStation, X-Box, GameCube, etc.)?

Never

Seldom

Sometimes

Frequently

Teacher Gamers vs. Teacher Non-Gamers

9. How often have you played a Web-based game (e.g., cards, puzzles, role-playing, etc. on the Internet)?
Never Seldom Sometimes Frequently

10. In an average week, how many hours do you spend playing video games?
Less than 1 1-3 3-5 5-7 More than 7

11. At what approximate age did you begin playing video games? _____

For the following questions, rate how much you agree with each statement using the following scale:

1 – Strongly Disagree

2 – Disagree

3 – Agree

4 – Strongly Agree

12. I am comfortable using basic computer applications.
1 2 3 4

13. I am comfortable using presentation software for demonstrating concepts in class.
1 2 3 4

14. I am comfortable communicating electronically with colleagues and students.
1 2 3 4

15. I am comfortable using the Internet for instructional purposes.
1 2 3 4

16. I am comfortable creating and updating class Web pages.
1 2 3 4

17. I am comfortable presenting information using various delivery modes (e.g., audio, video, text).
1 2 3 4

18. How often do you use computer applications to present lesson content in class?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never

19. How often do you use audio/visual equipment to display materials in class?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never

20. How often do you communicate electronically with parents?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
21. How often do you encourage or allow students to communicate electronically with you, other students, or experts via discussion boards?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
22. How often do you encourage or allow students to communicate electronically with you, other students, or experts via blogs?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
23. How often do you encourage students to use Web pages outside of class?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
24. How often do you encourage students to use Web pages in class?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
25. How often do you encourage students to use electronic tutorials outside of class?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never
26. How often do you encourage students to use electronic tutorials in class?
- Frequently (more than once a week)
 - Sometimes (more than once a month)
 - Rarely (a few times per semester)
 - Never

Teacher Gamers vs. Teacher Non-Gamers

27. How often do your students use word processors to complete assignments?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never
28. How often do your students use spreadsheets to complete assignments?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely(a few times per semester)
Never
29. How often do your students use databases to complete assignments?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never
30. How often do your students use presentation software to complete assignments?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never
31. How often do you take risks with your instruction by trying something new?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never
32. How often do you search for new ideas or products to enhance your lessons?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never
33. How often do you use alternative assessments such as digital rubrics and digital portfolios?
Frequently (more than once a week)
Sometimes (more than once a month)
Rarely (a few times per semester)
Never

34. How often do you provide individual feedback to students promoting high standards and providing motivation?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

35. How often do you reflect upon and assess you own teaching?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

36. How often do you coordinate activities within your classroom with out of classroom experiences?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

37. How often do you foster student learning by connecting difficult concepts from the curriculum with real-world applications?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

38. How often do you incorporate creative writing activities into daily lessons?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

39. How often do you promote teamwork within the classroom and the school?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

40. How often do you share your knowledge, skills, expertise, and resources with colleagues?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

Teacher Gamers vs. Teacher Non-Gamers

41. How often do you ensure that all students are experiencing some type of learning success in your classroom?

- Frequently (more than once a week)
- Sometimes (more than once a month)
- Rarely (a few times per semester)
- Never

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Chapter 4.22

Dance Dance Education and Rites of Passage

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ABSTRACT

The experience of a successful adolescent learner will be described from the student's perspective about learning the video game Dance Dance Revolution (DDR) through selected passages from a phenomenological interview. The question driving this investigation is, "Why did she sustain engagement in learning?" The importance of this question came out of the need for background on how to create an afterschool program that was to use DDR as an after school activity that might engage adolescents and tweens to become more physically active and reduce the risk of adult obesity, and to increase bone density for these developing young people through playing the

game over time. The difficulty of creating this program was the risk that the students would not sustain engagement in the activity, and thus we would not have a viable sample for the bone density adolescent obesity study. Implications of this study include understanding the potential construction of learning environments that motivate and sustain engagement in learning and the importance of identity construction for teachers to motivate and engage their students. In addition to the analysis of sustained engagement through the four socio- and cultural-cognitive theories, four major principals were extracted from the operationalized themes into a framework for instructional design techniques and theory for engaging learners for game design, training, and in classroom learning.

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INTRODUCTION

This article seeks to understand what engages young people in learning, and what sustains their interest to continue. It explores the elements that inform the lived experience of a chosen play activity and the possible social learning theories that might inform it. Four theories were chosen and operationalized for coding the transcript of the phenomenological interview because of their focus on motivation, social learning, and identity construction: Communities of Practice (Wenger, 1998), Affinity Groups (Gee, 2001), Social Interdependence (Johnson & Johnson, 1994, 2009), and Self-Determination theory (Deci & Ryan, 2002).

All of these theories seek to explain the motivation behind learning as socially constructed and distributed phenomena; all seek to describe the process of identity construction as an impetus for situated learning. The assumption in this study was that it is through the process of identity construction that engagement is sustained and supported through the process of group affiliation and is distributed through apprenticeship, modeling, group interaction, interdependence, and situated in space.

IDENTITY CONSTRUCTION RITUALS AND RITES OF PASSAGE

Traditionally, communities gather to provide ceremony for initiation and status transition for such things as the celebration of status change, where a child becomes an adult, and initiation, where single people become married couple. Although there may be many more transitions and rituals in today's society because of the great variety of cultural subgroups (i.e., churches, car clubs, self-help groups like Alcoholic Anonymous, and hobby groups like The Peoples' Revolutionary Knitting Circle, etc.), many of these groups traditionally necessitated face-to-face interaction. But with the Internet and today's computing power,

these relations can be mediated digitally through portals like Facebook, Xbox Live, *Second Life*, and other social networking tools—as well as expert systems that provide feedback based on performance, such as a video games like Dance Dance Revolution (DDR).

The DDR game club might be represented as a ritual rite of passage to understand how and why people build identities around their play, and sustain engagement to ultimately develop expertise. Central to the rite of passage is the initiation ritual (Van Gennep, 1960), where new roles and status are conferred through public performance where play (Geertz, 1973), the subjunctive mood (Turner, 1969), situates the activity, so that rules, roles, and consequences are suspended and participants can explore new identities, associated activities, and their semiotic domains and thus develop new status.

With this in mind, well-designed video games and their fan bases may represent and express new forms of the rite of passage and initiation ritual. Like a rite of passage, games are structured activities that are valued by certain cultural subgroups, depend on play as a subjunctive mood, represent expert systems that resemble apprenticeship activities, and involve performance initiation. The subjunctive mood observed in games and ritual are said to decontextualize the action and provide a suspension of rules, roles, and consequences found in ordinary life to allow for the exploration of new identities, rules, roles, actions, and social affiliations and status in a safe space. Games can do this well.

The ritual and process of identity construction may be an organizing principle in understanding motivation and engagement. The four social learning theories presented for discourse analysis seek to provide the impetus for motivation and engagement and how to structure it, and rely upon aspects of identity construction; these theories do not present themselves as descriptions of the identity construction process. Each theory has a different focus and seeks to describe aspects of

identity and focus on an element that informs identity construction: Community (Wenger, 1998), Activity (Gee, 2001), how individuals interact with each other (Johnson & Johnson, 1994, 1999), and needs of the individual (Deci & Ryan, 2002). For the purposes of this study, these theories were operationalized to provide insight for designing instructional environments that will motivate and sustain the engagement of the learner.

PURPOSE OF STUDY

This interview was to inform design features to develop a program for pre-adolescent exercise with DDR for the study of obesity reduction and increasing bone density. The study was also intended to get a sense of why a young woman sustained engagement with DDR over 3 years to develop expertise, and how educators might replicate that kind of commitment to learning and practice. This study may be especially pertinent to designing instructional contexts, exergaming, and structuring interaction and professional development.

BACKGROUND OF THE STUDY

Health care professionals have observed an increase in levels of childhood obesity. This increase has been attributed in large part to physical inactivity. Physical inactivity can lead to obesity and poor cardiovascular health, and it can also have negative effects on bone health. Bones function to support a mechanical load (a force exerted by body weight, muscle, growth, or activity). Bone is constantly formed and reabsorbed throughout life in a generally balanced way. However, in a three- to four-year window during puberty, bone formation is accelerated. In that period, as much bone material is deposited as will be lost during a person's entire adult life. During these pivotal years of bone development, physical activity is

important for optimizing bone health, as it has been shown to reduce the incidence of fractures later in life.

Because it is difficult to motivate children to participate in the type of cardiovascular activities that adults engage in (running, cycling, aerobics), new strategies must be developed, and these may demand elements that motivate the learner to sustain engagement over a longer period of time in order to promote and sustain life habits for physical conditioning.

DANCE DANCE REVOLUTION IS NOT YOUR TYPICAL VIDEO GAME

DDR is a game that you set up with mats, a TV, a game console and a game disk, and up to four people can play simultaneously (Figure 1). To play DDR, a participant responds to a series of directional arrows (see Figure 2), displayed on a video or TV screen to perform choreographed dance steps or hops synchronized to music. Song tempo and degree of difficulty increase as the player successfully progresses in the game. Because of the game's popularity and its cardiovascular exercise and jumping (bone-building) components, it could represent an appealing model for reducing physical inactivity in children.

DDR may be a possible solution to increasing activity and mechanical load because of the amount of jumping activity, but the young person must be motivated to start, and engagement must be sustained for the activity to produce valid and reliable measures of obesity and bone density.

The issue under investigation was how to help young people start an activity and sustain it; the simple answer to this was, seemingly, to make it fun—to make it a high-interest activity—but many toys, games, and activities are often tried once and then put aside. What came out of the interview was:

Figure 1. Dance Dance Revolution set up



- the importance of aligning the outcomes with a desirable activity,
- autonomy-supporting environments,

- the importance of group and environment to the construction of status and identity that makes belonging to a group desirable along with the sustenance of a common activity,
- the importance of status and relation for reinforcement,
- the centrality of group performance,
- the role of play as a subjunctive mood and portal to engagement,
- and again, the importance of identity construction for transformation to instantiate sustained engagement conveyed through affiliation, apprenticeship, positive interdependence, and expertise. The big idea here is that perception leads to transformation.

INTERVIEW-EE/INFORMANT

To explore this, we recruited Ellen as a DDR expert and possible employee to lead an after-school program at one of our sites at the Minneapolis Public Schools. We posted a hiring description for DDR experts and had a number of responses. One respondent, Charles, shared that he had a lot of

Figure 2. Screen shot and description of DDR



The arrows moving up the screen from the bottom need to match the arrows at the top. When they match, you need to step on the corresponding arrow on the mat. Good players do this in time to the music showing their rhythm & flow—maybe doing spins and hand slaps on the mat.

In this instance, the next move would involve the bottom arrow and the right arrow being stepped upon simultaneously.



friends who were really good at DDR, and Ellen was listed as one of those people. Ellen came into the lab to show us her DDR play, and we were impressed with her expertise.

What was interesting about Ellen was that she was not from a subversive or reactionary subculture. Ellen is part of one of the least studied cultural subgroup in schools (Buckingham, 2007)—an urban, middle-class teen that is successful in school, is respectful to teachers, has a part-time job, plays varsity soccer, in traveling band, is part of the International Baccalaureate Program, and has a satisfying home life.

These elements of her identity were surprising. We usually assume that video game players are a disenfranchised fringe group at school who do not engage with the typical academic fare. Ellen was able to balance not only her academics and music instruction, work a part-time job, but also play sports and have friendships. These elements of balance were enticing and we wanted to know how she was doing it so that we might try and replicate not only the physical health benefits in our bone density study, but also some of the psycho-social and affective elements necessary for sustaining engagement (Chapman, 2003). She seemed like a great role model for creating a curriculum that would rely heavily on identity development and she was an intriguing informant to help us understand how play identities might lead to work habits that help form healthy minds and bodies.

METHODOLOGY AND REVIEW OF LITERATURE

The question driving this investigation is, “Why did she sustain engagement in learning?”

According to Chapman (2003), engagement is more than behavioral time on task. When looking to measure growth or change, or even to understand whether a learner has truly engaged, an educator should also look for evidence of commitment

and positive attitudes related to the activity and subject matter.

- Engagement is not just doing the work, it is a connection and an affinity to an activity supported from the affective domains (Chapman, 2003).
- Skinner and Belmont (1993, p. 572) report that engaged learners show sustained behavioral involvement in learning activities accompanied by a positive emotional tone, select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration.
- Pintrich and De Groot (1990) see engagement as having observable cognitive components that can be seen or elicited through exploring the learner’s use of strategy, metacognition, and self-regulatory behavior to monitor and guide the learning processes.

These attributes do not appear in an activity because a student is told that it is good for them, and that they should commit to their betterment. Least likely is that they do an activity because we threaten, or just because we want them to.

A student must make a choice to commit to an activity and have that commitment reaffirmed over time to sustain engagement. True engagement in an activity is in some sense transformative and resembles identity construction, in that it changes who one is through cognitive, affective, and behavioral elements. It seems likely that without positive reinforcement (Skinner, 1938) the behavior may result in extinction and the game becomes another resident on the island of misfit toys. We look at social learning theories to explore issues of sustaining engagement through socially distributed reinforcement.

DDR is considered a high interest activity for many young people, and it does have a reward system that gives real-time feedback on perfor-

mance with rewards for successful play. But, without aligning those rewards and achievement with social capital, they lack meaning and status, and the reinforcement system remains a token economy (Ferster & Skinner, 1957) whose tokens are unredeemable except as social capital.

The work of Buckingham on identity development may provide some insight for connecting identity with purpose, motivation, and sustained engagement. Buckingham (2008, p. 3) states that Identity is developed by the individual, but it has to be recognized and confirmed by others. Adolescence is also a period in which young people negotiate their separation from their family, and develop independent social competence (for example, through participation in “cliques” and larger “crowds” of peers, who exert different kinds of influence).

Identity and status were traditionally conferred through rites of passage, and there may have been many culturally-specific instances of these rites for different groups and related activities. Video games may represent a new wrinkle in the way that we enact and view rites of passage. They may offer a form of guided, ritualized behavior for identity construction and group affiliation as an autonomy-supporting environment (Ryan & Deci, 1999), Affinity Group (Gee, 2001), Social Interdependence (Johnson & Johnson, 1994, 1999) or Community of Practice (Wenger, 1998).

A rite of passage does not need to resemble the tribal practices that led to vision quests, ritual markings, or exodus. A rite of passage may be organized in three forms: the process of separation, transition, and integration, (Van Gennep, 1960), but all three of these rites may also be presented as single rite (Barnard & Spencer, 1996). What was important for Van Gennep was the idea of Liminality, or the threshold. The threshold in an initiation represents a portal—a representative movement from the status of one social space to another, where ritualistically, the individual or group makes a transition by passing through a

metaphorical or literal portal to represent a change in social status and position.

In the context of Liminality, the activity space may be far removed from reality, and roles, rules, tools, values, and status may be situated in the flux of play as if a hybrid or interstitial space (Turner, 1969). This concept of the threshold and liminality seems to validate Geertz (1973) and his description of the “Center Bet” in describing the ritual of Balinese Cockfighting and Benthams’ concept of Deep Play. According to Turner (1969), there may be many rites of passage in a person’s life through sub-cultural affiliation (Cock Fighting, DDR, First Job) where identity and entitlement are inculcated through desire to become a respected and acknowledged group member, where the individual can share in and contribute to group activity, participate in group spaces, and publicly renew and further their status.

For Wenger (1998), identity is central to human learning; identity construction and learning are distributed through community and relations; learning is socially constructed; and motivation is based on a desire for sharing and participatory culture. The work of Wenger shares many attributes with Gee’s work, but the focus for Wenger was on socially distributed cognition and learning as social participation. Earlier work (Lave & Wenger, 1991) explored the role of learning in apprenticeship, where newcomers would enter into a space where learning was situated and contextualized, and goals and purpose were evident due to entering the space. One entered the space to gain apprenticeship and attempt to acquire and learn the sociocultural practices of the community. Thus, the individual is drawn to the group and begins to engage and learn by finding their role in a distributed, networked, cultural-cognitive process with the purpose of the individual as an active participant in the practices of a social community and become an acknowledged member with skills, knowledge, and the requisite values. This participation leads to the construction of his/her identity through these communities. From

this understanding develops the concept of the Community of Practice: a group of individuals participating in communal activity, creating their shared identity through engaging in and contributing to the practices of their communities.

The difficulty with this theory is that group membership is hard to define. A person may want to be part of group and claim group membership, but not have the identifiable characteristics that define the membership.

Since identity is conferred from others, there are factors that can identify a person as a group member and as having identity markings. For Gee (2001), the activity is primary and provides the motivation and engagement, the source of group membership and the identity markings; for Gee the community and relations are ancillary and stem from the interaction related to the activity. He states that these communities and spaces are hard to identify without knowing exactly why people are there. Whether a person actually claims group membership or is acknowledged can be difficult.

For Gee, whether group membership is acknowledged—claimed or not—attributes can still be observed. The role of Gee's work is central to operationalizing identity and group membership through offering observable sociocultural markers that come from semiotic domains central to the activity as evidence of group membership.

A semiotic domain recruits one or more modalities (e.g., oral or written language, images, equations, symbols, sounds, gestures, graphs, artifacts, and so forth) to communicate distinctive types of messages. By the word "fluent" I mean that the learner achieves some degree of mastery, not just rote knowledge ... Semiotic domains are, of course, human creations. As such, each and every one of them is associated with a group of people who have differentially mastered the domain, but who share norms, values, and knowledge about what constitutes degrees of mastery in the domain and what sorts of people are, more or less, "insiders" or "outsiders." Such a group

of people share a set of practices, a set of common goals or endeavors, and a set of values and norms, however much each of the individuals in the group may also have their own individual styles and goals, as well as other affiliations.
~Gee (2001, p. 2)

This work allows for certain attributes of group membership to be observable rather than subjective. A young person may have grown up participating in an activity with parents and young friends, but during the puberty years, may reject that affiliation based upon new goals for group membership and status. A new group may be more desirable than a current group, and the young person may cast off markings that identify them with the old group such as a hat from a uniform, ways of speaking, values, etc. This does not mean that markings of prior group membership with parents, family, and childhood affiliations are not still observable—an accent or mannerism may indicate origins or influence. For Gee (2001), it is the activities and the group practices that provide evidence of social learning and group membership from semiotic domains, and it is activity that is central to identity construction.

For Deci and Ryan (2002), the focus comes from work on motivation with a focus on Autonomy, possibly built from early work by White (1959), where organisms have an innate need to experience competence and agency and experience joy and pleasure with the new behaviors when they assert competence over the environment—what White called effectance motivation.

For Deci and Ryan, motivation is based on the degree that an activity or value has been internalized, and this is based upon the degree to which the behavior has meaning within the context of the arena of performance.

In order to sustain engagement for Deci and Ryan, motivation must be internalized—the external contingency must be “swallowed whole.” The learner identifies the value of the new behavior with other values that are part of the self. This

process of engagement is the transformation of an extrinsic motive, one that is reinforced from outside the learner's values, into an activity that is assimilated and internalized by the learner as an intrinsic value that becomes part of their personal identity. This process involves constructing values aligned with the group and environment, and thus assimilates behavioral norms that were originally external as part of a new identity. Based on the degree of control exerted by external factors, levels of extrinsic motivation can be aligned along a continuum. (Figure 3)

- External regulation: doing something for the sake of achieving a reward or avoiding a punishment.
- Introjected regulation: partial internalization of extrinsic motives.
- Identified regulation: doing an activity because the individual identifies with the values and accepts it as his own.

Identified regulation is autonomous and not merely controlled by external factors. It is motivation for an activity that has been integrated as part of the learner's values, and refers to identification with the values and meanings of the activity to the extent that it becomes fully internalized and autonomous (Ryan & Deci, 2000).

Social Interdependence describes what informs students' goal attainments (Johnson & Johnson, 1994, 1999). According to Johnson and Johnson (1999)

Students' learning goals may be structured to promote cooperative, competitive, or individual-

istic efforts. In contrast to cooperative situations, competitive situations are ones in which students work against each other to achieve a goal that only one or a few can attain. In competition there is a negative interdependence among goal achievements; students perceive that they can obtain their goals if, and only if, the other students in the class fail to obtain their goals

In cooperative situations, students work with Positive Interdependence, where group members perceive that they are linked with each other, and that the success of each member is linked to the success of the others.

Twelve themes from these theories of identity construction, ritual and rites of passage, engagement, motivation, and social learning were taken to code the interview transcript to inform analysis and make decisions on what factors might be important for the construction our after-school program for tracking design efficacy and measure performance.

THEMES FOR CODING

Of these twelve themes, there seemed to be four major themes, and the rest seemed to be interdependent sub-levels that were common across all of the theories. With this in mind, the major themes are:

- Play as Subjunctive Mood
- Activity Space
- Desirable Social Grouping, and
- Desirable Activity.

Figure 3.

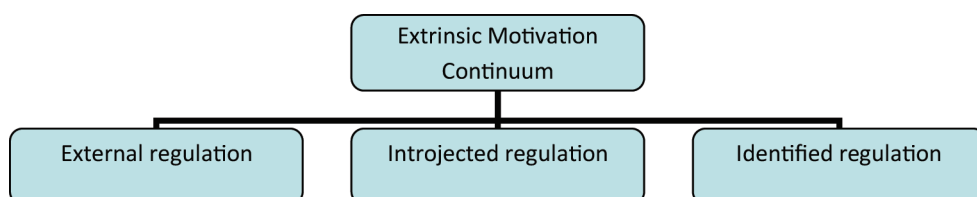


Table 1. Themes for coding

Play Subjunctive Mood	Activity Space	Desirable Social Grouping
Ritual Rites of Passage Initiation, separation, integration	Positive Interdependence	Belonging/ Relatedness
Desirable Activity	Identified regulation	Apprenticeship
Affective Commitment	Autonomy/ Competence	Cognitive Theories of Action

These themes were the most common descriptions of “why” when Ellen described her DDR play. These three themes also represent an aggregation of each theory, but with emphasis on activity, space, and groups, as well as the mood that needed to be present in those themes to be attractive.

DATA COLLECTION

The phenomenological interview methodology (van Manen, 1997) was used to try to elicit responses beyond descriptions of rationale to gather “thick descriptions” (Geertz, 1973) of affective, social, corporeal, and cognitive behaviors behind the activity and experience of playing DDR. And, also to encourage descriptions that were thick enough that the researcher might be able to identify instances of learning and engagement situated and distributed across networks of time and space, mediated through shared activity, and perhaps to see if there were evidence indicating what elements in the identity construction process inform motivation and engagement.

DATA ANALYSIS

The critical discourse methods as espoused by Gee (1999) and Fairclough (2003) not only provide methodologies that are fundamental to qualitative analysis, but are also fundamental to the study of “the scaffolding of human affiliation within cultures and social groups and institutions,” Gee

(1999, p. 1) and “how do existing societies provide people with the possibilities and resources for rich and fulfilling lives,” Fairclough (2003, p. 202). It was for this reason that these methods were used to explore and code the phenomenological interview transcript. Although a sample of one participant is not very robust for generalization, it provided a starting point for more focused theory testing, as well as to provide insights for us as designers, theorists, and education practitioners.

INTERVIEW

This first excerpt from the interview begins to describe the motivation to learn to play Dance Dance Revolution. Ellen and I met on a nice spring day in the Whittier neighborhood near the Minneapolis Institute of Arts at a coffee shop called Spy House. When I asked her about her experience of playing DDR, she said:

The first time I ever played Dance Dance Revolution was with my friends Tyler and Ben. They had it at Devon's house and everyone was playing this game. Really, I wanted to hang out with them, I wanted to participate and so that's when I started learning. Then it was after playing with those guys for so long that I really started to enjoy the game. I actually didn't have a play station before that, so I went out and bought a play station just so I could play DDR, yeah ... yeah, I didn't want to be left out of it. Games are fun and I just wanted to spend time with my friends and this is something that they were all doing.

The basis for Ellen's learning was Belonging/Relatedness to a Desirable Group. This idea of relatedness and Belonging were fundamental in her development of skills and collection of resources to develop as a player. However, she did not have the feeling of connectedness until she was really able to engage in the activity as a participating member—Autonomy/Competence. This indicated introjected regulation, and Identified Regulation seems to require the performance and seems to require some external indication of having internalized the values of the group that are expressed through public performance in the group and a commitment to practice that showed her effort toward group success as an indication of Positive Interdependence.

Surprisingly, the activity was not initially a Desirable Activity, "I wanted to participate and so that's when I started learning." After some time participating, she found enjoyment along with her sense of Belonging to a Desirable Group. This phenomenon suggests precedence of Belonging to a Desirable Group for Ellen over engaging in a Desirable Activity, and also suggests that an individual can develop interest in activity that might not have been initially motivating due to a desire to belong. Speculatively, there may be some indication for the importance of Play as a Subjunctive Mood for developing affinity for an activity. It was clear that she had already identified with the people, but, based on the next excerpt, she had not identified or been identified with the activity. The descriptions she offers indicate that the activities need to be playful and not so serious, and that the activity should offer success for assured status. There must be an entry point for a public performance, and perhaps since this game was new, she could enter without the loss of status that would come from being new and unskilled while the skilled players watched her and perhaps lost interest in her performance, and possibly in her.

I was excited because this was something I could participate in. I've played Halo and I'm not that good at it and everyone was starting out on this for the first time, so I thought I could be one of those good people at it and get respect from people. I was really excited. They have this huge TV at Devon's house and everyone's around you. I was kind of nervous too because you have to do this in front of people. Well, we were all kind of sitting on the couch watching the men and I was like I want to try it. I mean, some of them were interested in seeing me probably because they knew I never played before and they made me where I was probably going to fail, but then I actually really wanted to do it, so I was like, I want to do it next! I thought I was going to be better at the game than I thought I was because I'm thinking, oh these guys they don't have any coordination. This'll be easy for me. I'm kind of in shape, so I was thinking it would be pretty easy and then I do some of these songs and I was like oh, I need to go down a level! I thought I caught on fairly quickly.

What was clear from this passage was the importance of the activity and her feeling that she could be successful participating and "be one of those good people at it and get respect from people." There are several parts to this that are especially interesting:

1. Belief in her ability to succeed was essential in her willingness to perform publicly. Research on adolescents' engagement in literacy, for example, has found that adolescent perceptions of their competence and ability to succeed may be a more important predictor of whether they will engage, than their past performance. (Alvermann, 2001; Anderman et al., 2001; Bean, 2000; Guthrie & Wigfield, 2000). Studies of adolescents have also found that they prefer to perform where they know they will have success

- (Csikzentmihaly, Rathunde, & Whalen, 1996).
2. The fear of performing in front of the group with Autonomy/Competence, but that since people were just starting out, she might have a chance to be good at it and to be respected. This may have played an even larger role because she was one of the girls who watch from the sofa, not one of “the men” who play the games and perform.
 3. The importance of the Activity Space and its affordances as well as the possible change in atmosphere with this new game, where there may have been more emphasis on Play as the Subjunctive Mood.
 4. The role of Belonging/Relatedness seemed to be an important component in her participating in the activity and her feeling of becoming an acknowledged group member. The structure of the activity, according to the next excerpt indicated that DDR, as compared to other games, offered more of an Apprenticeship situation, where others were willing to teach and share; raising the level of success and fun through Positive Interdependence.

This makes a case for the importance of Affective Commitment, Belonging, and Competence, as well as a Cognitive Theory of Action. Although these seem to be sublevels of Desirable Activity and Desirable Group, that inform and reinforce action, they are important factors that indicate engagement and are likely fundamental to its sustenance, and also seem to indicate a form of reinforcement as socially distributed affect and cognition.

Ellen had created a Cognitive Theory of Action and knew that it was essential for her to perform to be acknowledged and claim membership—another indication of Chapman’s (2003) description of engagement, and evidence of Identifiable Regulation. To claim Belonging to this Desirable Social Group, she realized whether implicitly or

not, that she needed to participate through performance (Autonomy/Competence) to Belong. This supports Deci and Ryan’s position that Autonomy, Belonging, and Competence are basic needs that underlie motivation and engagement and satisfy Skinner and Belmont’s (1993) assertion of affective involvement. What is central to these needs are the Activity Space where these young people could interact as a community through the game; the subjunctive mood of play that may have allowed for the desirability and beliefs in success; and the game itself, which seems to be structured to promote Positive Interdependence and can create Identified Regulation through structuring relations through space and activity.

Ellen had already aligned her values internally as Introjected Regulation, but she had not found an opportunity with a Desirable Activity where she might have success in the Activity Space and feel confident that she would succeed and enjoy the activity, “I could be one of those good people at it and get respect from people.”

Halo and *Counterstrike* she described as work (Sutton-Smith, 1997), which has consequences for failure—the desirable group may have been much more advanced in their performance in *Halo* and *Counterstrike*, and perhaps took playing the game much more seriously and raised the stakes of the performance.

Games and play are often about choices without life-threatening consequences, but that does not mean that games are not taken seriously. They can be performance tests (Autonomy/Competence) and Ritual/Rites of Passage that allow for the development and affirmation of a place within a group, establishment of pecking orders, and through this, community status and entitlement; it is possible that the experience of being positioned to perform and possibly fail was some sort of initiation, a form of deep play (Geertz, 1973).

This act of bettering oneself in public can be risky situation—and it really must occur in public for a person to be seen as Competent/Autonomous and as an acknowledged group member (Belong-

ing). This Ritualistic phenomenon was described by Geertz as the “Center Bet” in “Deep Play,” (1973) and based on Ellen’s description, it may be that as competence and expertise evolve, the play gets more serious and the stakes and status of the performance (Ritual) change, the fear of failure increases with the perceived change in subjunctive mood from play to work ethos.

THE PERFORMANCE/INITIATION

Previously, Ellen may have wanted to be part of the group, but Ellen stated that the games they were playing did not provide her with much interest to play, even though she wanted to belong to the group and participate in their space. Because of this, she may not have been considered as part of the group, but maybe more of a tourist or poser because belonging seemed contingent on being able to “do.”

I have a lot of friends who play Counterstrike and a lot of... almost every guy I know plays Halo. You can enjoy watching those games. I don't enjoy it as much. Like I said, it's just way more serious. They get more serious. Well, it's like everyone is more quiet and focused, like they really get into trying to hunt these people down and kill them before they are hunted down and killed. DDR, you are playing against someone but then with Halo and Counterstrike you're against all these people and you have to be, like, watching your back all the time. Even the people watching, they zone out and just watch it. For me it's not as fun. As for DDR, it's more like people jumping around and are less serious, but it's still a lot of fun.

Prior to Ellen’s embrace of the game, she was a groupie. She could talk about how Devon did, but not about her own experience. This came, in part, as being recognized as a player by her community, but it was also a confidence that came of public performance (Autonomy/ Competence);

sustaining engagement with the practice; and working hard to develop status and identity related to the group and the activity and the freedoms and responsibilities that accompany them.

So, what followed was me just trying to find where I could go to play. Then I kind of got eventually frustrated with it—well, not frustrated, but I wanted to play more, so I decided to buy it for myself.

Yeah.

You play by yourself to get better to play with other people. I mean, it's always fun to play by yourself and unlock new songs and things like that.

I got it for Christmas from my parents, so I didn't have to buy it, but I had to persuade them and make sure they got me what I wanted. They didn't really understand but they felt okay about it because it wasn't something violent or anything like that.

Then I was, like, look what I can do! They watched me. They thought it was kind of interesting. This was with my family on Christmas. Then my uncles and my little cousin, who was maybe like seven, they all got really interested by it. So my fifty-year-old uncles are trying it and they're getting really excited. My little cousin, she's getting excited too. She doesn't even really understand what's happening on the screen but she's like jumping around on the pad.

In the DDR trial, Ellen was tested to see how she would respond to public failure: she could have quit and gone home, or she could have laughed it off and found the fun in learning and worked towards acceptance. Ellen found that there were others who were beginners that she could improve with, and more experienced players who were actually helpful and willing (Apprenticeship/ Positive Interdependence) to teach. She, also, found that there is no substitute for experience, and that in order to become a part of the group, she had to go

through the rites of practice and public initiation. According to Van Gennep (1960) this ritualized process is common to many societies where an individual passes from one stage of life to another, and it can involve separation from childhood environment, transition, and incorporation with new status. For Turner (1969), this game may not be as monumental as rites celebrating marriage or death, but it still represents a moment of social transition and eventual change in status. The importance of this is the public acknowledgement of Competence. This seems to be essential to identity construction and acceptance as a member of a group through the activity that is structured in a way that resembles positive interdependence, and may be the reinforcement for sustaining engagement.

It was through the activity that Ellen was conferred status and identity as member not only by her new friends, but through her family and the community, that had the power to convey her status and acceptance. She became a “gamer girl.” This conferred new identity and acceptance allowed her to become that gamer beyond her normal relations and to extend her community network and develop new relations and status:

Because we shared this thing, so it would be, like, oh, so whose house are we going to go to tonight to play DDR? Okay. Well, my friend Devon, his house was the main DDR house just because he had a great room for it and everything. And his parents didn't really care how much noise we made or how late we stayed there, so his house is generally the DDR house. Tyler, who was my friend prior, we would get together and practice a lot. Michael, he bought DDR around the time that I did and we were basically kind of on the same level, and I got to know him better that way just by spending time with all these people. Nick, all these other guys, I had kind of known beforehand, but now we spent all this time together. So, it was basically we all met at Devon's house and that's what we would do for weekend-after-weekend-after weekend.

If we can draw from these Activity Spaces and domains and inspire the learner to feel a connection and affinity to traditional academic fare like engineering, literature, mathematics, and so forth as Desirable Activities, we may provide a portal to embracing academic learning. The challenge seems to be embedding the learning outcomes in a high-interest activity with a reinforcement network to sustain the activity and continue to validate the identity.

As Ellen's ability with the game progressed, she was being recognized as a DDR “gamer girl,” and this conferred upon her a new identity and status. She began to find new connections through familiar school activities. Her familiar conversations changed to unexpected connections in school and at her job; as more people learned about her new status as a gamer girl, the more she began to meet others with an interest in DDR and to connect with the gamer culture. She had begun to move beyond her former status as an International Baccalaureate student (Academic), varsity soccer player (Jock/Athlete), Band Member (Musician/band geek) into a more generalized, pop-culture status, where she was seen as not so serious and more approachable. It may have been important to Ellen to branch out and change people's perceptions. Perception seems to be essential to transformation. We can work to create an identity, but it must still be acknowledged to have status. This may have been her first activity that was run by her contemporaries—autonomous and not overseen by adults.

Perhaps all her work in academics, sports, and band had made her appear to be too serious, and easily influenced by adults—a follower. She may have also felt constrained by all of her commitments and wanted to break out to meet new, fun people, “Really, I wanted to hang out with them ... games are fun.” The proposition that might follow as if a syllogism is that: Gamers are fun, and I want to be fun too.

It is only conjecture and anecdotal, and she did not abandon her commitment to band, sports, or

academics—she graduated with an International Baccalaureate diploma—but as can be imagined, all her work in those areas may have made it important to her to find friends who had interests beyond her everyday world, and that being a gamer would allow her to step away from conversations about the team, assignments, practicing certain pieces of music, and set her apart. Playing the game and being part of that community allowed her the ability to decontextualize and detach from work and become perceived as fun.

Developing these relations may be more than fun; it may be an apprenticeship to develop a coping tool. The importance of play, according to Vygotsky (1978), is decontextualization, where an individual can gain gratification and pleasure even in the midst of unresolved issues and larger, and time-consuming projects. The role of pretense and imagination can bring about pleasure and gratification in the face of uncontrollable circumstances; this can provide some relief through affective reward and pleasure. Perhaps the gaming provided an opportunity to decompress and laugh in the midst of all that responsibility and preparation. But, it was seemingly more than that. It was also a way to connect and extend her status by initiating new players and drawing on the interest and social capital, for example, in a hotel room on a band trip—another autonomy supporting activity space where the identity could be reinforced with status from new participants.

Yeah, it was a school band trip. So, a lot of us went and it turned out that a whole bunch of people knew what DDR was. It was interesting to see them play. Tyler and I, we kind of felt cool because our group that we had played with had progressed better than these other people that we were seeing play. They were like, oh man, this kid is so good and we play with him all the time. Tyler and I played against these people. Yeah, we beat them pretty bad.

In this instance, the game activity did extend beyond the familiar Activity Spaces like Devon's basement; it even seemed to provide an activity

that would make others see her as representative of a Desirable Group. The game and her new status seem to have supplanted the importance of being part of the gamer group in Devon's basement. The activity became a means for extending her friend identity reinforcement network as an Affinity Group (Gee, 2001), where people affiliate because of an affinity for an activity, maybe to be part of the fun—to play. As the activity began to change for the group members, relationships started to change, and the emphasis on the game, itself, diminished.

Well, a lot of the guys that I started playing it with, they moved on to other games because that's what they do. They focus in on something for a really long time and then they'll find something else will be just released and everybody else will just be playing that, so they'll jump into that. Then there was always the people who have it, like Tyler and I, who will still play it. We didn't get bored with it; it's just then there were other things. No. I don't play it as much as I do anymore and my friendships through that have become different. I mean, we're all still friends. DDR was just like this common thing that we had to, like, start us talking and then after that we talked about normal things. I became pretty good friends with a lot of people. I dated one of the guys that I met for awhile. I don't know, it wasn't, like, any different than like you meet people playing for a sports team. You have something in common and that's what you're coming together to do, and then you talk about other stuff because we're not just focused on DDR. Well, at my work it's kind of similar too. We're all stuck working together and so then we get talking. Soccer and sports a lot. Any kind of group that you all come together and you have something to talk about and then we just eventually expand on that and that's how we became friends.

The DDR game did facilitate relationships in ways that other games and activities did not,

but in the end, the initial motivation may need to come from a purpose that only the individual can develop. But, play can facilitate this and may make the entrance to a group, the practice, and eventual mastery of knowledge, activity space, and activity more likely to be enticing, and possibly provide for sustained engagement and eventual mastery. This makes a case for Play as a Subjunctive Mood and the importance of Positive Interdependence.

Playgroups, and the activities that support them, provide a common ground for interaction. There is definitely a pecking order that comes from demonstrable competence and evidence of knowledge from the semiotic domains from the game. Games are built upon play, pretense, and decontextualization, but once these activities no longer provide pleasure and gratification, the activity may quickly end and the relationships and spaces that contextualize and support them may change in the way that Ellen's DDR group cooled off: "and my friendships though have become different. I mean, we're all still friends."

Games are structured forms of play, Dubbels (2008) that provide rules and roles that are defined to help members to decontextualize from the ordinary world where they have responsibility, deadlines, and environments that they cannot control. These same rules and roles also help them to know their status in the game, share common, spontaneous, and authentic experience without going too deeply into personal motives, negative feelings, and Freudian melt-downs. Corsaro (1985) called this play group phenomenon the Actors Dilemma. According to Corsaro, the Freudian meltdown, or over-sharing, is one of the most common causes of playgroup breakup. Perhaps play is the coping mechanism that allows for detachment and the ability to constructively work on what can be changed and separating out that which cannot be changed. Game roles may also allow for exploration of other peoples' values and experience in a safe space without getting too deep or real, which represents an opportunity to

try on and project different emotions, and build comfort and trust through a common experience.

In terms of identity construction, the game may take a form of a Ritual/ Rite of Passage: The Activity Space is no longer like the ordinary world. The rules and roles in a game are different and even changed for the sake of experimentation with social norms. Interpersonal boundaries can be tested without endangering status and relationships—it is a trial, a testing. As with Ritual/ Rites of Passage, when Play acts as the Subjunctive Mood, different parts of person can emerge and people can try on different personae without recrimination, because they are only playing.

CONCLUSION

In answering the original question, "Why did she sustain engagement?" it became evident that her motivation to sustain engagement over time changed. She was attracted to the activity because she wanted to be friends with the kids who hung out at Devon's basement—she wanted to be an acknowledged member of the group, not part of the fan club. To do this she had to perform and risk ridicule and a possible reduction in status. Geertz (1973) described this spatially in that the further away one is from the "Center Bet," or the central public performance, the lower your status and importance to the main event and performers.

To be part of this group, she needed to perform, but she was hesitant to try because the games being played did not mesh with her sense of play and fun. Perhaps because the play of these group members with these games (*Halo*, *Counterstrike*) was already too far advanced for them to tolerate a "newb" (new player) at the controller, and might create a break-down of the activity. In this case, the challenge is learning how to improve performance through the activity of playing better players than oneself.

Ellen decided that it might be better not impose her learning during prime-time play and risk the

ridicule or contempt of poor performance. The lesson seems to be readying oneself to play in the “Center Bet,” which she did with DDR. If one is not contributing to the play, learning, and/or status of the group, perhaps spectators understand their place on the periphery, and that perception is the key to transformation, and this is mediated through play as subjunctive mood.

This ability to detach and decontextualize through play can be a very valuable trait when dealing with pressures of studying for exams, working, and other responsibilities that cannot offer immediate gratification. This inability to decontextualize and detach is one of the central behaviors inherent in Play Deprivation (Brown, 1999), a diagnosis used to make sense of the incredible violence of Charles Whitmore and his shooting spree from the bell tower at Texas A&M University. It was found that Whitmore was raised in a very rigid environment where he was not allowed friends or play. He experienced a life that looked very successful on the surface. But, in 1966 he committed what was the largest mass murder in the history of the USA. According to the National Institute for Play (1), Brown, who was a psychiatrist at Baylor College of Medicine at the time, collected behavioral data for a team of expert researchers, appointed by the Texas governor, to understand what led to Whitmore’s mass murder. What was found through interview, diary, and reconstructing is that Whitmore had been under extreme, unrelenting, stress. After many unsuccessful efforts to resolve the stress, he ultimately succumbed to a sense of powerlessness; he felt no option was left other than the homicidal-suicidal ... Whitman had been raised in a tyrannical, abusive household. From birth through age 18, Whitman’s natural playfulness had been systematically and dramatically suppressed by an overbearing father. A lifelong lack of play deprived him of opportunities to view life with optimism, test alternatives, or learn the social skills that, as part of spontaneous play, prepare individuals to cope with life stress. The committee concluded

that lack of play was a key factor in Whitman’s homicidal actions – if he had experienced regular moments of spontaneous play during his life, they believed he would have developed the skill, flexibility, and strength to cope with the stressful situations without violence.

Brown continued exploring Play Deprivation as a construct and found similar patterns in other violent offenders, and even traffic deaths related to aggression and chemical issues. The role of play cannot be underestimated for its ability to decontextualize and reframe experience. Play therapy currently is a treatment in child psychology for helping children talk about and understand forces beyond their control.

RELEVANCE OF ANALYSIS

The utility of this analysis comes from these recalled phenomena as a pattern for planning instruction and understanding why people learn. We learn to become. We create and engage to gain new experience and entitlement and gain status without danger in our social network, as well as to learn from others, whether it is a workplace competency, gaining social skills, or as a means of adapting to stress.

The role of Play as a Subjunctive Mood in these Activity Spaces and Desirable Groups may be the organizing principle that makes these groups and activities desirable as part of identity construction, as well as the means for identity construction and reinforcement to sustain engagement. For a person to facilitate and construct an identity, they may need to play, just as children play as doctors, fire-fighters, teachers, mothers, and even animals and dinosaurs in games. It is through pretense that we are able to imagine and create cognitive theories of action and circumstance, and it is through play that we develop this capacity.

If we want to sustain engagement, we need to help students develop the capacity for Identified Regulation, where they may turn their play into

meaningful performance when asked to perform in activities that begin to resemble rites of initiation and deep play. This process creates a subtle transition where the initial play activity becomes serious and is approached with the focus of work. Like what Ellen experienced watching advanced players of *Halo* and *Counterstrike*, and eventually what she experienced in practicing in addition to school, homework, and lessons, to prepare for DDR at Devon's.

IMPLICATIONS AND LESSONS FOR DESIGNING INSTRUCTIONAL ENVIRONMENTS

This transcript from Ellen's experience makes a case for developing instructional environments that allow for playful, autonomous group interaction structured as a game to allow for play in much the same way that ritual demands play. The group and space "Re-Place" and the rite offers "Re-Creation."

The use of play as the basis for designing instruction should not be underestimated. Often we forget that play is our natural approach to learning. When working with very young people, such as infants, toddlers, and small children, we align instruction with their interests, and allow objects to help direct inquiry. It is through the use of toys and exaggerated actions and emphasis in modeling target behavior that we allow for failure to be an inherent and necessary part of learning. The hesitation many educators express with this approach is that we have much to do, and little time to do it. It begins to sound like the white rabbit in Alice's Adventures in Wonderland running worriedly and anxiously "we're late, we're late!"

Stress pressure and anxiety are a natural part of learning, just as play is a natural part of learning, however, fear and threat scenarios are not often great motivators, in addition, fear and stress eventually take their toll on the body, mind, and spirit. Play may be the correct context for sustain-

ing engagement and creating the initial portal for engaging learners in focused approaches to work and delay of immediate gratification for the kind of rewards that rigor and sacrifice deliver.

I have used these principles on several occasions to explore games and play as effective methods for aligning content and process with resistant and reluctant learners. I have used it to create games for reading instruction, literature instruction, engineering, mathematics, leadership, and organizational change. To demonstrate how this can be done, I created a game called *Dry Dock* to teach engineering that I will use to demonstrate the four major instructional design principles for play.

PRINCIPLE 1: PLAY AS A SUBJUNCTIVE MODE

Engineering can be a very fun class, but the curriculum I was supposed to teach was very un-fun. In fact the curriculum was the source of the *dysfunction*. I was being asked to start class by presenting standards, why the standards were important, and tell the students why they were learning what they were learning. I found that this was much more for the benefit of observers evaluating the quality of my teaching than it was to motivate and engage the students.

I use standards, and I feel it is important to share the larger scheme of things behind activities and what they might be preparing for, but I do it with Play as the Subjunctive Mood. The first thing I did was to quit thinking that these kids would commit to a curriculum just because it was posted up on the wall. It is not enough to tell students how they are going to fulfill standards and a rubric.

For most, fear of failure was not an issue. Many of them were accustomed to it. They had checked out as an act of integrity, and in doing so, had found that they could dictate terms to teachers because of their disruptive behavior. Although my departure from the scripted curriculum of having

students redesign coffee mugs and the “do it or fail” curriculum did not always sit well with the administrators; it did result in engagement from my students (who did not drink coffee).

I told the students that we were going to be having a boat race, and that I would be bringing in my wading pool from home, and that we would be making sail boats out of Styrofoam to race across the pool. I structured all of the engineering, statistics, and technical writing so that they were embodied in the task, and that through experience, they could discover them. What was essential in this case was not so much joining a desirable group, but in participating in a desirable activity where their group could interact in the activity space semi-independently, and that the task was one where they believed that they would have early and instant success.

In addition to this, I also tried an experiment where I used a different approach to creation of subjunctive mood in the activity: Work as subjunctive mood: I told the students that we were really behind in our work and that we would have to work hard and be rigorous in our approach to these boats. I stressed that it was incumbent upon us to learn terms like resistance, surface area, momentum, and force and apply them into our hull designs. I was talking, but they were ignoring me, tuning me out. When I asked them what they were supposed to do, many of them did not know, and many of them expressed that they did not care.

To test this I introduced the activity where Play was the subjunctive mood: I told the class that we had a fun activity where we were going to be building boats and that we were going to have four kinds of races: speed, weight bearing, stability, and general purpose. I told them that I was going to be showing them examples of boat hulls and that they should play with them a bit to decide what style of boat they were going to make for the races they were going to participate in. I found that kids had listened, knew what to do, and really wanted to start. All of the same principles and terms were still present in the unit,

but they now had permission to be playful and perhaps fail. Play implies failure, recovery and experimentation. Many of the kids made crazy boats that would never work, but they were fairly successful in using the terms to justify their design for each race. It is not always what you do, or whom you do it with—it is how you do it, and that you do it at all.

PRINCIPLE 2: DESIRABLE ACTIVITIES

One of the key issues in creating sustained engagement and identified regulation is in creating activities that align with the goals and purposes of the learner, or exposing the learner to something they think is really cool and they want to do. Making boats was not what many teens would consider a “cool” activity, but it did hold attraction for them when I showed them the tools, the materials, and gave a brief overview of what they would have to do. Getting kids to engage may just be a matter of creating some fun, and showing that they can have early and instant success; that they can work with some autonomy in a space where there is wiggle room for them to be expressive; and that they can make adjustments if they make mistakes. There must be time allowed to go deeply into learning to allow for the student to commit to the *expression of self* into their work. This might mean going off task and making red sails even though it has nothing to do with learning the Bernoulli Effect, the competition, or the embedded learning outcomes.

The opportunity to make aesthetic and seemingly inconsequential changes allowed them investment in the activity through personal expression and to eventually invest in a cognitive theory of the activity, and also allow for a belief in their future success. Add to this the opportunity to work cooperatively and learn from the work of other class members—some call this copying, I call it modeling and apprenticeship—then they can make a start (often full of errors and mistakes)

and adjust for excellence as they work with others and begin to better understand the project/activity. In this way we enable the spontaneous neutral experience that can be useful for beginning the learning process and also building relationships and belonging, and autonomy and competence through the activity.

The key to this principle is in embedding the learning in the activity so that learners can discover the learning principles in the process of the activity through performance and reflection, where they compare what they have done with the work of others, and the instructor can provide encouragement to scaffold further development—this is an apprenticeship model with roles, rules, and positive interdependence. Oddly, this is often also the process of inquiry, discovery, and failure recovery, although time consuming, is often the process through which scientific principles were discovered before they were concentrated into abstractions in textbooks for memorization and testing-- they were tripped over by the scientists and then operationalized into methodology. This can be done when we think of instruction as games and learning as structured forms of play. Some important elements for designing instruction as play are offered in this framework of play for instructional design modified from Dubbels' (2008) Taxonomy of Play:

- Cognitive Theories of Action: we capture the imagination and build cognitive theories of action through imagery/ visualization (mental modeling).
 - A key word for the instruction should be “IMAGINE”.

This first category in the taxonomy provides a basis for testing comprehension. It is important to be able to create mental model and theory of the action. The key attributes are visualization and imaginatively creating mental models and segmenting process and attributes for indexing in memory. If learners index and visualize well,

they will likely have fine grain memory of the experience to draw upon for future use. Thus, creating these mental images is very important for creating the motivation to engage, belief in future success, and a cognitive theory of action.

- Desirable Groups: provide roles and identities they can try on and play with and offer the ability to change roles and play with the identities.
 - A key word for instruction should be “TOGETHER”

Working with others: A great draw because it allows for interaction. Many students need to be able to copy other students until they are able to IMAGINE and create a cognitive theory of action. Some learners do not learn well from instructors. They need to watch another learner translate the experience. Through this, they not only learn how to start the assignment, but also how to create a cognitive theory of action on which they can improvise and express themselves through and commit to the activity. I cannot tell you how many times I have seen resistant learners get into a groove and not want to stop the project once they finally get started!

- Roles: In the case of the boat project, they became Naval Architects and Marine Engineers; just learning about what these folks do as a profession, and, that these professions exist opened a lot of student eyes and created schema for the semiotic domains of each role. They also had Learning and Functional roles (see Appendix B).
- Structuring group work: The creation of roles in cooperative learning as Johnson and Johnson suggest (1994) is very powerful and also what we see in early childhood play, as well as more advanced game experience for video games, teaching empathy, and modeling interaction for professional development. In structuring the work

through roles, each group member has role specific tasks. One can play Return to Castle Wolfenstein or look at game-specific roles (character classes) in Appendix A and Appendix B, and imagine how these roles would culminate in teamwork for a mission. Each character class has several unique abilities and these come with different learning roles and functional roles.

- Identity/Semiotic Domains/Epistemic Frames: Provide rules, roles, values, language, actions, and tools associated with the roles and identities (semiotic domains) that they can work with, and act on that which is inherent to the task, where the performance is the assessment. The role of the Naval Architect is to design a marine vessel for specific activities. The elements that define this role are the tools, activities, language, values, and outcomes associated with the role, and ultimately, the boat floats or it doesn't. This embodiment is informative assessment, where the action provides immediate feedback through complete or partial mastery, or failure and the role provides for measure of progress and schema development based on knowledge of the semiotic domains.
- Create choices and branching decision network: It is important here that the learners explain their cognitive theories of action and are asked to utilize and explain the identity tool box to support their choices and why they did what they did, and what might be next.
- Contingency/Probability: This comes about when we consider the possible contingencies that might come from an action through prediction and hypothesis testing. Examples of this are

resource management; awareness of likelihood of an action based on knowledge of the game and instructional environment, and attempted quantification and probability of failure or success.

This structure for instructional design comes from A Taxonomy for Play and is aligned with a scale for levels of cognitive theories of action in Dubbels (2008). This triarchical model, the third leg being reading comprehension, has been the basis for a number of successful curriculum units as well as digital games, allowing for direct linkage to learning and comprehension metrics and is also available at <http://www.vgalt.com>.

PRINCIPLE 3: SPACES

Spaces are where we can offer activity, autonomy, interaction, and relationships. By creating spaces where learners can self-govern to an extent, we make them desirable, especially if there are desirable tools and resources as affordances. What I did with the boat unit was to create a rite of passage to get from one learning space to another. The students were told that to use the tools and start on their hull designs, that they had to use the hull examples and sketch a hull design, and then explain why and how the hull would perform well in specific race conditions (speed, weight-bearing, stability, general purpose)—then they were to go and test their design and hypotheses.

I was able to create different work spaces by offering tools and independent construction of their boats with a number of hot-wire cutting tools (for the Styrofoam) if they were able to sketch and explain their design based upon the hull exemplars and key vocabulary I had postered around the classroom walls; this was also where I had placed the wading pool for the races, and where students could make test runs of their constructed boats.

In a sense, I had created a threshold or Liminality into my classroom space, much like a game allows one to level up, or passing a rank elevates a soldier. It was a rite of passage of one space to another. The new space allowing more autonomy and less controlled interaction through a verbal examination and demonstration of applied knowledge and competence—a knowledge act (Dubbels, 2008).

PRINCIPAL 4: DESIRABLE GROUPS

This was mentioned in the Desirable Activities, but this deserves its own principal. The role of Desirable Groups was primary for Ellen as a motivator for her to become a DDR expert. What makes it especially relevant is the role of socially desirable groups and the influence they hold in conferring identity, the entitlement, and status that go with it. The role of groups cannot be underestimated for identity construction and the rituals that convey it. If Wenger (1998) is correct, and identity is central to human learning, and as Buckingham states, that identity is developed by the individual, but must be recognized and conferred through community through some type of performance or ritual, then the structuring of ritualized activities for status and competency construction may be immensely important for not only creating engaging activities, but to sustain them and make them life habits.

The studies operationalized in this analysis provide several key features, that when brought together provide a very powerful tool kit for instructional design:

- Communities of practice, which represent the established pathway into community, status, and entitlement. This model aids in our understanding of the distribution of knowledge through webs and networks of sharing, modeling, and instruction through status, identity, community ritual, and affiliation

- Affinity Groups, which explicate the importance of the activity in conveying group membership and status through evidence from the semiotic domains, which are signs, signals, and markings acquired and bestowed through experience in communities of practice and apprenticeship experiences.
- Self-Determination Theory provides the elements that lead to internalization of these activities, values, language, relations, and spaces for the actualization and internalized regulation of motivation and engagement into activities and habits that provide a source of satisfaction beyond the external, or extrinsic rewards that into activity that is self-satisfying and self-fulfilling for enjoyment and effectance, so that engagement is sustained and informs the individual's identity and status.
- Social Interdependence and Cooperative Learning, which provide insights into how to structure learning contexts and positive interdependence for learning, relations, and alignment of identity with valued cultural norms through Instructional design.

These are all brought together with the awareness that play may be the foundation for the construction and development of these descriptions—a portal to work, where we learn that play is the initiation, as well as the rite—and through ritualized behavior, activity, and representation, with allowance for learning and failure recovery we grow, evolve, and make meaning through mental models and prediction-- and thus innovation and deep seated cognitive theories of action due to the inherent process of reflection and do-overs in play and games to heighten public performance and status.

Play seems to be the subjunctive mood that mediates entry into work and competence, and possibly to expertise. As play becomes more competitive through more complex cooperation

and trust, play and learning deepens into effort, application, and work.

In addition, play is the foundation for ritual and representation, and central to creating the context and subjunctive mood for performance that supports apprenticeship, culture, and social learning. Play is fundamentally important for building life habits such as fitness, reading, and even simple things such as manners and cooperative behavior. In his treatise on play, *Homo Ludens*, Johan Huizinga (1938) posited that play was the basis of culture, and Lewis Mumford (1945) reasserted this in his treatise *The Myth of the Machine*—stating that it was imitation (mimesis), role play, the creation of miniature environments, and the symbolic fields of play where every function of life were modeled as a game to develop competency and advance what was known and yet to be known.

Dubbels (2008), in the spirit of Vygotsky, (1978), furthered this by stating that play and representation are the factory of our conceptual abilities, and if play involves the creation of abstractions and models of the world, then sharing play necessitates complex communication as well as a means for innovation and production, and perhaps the basis for cognitive theories of action, mental models, hypothesis creation, and ultimately comprehension.

With play central to our approach, we may find that motivation and engagement increase with little need for threat because of the inherent pleasure of learning without the dangers of repercussion or loss of status through failure. Failure is an inherent part of play, but a gentle entry with play and the promise of early and instant success (as in sail painting) can provide the portal to more profound success through failure recovery, modification, continuous improvement, and iterative design. In a game, there is often a loser, and in order to get better, we assume that we must fail to get better, as we must seek better players and more difficult conditions to improve, develop, and even transform.

Games are structured forms of play (Dubbels, 2008) that can provide the portal to complex social and cultural cognitive enhancement and progression. They represent new forms of ritual and safe contexts for contest and accomplishment through challenging apprenticeships in expert systems, where an expert might not have been available in the past. Games may be the new rite of passage and rituals, or as Vygotsky (1978) called toys “pivots,” where a banana can become a phone in a child’s play, where play is a transitional stage that is the beginning of separating the meaning of an object from literal to figurative. Games may be an elaborate pivot for accomplishment, status, and entitlement through modern day social and cultural networks in virtual and real space, and these may be the elements that motivate and sustain engagement and provide real answers for designing learning contexts and sustaining engagement and creating the kinds of identities that engender habits of lifelong learning and activity.

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APPENDIX A. CHARACTER CLASSES

Typical character classes and game roles from a video game can be used as a model for designing classroom instruction for learning roles (see Appendix B also). In this case from the game *Return to Castle Wolfenstein*. Each character class has different skills and fit what Shaffer (2006) calls an Epistemic Frame: the ways of knowing, of deciding what is worth knowing, and of adding to the collective body of knowledge and understanding of a community of practice, where by playing the medic and learning the opportunities and constraints, one begins to create a cognitive framework, or schema for a content domain of identity, knowledge, competence, language, values, and activity. Roles like these can be structured into instruction, just as they are reinforced in communities of practice and the hegemony of social practice and institution.

From Wikipedia:

Soldier: The soldier is the only class that can use heavy weapons. They are: mortar, portable machine gun (MG42), flamethrower, and bazooka/Panzerfaust. On the No-Quarter mod the Venom machine-gun and the BAR (Allies) or StG44 (Axis) have been added as well. Leveling up gives the Soldier benefits such as the ability to run with heavy weapons (instead of being slowed down).

Medic: The medic has the unique ability to drop health packs, as well as revive fallen players with a syringe. They also regenerate health at a constant rate, and have a higher base health than any other class, which makes them the most common class for close-in combat. When a player has achieved skill level 4 in medic, they get Self Adrenaline, which enables them to sprint for, longer and take less damage for a certain amount of time. Some of the medics act as Rambo Medics. Their emphasis is on killing rather than healing or reviving.

Engineer: The engineer is the only class which comes equipped with pliers, which can be used to repair vehicles, to arm/defuse (dynamite or land mines), or to construct (command posts, machine-gun nests, and barriers). As most missions require some amount of construction and/or blowing up of the enemy's construction to win the objective, and as defusing dynamite can be very useful, engineers are often invaluable, and one of the most commonly chosen classes. The engineer is also the only class capable of using rifle muzzle grenades.

Field ops: The field ops is a support class which has the ability to drop ammo packs for other players, as well as call air strikes (by throwing a colored smoke-grenade at the target) and artillery strikes (by looking through the binoculars and choosing where they want the artillery support fired). This class has low initial health, but makes up for having an unlimited supply of ammunition.

Covert ops: The covert ops is the only class which can use the scoped FG42 automatic rifle, the silenced Sten submachine gun (or MP-34 on some Mods), and a silenced, scoped rifle (M1 Garand for Allies, K43 Mauser for Axis). The covert ops has the ability to wear a fallen enemy soldier's clothes to go about disguised, throw smoke-grenades to reduce visibility temporarily, and place and remotely detonate explosive satchels. By looking through a pair of binoculars, the covert ops can spot enemy landmines, bringing them up on their team-map. The covert ops also show enemy soldiers on the team-map. Medic, Engineer, This creates a fluid transition to the next category.

APPENDIX B. LEARNING AND FUNCTIONAL ROLES FOR DESIGNING STRUCTURED INTERACTION AND POSITIVE INTERDEPENDENCE

Functional Roles—Adopted from <http://www.myread.org/organisation.htm>

ENCOURAGER and COP

- Reads instructions and directs participation
- Read the instructions
- Call for speakers
- Organize turn-taking
- Call for votes
- Count votes
- State agreed position

ENCOURAGER and SPY

- Summarizes findings and trades ideas with other groups
- Check up on other groups
- Trade ideas with other groups

*Allowed to leave your place when directed by the teacher

ENCOURAGER and SCRIBE

- Writes and reports groups ideas; is not a gatekeeper.
- Record all ideas
- Don't block
- Seek clarification

ENCOURAGER and STORE KEEPER

Locates, collects and distributes resources including informational resources like web pages and encyclopedia entries

- Get all the materials for the entire group
- Collect worksheets from the teacher
- Sharpen pencils
- Tidy up

*Allowed to leave your place without teacher permission

LEARNING ROLE for LITERACY

Freebody (1992) and Freebody and Luke (1990) identify the roles literate people take on that can be used in a classroom for activities that involve reading or the study of literacies that involves narratives and cultural phenomenon.

CODE BREAKER

How do I crack this code?

What words are interesting, difficult or tricky? How did you work them out?

What words have unusual spelling?

What words have the same sound or letter pattern or number of syllables?

What words have the same base word or prefix or suffix?

What words mean the same (synonyms)?

What smaller word can you find in this word to help you work it out?

What words are tricky to pronounce?

How is this word used in this context?

What different reading strategies did you use to decode this text?

Are the pictures close ups, mid or long shots?

Are the pictures high angle or low angle?

Were there any word pictures, eg similes and metaphors? How did you work them out?

USER

What do I do with this text?

What sort of text is this? (Information, story/narrative) How do you know?

Is it fact or opinion? How do you know?

How can you find information in this text?

How did the author start this text? Did it suit its purpose?

Who would read a text like this? Why?

If you wrote a text like this what words and phrases would you use?

How is the language the same/ different from other similar texts you have read?

Could the text help solve a real life problem?

If you were going to put this text on a web page, how would it be different to the print version?

What is the purpose of this text?

Could you use these ideas in a poem, story, play, advertisement, report, brochure or poster?

How would the language, structure and change?

PARTICIPANT (EXPERT)

What does this text mean to me?

Does the text remind you of something that has happened to you or to someone else you know?

What does the title/cover suggest that the text is about?

What might happen next? What words or phrases give you this idea?

What are the characters thinking and feeling? How do you know?

What message is the author presenting?

What are the main ideas presented?

What do the pictures (graphs, diagrams, tables, captions, illustrations) tell us?

Do they fit in with the text and do they provide more information?

What did you feel as you read this part?

Describe or draw a picture of a character, event or scene from the text.

ANALYST (INVESTIGATOR)

What does this text do to me?

Is the text fair?

What would the text be like if the main characters were girls rather than boys and vice versa?

Consider different race and cultural backgrounds too.

How would the text be different if told from another point of view?

How would the text be different if told in another time or place, eg 1900 or 2100?

Why do you think the author chose this title?

Think about why the author chose particular words and phrases.

Are there stereotypes in the text?

Who does the text favor or represent?

Who does the text reject or silence?

How does this text claim authority? (Consider language, structure and content)

Who is allowed to speak? Who is quoted?

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Section V

Organizational and Social Implications

This section includes a spacious range of inquiry and research pertaining to the behavioral, emotional, social and organizational impact of instructional design around the world. From case studies in Africa to studies of gaming on developmentally disabled and learning disabled children to plagiarism and community collaboration, this section compels the humanities, education, and IT scholar all. Section 5 also focuses on hesitance in some faculty members' integration with instructional design, a growing issue among those involved with education who are already forced to "wear many hats" at the higher education level. With more than 20 chapters, the discussions on hand in this section detail current and suggest future research into the integration of global instructional design as well as implementation of ethical considerations for all organizations. Overall, these chapters present a detailed investigation of the complex relationship between individuals, organizations and instructional design.

Chapter 5.1

Culturally Negotiating the Meanings of Technology Use

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ABSTRACT

This chapter explores how the “meanings” of technology use are being culturally negotiated between Western educators and native Iñupiat Eskimo learners at schools across the Alaskan Arctic region, as part of a wider examination of the impact of the Western product and process technologies embodied by these schools upon the socio-cultural consciousness of the non-Western learners whose educational needs they seek to serve. There are two distinct aspects to this intercultural negotiation between educators and learners: (1) attempts of the former to reconcile their practices with the latter’s values, standards, and expectations; and (2) efforts of the latter to culturally appropriate the non-indigenous technologies being made available to them. It is expected that professionals work-

ing in a range of organizational contexts within our field may be able to gain insight from the remarkably universal nature of the problems and solutions involved in this extreme and instructive situation of socio-cultural tension.

INTRODUCTION

Our field has, in recent decades, witnessed vast populations of learners and performers in schools and workplaces across the planet being dramatically affected by the rapidly strengthening twin forces of globalization and human migration. On the one hand, the worldwide spread of Western capitalism is leading to the rapid infiltration of Western technology into far-flung areas wherein they were previously absent, thereby impacting formerly unaffected populations. On the other hand, rising mobility as a result of improved

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transportation links and growing international commerce is leading to increased demographic heterogeneity within hitherto comfortably homogenous societies. The increasing diversity of socio-cultural variables—including race, ethnicity, nationality, language, and religion—among learner and worker populations resulting from the aforementioned phenomena will undoubtedly mediate learning and performance across a wide range of educational and organizational settings (Powell, 1997a; Subramony, 2004).

Mainstream theory and practice in the field of educational technology, however, have not been very successful at evolving and adapting in light of these socioeconomic and demographic changes (Subramony, 2004, 2006). While dominant Western-originated ideas, tools, and procedures—in other words, product and process technologies—related to education, instruction, training, and performance are impacting the lives of more and more non-Western learners both within and outside the geographical boundaries of Western civilization, very little research is being done in our field to document and understand the dynamics of this cultural interchange, specifically in terms of the negotiation between Western and non-Western cultural groups of the sociological “meanings” of using these technologies—that is, what, if anything, are those agents promoting and implementing these technologies doing to make the latter more culturally relevant to the lives of Non-western learners; and how these technologies are being culturally appropriated or rejected by non-Western target populations.

In a modest attempt to steer the prevailing theoretical and practical discourse in our field towards considering questions and issues of the aforementioned kind, the author of this paper enlists the help of data from a particularly interesting and dramatic case involving the introduction of Western educational technologies into a culturally unique non-Western population. Very briefly, the geographical context of this cultural interaction is a vast expanse of Arctic tundra in northern Alaska

where the indigenous Iñupiat (Eskimo) population has, in recent decades, been impacted by unprecedented oil wealth. The area of particular interest to us, in this case, is the resultant provision of an environment that is exceptionally rich in Western technologies within the region’s schools, which, incidentally, happen to be run almost entirely by expatriate educators from the “lower 48” United States. Meanwhile, the majority of learners served by these schools come from traditional Iñupiat families that, until very recently, depended almost entirely upon subsistence hunting, whaling, and gathering for survival.

In this paper we will briefly examine the impact of the Western product and process technologies that are embodied by the Boreal Slope School District (BSSD) schools upon the socio-cultural consciousness of the native Iñupiat Eskimo learners whose educational needs are served by these schools. This documentation involves exploring how the meanings of technology use are being negotiated between the imported Western educators on the one hand and the native Iñupiat learners on the other. There are two distinct aspects to this negotiation, namely: (1) the attempts of the former to reconcile their practices with the values, standards, and expectations of Iñupiat learners; and (2) the efforts of the latter to culturally appropriate the non-indigenous technologies being made available to them. This author believes that professionals working in a range of organizational contexts within our field may be able to gain insight from the remarkably universal nature of the problems and solutions involved in this extreme and instructive situation of socio-cultural tension. As cultural anthropologist Norman Chance explains, “by seeing how events are intimately linked to comparable forces present in other settings (we can) come to appreciate the common themes of historical process along with the uniqueness of cultural difference . . . (since) though differentiated by culture, we are all united by history” (Chance, 1990, p. xvii).

BACKGROUND

This two-part section features a brief discussion of the current state of inattention towards issues of cultural diversity among learners and technology users within the mainstream academic discourse in educational technology, followed by a concise contextual description of the site and case from which data has been drawn to illustrate the key issues discussed in this paper.

Background of Inattention

Back in 1997, Gary Powell—then a faculty member at Wayne State University’s prestigious Instructional Technology Program—was among the first scholars to recognize the neglect of cultural factors by the mainstream discourse within our field. He lamented how matters of cultural, racial, and ethnic diversity among learners were not eliciting the level of attention they deserve in our field’s texts, journals, and conferences—a neglect that persisted despite a growing acknowledgement that key learner characteristics such as prior knowledge, entry behaviors, ability, and motivation, all of which are heavily influenced by the latter’s cultural backgrounds, must be taken into consideration to enhance learning (Powell, 1997a). Seven years later, Subramony (2004) surveyed the current situation and found that not much had changed in the intervening time: Much of the curriculum in leading graduate programs in the field across the nation still did not address the relevance of cultural differences among learners; only three out of 41 chapters in the most recent (2003) *Handbook of Research for Educational Communications and Technology* brought out by the Association for Educational Communications and Technology (AECT) contained any discussion of cultural issues; a mere 2.5% of the more than 500 refereed presentations at the 2003 AECT International Convention tackled this topic; and finally, just 2.9% of the 379 research- and development-related articles published in six, key,

peer-reviewed journals in the field during 2002–2003 featured an explicit discussion of cultural factors in learning or technology use.

Reformist, culturally conscious scholars have attributed the neglect described previously to the historical foundation of traditional curricula within our field in the conservative, Western philosophical canons of positivist science, patriarchy, and Eurocentrism. According to them, this prevailing view of the field (1) distances our research and practice from the multiple values and needs of non-Western sociocultural groups by co-opting its language, analogies, and metaphors from military, industrial, and medical spheres (Jamison, 1992); (2) tends to hold largely media-based and exogenous views of cultural minority groups; and (3) generally sees success as a de-raced phenomenon achieved through meritocracy (Swartz, 2003). Many mainstream scholars in our field thus seem to believe that issues of cultural diversity among learners are already being given more attention than they deserve, that—as noted educational evaluator Reeves (1997) described their feelings—these issues are merely “a passing fad, a byproduct of the current attention to multiculturalism” (p. 27) within North American and European academia.

Reeves (1997) went on to describe how his own perspectives on the field—as those of other evaluation authorities, most of whom are White males steeped in Western philosophy, psychology, and research methodology—have been biased by professional experiences that rarely addressed multicultural or diversity issues. Powell (1997b) also revealed how many middle-class, White scholars and practitioners in our field display ethnocentric attitudes, judge the world by their own cultural values, and have little interest in understanding any cultural differences lying at the heart of their target learners’ lives. Thiagarajan (1988) concurred with Powell (1997b) in noting that mainstream Western scholars commonly ignore minority learners’ cultural reactions to competition, public recognition, negative feedback, authority figures, and gender differences,

instead assuming that their own cultural tradition represents the best or only way. Meanwhile, noted learning scientist Thomas Schwen (personal communication, 2003) bemoaned how educational technologists are often “seduced by the belief that their research and development endeavors are value-free and therefore immune to social and technical criticism.”

Scholars and practitioners in our field are thus finding the faces of their target learners changing faster than their ability to modify their instructional and classroom management strategies, curricular materials, and, most importantly, their mindsets that leave them predisposed to regard diversity at best as “interesting,” and at worst as a “deficit,” and to make erroneous assumptions about cultures other than their own (Powell, 1997b). Such attitudes, in Schwen’s words, serve to restrict social choice, impose pedagogical options, and deprive equal access. As Thomas, Mitchell, and Joseph (2002) go on to describe: “By not directly addressing culture in the design of instruction, many products have been designed that inadequately address the needs of the population for whom the instruction was designed. Unintended consequences of this shortcoming include the production of ineffective instructional products, the under-use of potentially effective products, culturally insensitive products, and products that are deemed overtly culturally offensive by some members of certain populations.” These negative consequences of our field’s neglect of cultural issues are worsened by the pre-existing, well-documented socio-economic and educational challenges faced by many non-Western learners.

Site/Case Background

The case described in this paper, the BSSD, (please note that to protect the privacy of informants/actors and organizations involved, all geographical, institutional, and personal names pertaining to the site and case have been changed) was extensively

studied by this author through successive site visits over a 2-year period. Inquiry methods employed to this end included individual and group interviews, observations, and document analyses. This vast Arctic district is headquartered in Borealis, administrative headquarters of a region of sparsely-peopled, treeless, marshy, mostly-frozen tundra that holds “the largest petroleum deposit ever encountered in North America, with an estimate of 9.6 billion barrels of recoverable oil” (Chance, 1990, p. 153). Borealis has grown into “the focal point of Eskimo adjustment to the modern world, the crossroads of contact with big money, western culture, and industrialization” (Boeri, 1983, p. 193) and the “testing ground where the success of the wedding of modern government, Western technology, and big money with the values Iñupiat place on their heritage and traditional lands will be decided” (Blackman, 1989, p. 32).

Blackman (1989) describes Borealis as a site that “leaves a strong impression on the Outsider. As the northernmost city in the western hemisphere, the largest Eskimo community in North America, oil boomtown, and seat of the largest ‘county’ government in the United States, (Borealis) is the sort of place that attracts modern-day curiosity seekers” (p. 3). What makes Borealis’ character especially unique is the pace at which it has evolved from a pre-agricultural, hunter-gatherer settlement into a modern, technology-intensive socioeconomic hub for the entire northern third of the state of Alaska. As cultural anthropologists Worl and Smythe (1986) explain, Borealis natives currently in their 60s and older experienced, within the span of their lifetimes, “changes from dog-sleds to snowmobiles, from heating homes with blubber to natural gas, and from wearing caribou clothing to denim and polyester. Some witnessed the abandonment of customary practices, such as the (formal wife-swapping arrangements) and the burial of personal property with the dead” (p. 22).

Particularly intriguing to an educational technologist is the unique educational environment that

Borealis' K-12 schools are providing to an equally unique learner population. These schools feature the juxtaposition of a technology-intensive, oil-wealth-fuelled educational system, based on the modern, dominant Western model, with a student body coming from Iñupiat families that deeply and demonstrably cherish their traditional native ways of knowing and being. The BSSD currently runs 10 technology-rich schools spanning the enormous, sparsely populated region. While the relatively large settlement of Borealis—boasting a population of a few thousand souls—is served by separate elementary, middle, and high schools, the seven other significant Boreal Slope settlements, given their small sizes, each have a single, unified K-12 school. Borealis High School (BHS) opened in 1983 at a cost of \$85 million and incessantly expanded and upgraded since then as the flagship institution, the largest and best-equipped school on the Boreal Slope, “the showpiece of them all” (Blackman, 1989, p. 31). In 2004 the total enrollment at BHS was 273 students. The school costs averaged \$21,000 per student per year to run, with the average graduating class comprising around 30 individuals.

Interestingly, as Blackman (1989) explains, while home rule for the Iñupiat has brought a measure of local control over Boreal Slope schools, with the Iñupiat-majority Boreal Slope Borough School Board making decisions on programmatic and budgetary issues, the education of Iñupiat students within the BSSD schools remains largely in the hands of non-Native administrators, teachers, and staff imported from outside the region, mostly from the “lower 48” United States. It is these Western-educated outsiders who get to make most of the immediate administrative and pedagogical decisions that affect the educational experiences of the Iñupiat students. Such cross-cultural control, common across the inhabited world since colonial times, has strengthened as a phenomenon in recent decades thanks to globalization. Those interested in performance technology

issues within corporate settings may be interested in Marken's (2006) recent account of a Fortune 100 company featuring a similar circumstance.

KEY ISSUES

Getting back to the case at hand, it is indeed a recurring feature at schools in Native-populated regions across North America—such as the Far North and Indian reservations further south—that a predominantly indigenous learner population is being served by a predominantly Western educator group. Such circumstances pose unique challenges to both learners and educators. When this author interviewed new BHS teacher Lacy while conducting fieldwork in Borealis, the incongruity of this situation seemed apparent to her from very early on:

In the first week of school, we had that welcome assembly, and that's when it really hit home, because I'd had the classes, that whole day, seeing new faces and trying to get names, but being in that assembly literally gave a very clear picture of kind of what was happening in the community, because we had the superintendent, the principal and the vice-principal, they all spoke at different times up on stage, and we're in this really nice auditorium, and then you've got all the teachers, kind of up and around the auditorium so you can see all the teachers they're standing in the stairs and in the back, so it's like this, and everyone's White, almost everyone has come from the 'lower 48,' the teachers, the superintendent, the principal, kind of the positions of power in terms of the schools are White, and then, I was standing in the back, and you look down through all the students sitting right in the middle, and most of them have this jet-black hair; and it was like, OK now what exactly are we doing here? And it was just very, it was kind of eerie, disconcerting.

Meanwhile, interacting with Native Iñupiat informants in Borealis and reviewing the literature pertaining to the evolution of modern Western-style education in the North American Arctic over the past century or so leads one to an understanding that there existed no such institution similar to a Western “school” within traditional Iñupiaq society. Learning was experiential and organic, with the young learning their social behavior and Arctic survival skills from their family and from the community. The process of education was thus naturalistic and all-encompassing, because, in essence, as a local Iñupiaq elder expressed it, “school was life.” But with the advent of Western-style schooling in the Arctic there was now a dichotomy between education and life, between school and community, a division brought about by the product and process technologies that came along with the Western educational institutions—institutions that were systemically alien to the physical and cultural environment of the Boreal Slope.

Add on to this fact the unique exigencies of Borealis’ Arctic location and the extreme technology richness of its school environments, and the matter becomes even more complicated. One of this author’s primary objectives in studying this case, as mentioned earlier, was to document the impact of the Western product and process technologies embodied by the BSSD schools upon the sociocultural consciousness of the native Iñupiat learners whose educational needs were being served by these schools. It was explained that this documentation involved exploring how the meanings of technology use were being negotiated between the Western educators on the one hand and the Iñupiat learners on the other, with their being two distinct aspects to this negotiation, namely: (1) the attempts of the former to reconcile their practices with the values, standards, and expectations of Iñupiat learners; and (2) the efforts of the latter to culturally appropriate the non-indigenous technologies being made available to them. In the following two sections the reader is presented with a short exploration into these aspects.

ON THE USE OF WESTERN EDUCATIONAL TECHNOLOGIES TO SERVE NON-WESTERN LEARNERS

In an illuminating session at BHS, technology teacher Annabelle permitted this author to observe a 75-minute keyboarding and word processing skills class session she was conducting. Annabelle started the class off by handing her learners hard copies of a sample cover letter for a job application, asking them to copy it into a Microsoft Word file as a “warm-up exercise.” Written by a certain Robert Goldstein of Huntington, WV, the letter was addressed to Frank Westerman, Fire Chief of the Huntington Fire District and expressed its writer’s desire to be considered for a position of firefighter trainee. Annabelle reported having photocopied the letter from a textbook on business communication. The fact that the letter did not contain a single reference to an Arctic or even an Alaskan context—being, instead, set entirely within a “lower 48” milieu—did not appear to cause much concern to Annabelle, nor did she seem to have considered the possibility that this situation could be fixed so easily, that is, just by changing a couple of names and geographical references in the letter before handing it out to the learners.

In the meantime, after the learners—seven Iñupiat and a Filipina—had finished copying Mr. Goldstein’s letter to Mr. Westerman, Annabelle had them move on to do a set of typing exercises using the *All The Right Type* software program, which had been purchased by BHS and made available on the school server. The program presented the learners with a series of sentences in succession to copy, keeping track of their speed and accuracy and providing feedback on these variables. Once again, not a single one of these practice sentences seemed to be related in any way to the learners’ cultural or geographical context, but instead smacked of a traditional “Dick and Jane” paradigm. Examples of sentences the learners faced included “Danny is flying to Denver in January”; “Nora is staying

over in Niagara Falls”; The 6 girls each ate over 6 plums”; “I baked 23 pies, while Jill baked 13”; “24 cows, 14 cats, 24 pigs, 44 horses”; “Manuel picked 114 apples from 4 trees”; and so on. It was rather intriguing for this author to watch the learners dutifully copying these sentences while belonging to a geographical locale in which there existed no trees, cows, pigs, or horses whatsoever, and where the general population, as a rule, did not keep cats as pets, or include pies, plums, or apples as part of their diet.

Meanwhile, when Annabelle—who also taught media classes and oversaw yearbook production—was asked to describe what she did during these classes to make the classroom experiences more responsive to her learners’ native culture, this was what she answered:

(For example) if I taught TV production here, the subject matter for some of the videos may be different than in the ‘Lower 48,’ but certainly the use of technology would be the same ... I think as a teacher, that’s the one thing you want to be really careful of, and I think as any good yearbook teacher ... I try and be a guide and a coach, and I try and teach them journalistic (and design) standards ... but the content, I really try and let the kids decide. And yeah, there will be cultural elements in the yearbook, you know, the big headline when you open page one, is, “Arrigaa,” which is an Iñupiaq word, and that’s the first word in the yearbook this year! So yeah, there is a lot of that ... the theme for the yearbook is “The View from the Boat,” it’s a reference to whalers and whaling, and things work in like that a lot. They ask a lot of times whether senior quotes, do they have to be in English. “No, your senior quote doesn’t have to be in English,” ... and I think we had them submitted in three different languages so far besides English ... so, I think it would be horrible if the yearbook from Borealis High School looked exactly like the one from (a school in the ‘lower 48’ United States)! It would be wrong, and, I don’t think it does!

Readers may note how Annabelle’s response seems, interestingly, to convey the assumption that technology could be used as a vehicle for working with culturally relevant subject matter—in other words, that it was basically the “content” in which cultural elements found their expression. Such a viewpoint would also suggest that, with cultural elements being primarily couched within content and with technology being merely a tool used to deal with the content, there was, thus, not very much in terms of embedded cultural elements within the technologies themselves. Such assumptions would be neatly congruent with mainstream discourses in our field that, as Jamison (1992) describes, define technology as a neutral technical apparatus or technique, and promote Western technology as the ideal catalyst for global progress.

Annabelle meanwhile had provided this author with copies of six previously published BHS yearbooks. Upon analysis, however, very little evidence could be seen of any conscious efforts to include Iñupiaq cultural elements within even the content of these volumes, except that most of the photographs therein showed Iñupiat faces. While some of the yearbooks sported vaguely culture- or location-specific titles—the 1996 volume was titled “Breaking the Ice;” the one from 1997 was “Dancing to the Beat of a Different Drummer;” and the 2004 edition was titled “On the Water’s Edge...” —none of the six yearbooks had a single page devoted to content in the native Iñupiaq language. As for the reporting of any Iñupiaq culture-specific activities, the 2004 yearbook could well be held as a representative exemplar: within its 104 pages, there were exactly three photographs related to whaling, one picture from a sewing class, and, rather inexplicably, one of a skin mask made by a different (Nunamiut) Eskimo group. The rest of the yearbook indeed looked very much like one from anywhere within the “lower 48” United States, with coverage devoted to matters such as sporting activities, academics, fine arts, student government, and Western-style

social events such as a block party and the annual Homecoming ceremony, plus with the usual student portraits. And ironically, these yearbooks displayed production standards equaling those of yearbooks from any affluent suburban U.S. school, featuring profuse illustrations and high-quality paper and binding materials.

This author also visited a 75-minute CAD-CAM class at BHS, taught by shop teacher Liam using an expensive, new *Shopbot* device. The installation comprised of a bank of computers for design work, plus the *Shopbot* machine for doing the actual machining. Learners could design an object on one of the computers using CAD software, and then go over to the *Shopbot* and have it create the object they just designed. Two Iñupiat male learners were working on designing wooden wall plaques the day the class was observed. One of the former was making a plaque that read “The Ahsoak’s Residence—No Trespassing—Guard Dog on Duty,” while the second was making one that read “Mama Susan’s Kitchen.” It was intriguing to watch the two boys manufacture plaques of the kind that, honestly, could be encountered pretty much anywhere in the country. This author asked Liam how might any of this relate to the Iñupiat’s own craft traditions. He replied that he would sometimes find Iñupiat learners picking out from among the standardized design templates those that featured vaguely “native-looking” patterns or elements, for the products they created using the *Shopbot*.

The aforementioned examples have been cited basically to illustrate a strongly felt perception on this author’s part that, while some efforts were certainly being taken to allow the learners to express their cultural elements, the school as a whole remained an essentially Western institution in the way it was structured and run, and in the product and process technologies it employed. Gail, chief of the BSSD’s Department of Bilingual and Multicultural Education (DBME) and a native Iñupiat herself, seemed to agree with this perception:

I mean, look at, when you walk into the school, you feel like you are an outsider in your own community in a building that is Western. So, in the first place, there is that discomfort with just aesthetics, with the environment, as you walk into a building. All the people who are in the school, as the teachers, as the administrators, they are from the ‘lower 48,’ they hardly know much about the kids they are working with ... so, in the first place there is that, well because of the differences in who and what the school is all about, and who and what the community is all about ... because we’ve continued to import curriculum, import all of the text books, import anything we use in the classroom, coupled with the fact that 99.9 per cent of our teachers are not of this area, they are from the ‘lower 48,’ we’ve continued to perpetuate, I think, and strongly believe, the assimilation that occurs ... in the schools, we’ve of course initiated a language program and we’ve done little bits and pieces of integrating culture here and there, but it’s not systemic, it’s not systematic. And so, by virtue of that fact, I believe that we make our children, when they enter the classroom, leave who they are outside; we are mainstreaming them.

Meanwhile, when this author spoke to Isabel, one of the very few Native teachers in the District, about how she, as an Iñupiat educator, might use technology differently—from mainstream approaches—within her classroom, she described her approach thus:

Um, it’s mostly teaching techniques, or how I teach, I teach it, instead of sitting at the board writing down, this is what you do, you know, and then talking, what I do is I sit with them and I rarely say anything because in Iñupiat culture when you are showing somebody how to do something, you don’t, it’s not an oral thing, it’s a very visual thing, you see somebody doing something, and they just follow you. Most of the time we’ll just sit there and I’ll be at a computer, and the kids will be all around me and I’ll say, this is what I’m

trying to do, you know, I tell them to explore, that kind of stuff, it's very visual. I do say it orally, I say it and I write it on the board, but most of my teaching techniques is showing them how to use a computer, what icons mean what ... you know, that kind of awareness is, I had no idea that my teaching techniques were different, I think when I was in grad school it kind of made me aware that I was doing it. [laughing]

Some of the Western teachers that this author spoke with divulged—during informal lunchtime chats in the BHS staff dining room—that they realized how the BSSD schools, and all the product and process technologies therein, represented an inherently Western system. The academic year model, with school during fall and spring and time off in the summer, was based upon the Euro-American agrarian cycle, being originally set up that way so as to permit pupils to help their families on the farm during the warmer growing season and attend school during the lean period between fall harvest and spring sowing. Meanwhile, the nine-to-three school day was based upon the prevalent day-night cycles—and consequent diurnal routines—at much lower latitudes than in the Arctic. This incongruity was not lost upon new BHS teacher Lacy:

...(T)his traditional (Western) kind of schedule, you know, every 90 minutes, and getting here at 9:00, and being out at 3:30, it just seems to go very against the more traditional (Inupiat) way of living in terms of real cyclical—the reason they don't see time the way we do is because of the kind of seasons they have, the constant light and the constant dark, it is very different from the diurnal cycle we know, and I was reading somewhere before I came up here, was that bring your earplugs, because the kids will be out at four in the morning during the summer, playing, and kids literally will, they'll take naps, get up, play, eat something, and then go to sleep again, then wake back up, and then when darkness sets in that just

seems like hibernation time to them, it's just so different – and I don't think life is compartmentalized as much here by the mainstream as it will be down South, you know where you've got your work and your exercise time and your friends and your family and it's all split up in different things, seems like here it is just natural for everything to kind of blend together, so, the education would come naturally, and part of it does, subsistence-wise, from family...

BHS assistant principal Carl also spoke about the incompatibility of Western-style diurnal scheduling in the geographic and cultural contexts of the Boreal Slope:

Up here people, their time clock gets very messed up, because you have to look at the fact that starting beginning of May, the sun's out 24 hours a day. And so, throughout the summertime these kids might sleep from nine a.m. to three p.m. and be up all night long. It's just, you know, there's no record of time really, time isn't necessarily important to them, and so they just sleep when they are tired and participate in activities, subsistence activities, or hunting, or time with family and friends, whenever. And so, as we get into the Fall season, when school starts, we have all these kids that are completely backwards as far as their timeline, and then of course we go into the opposite, where, now, here at the end of October, you know, the sun doesn't come in up now until ten or eleven and it's going down at, you know, five o'clock, and that's going to get shorter and shorter, to the point where, you know, the sun won't be coming up at all. And so then you get the opposite people, sometimes that are sleepy during the day and awake at night and vice versa. It's just, you don't realize how much it affects you until you come and you live it. And it's hard to really understand it being in the 'lower 48,' because, you just get used to it ... and here, it's a little bit different.

Meanwhile, when this author examined the list of Approved Course Offerings for 2004-2005 at BHS, there was little to show that this school was following a curriculum that was different, to any meaningful degree, from high school curricula at any mainstream “lower 48” school. Out of the total of 238 approved courses listed, a mere 7.6%, or 18 courses—two courses in Arctic Science, two in Alaska Studies, two in Subsistence Art, two in Skin Sewing, eight in Iñupiaq Language, and two in Arctic Survival Training—were explicitly related to the physical and cultural environment of the region. When this author pointed this out to BSSD administrators and asked them why the curricula at BSSD schools had to be so similar to curricula at schools elsewhere, the common response was that the district was compelled to adhere to standards formulated externally at state and federal levels, standards imposed by the Alaska Department of Education & Early Development and mandates from Washington, DC such as the No Child Left Behind Act (NCLB). As BHS principal Ryan lamented:

... every time indigenous people in Alaska seem to be making some progress, there's a piece of legislation that comes about with a hammer that can knock them down again ... that's the conflict all the time, because, you know, we have a federal mandate, and then you have a community and a cultural expectation, and no one ever seems to be able to agree on how those two should be integrated.

Focusing particular ire on the controversial and influential NCLB legislation, Ryan described it unflatteringly as a “ball and chain” on the BSSD schools, a “one-size-fits-all kind of thing” that ignored the fact that “every area geographically is different, has different needs,” and thus penalized Iñupiat learners “for being an indigenous people, for being isolated, for not being in a position to be exposed to a lot of the same types of educational situations, just everyday living situations

that are often reflected in the standardized tests.” He claimed that NCLB and other such external mandates had drastically reduced local educators’ powers to make the administrative and pedagogical decisions they judged as being appropriate to the cultural and geographic needs of the learners and communities they served. He specifically mentioned the NCLB’s overarching focus on “reading, writing, and math,” as discouraging local efforts to develop geographically and culturally relevant practices, curricula, and technologies.

ON NON-WESTERN LEARNERS’ CULTURAL APPROPRIATION OF EDUCATIONAL TECHNOLOGIES

During a session at the Borealis Public Library, this author observed 11 Iñupiat teenagers—five males and six females—use a bank of public computing stations. Without exception every one appeared supremely at ease with the computer; most seemed to be in a very cheerful mood indeed. What is more, the same cheerful, comfortable manner—one might even characterize it as “happiness”—was also visible among young technology users in the various school settings this author observed. Each one of them seemed able to touch-type rapidly while keeping their eyes fixed on the screen, and their very sparing use of the mouse suggested that they were also familiar with common keyboard shortcuts. The youngsters, without exception, had multiple windows open on their computers and were switching between windows rapidly as they worked. Most of these windows were of instant messaging conversations; in fact, the only programs that any of the youth could be seen using were instant messengers and Web browsers.

Computing at the public library seemed to be a “social” activity for most of the Iñupiat youngsters this author observed, in the sense that they could be often seen chatting verbally with each other—smiling and laughing a lot during the process—while working on the computer, and also

appeared to be frequently interrupted by friends and acquaintances that came and left as they pleased, the latter often staying for not more than a few minutes. Even the computer users themselves often quit their machines and left the building, only to return a short while later and reoccupy the latter—or whatever machine was available at the time. The most interesting part was how some of the Iñupiat youth using the computers seemed to all be part of the same chat room(s) online and seemed to be communicating with each other via the chat software as well as—by virtue of being in the same room together—verbally.

The interesting social behavior described in the previous paragraphs—using the public library’s computer bank in an intensive, informal, familiar manner; using this setting as a social venue to touch base with friends and acquaintances; chatting with peers via the computer even though the latter might be in the same room at the time; and so on—might be attributable to a relative lack of access to computers and the Internet at home. The learners, by virtue of having plentiful access to these technologies at school, had become used to working with them and were thus led to counteract the fact that they often did not have such access at home by making the public computing facilities—such as the computer bank at the public library—into a veritable home-away-from-home, where they could do the things that boys and girls who had access to technology at home would logically do from the comfort of their own homes.

Moving on to school settings, consider the air of mischievous confidence permeating the following exchange, between Annabelle and Iñupiat learners in her keyboarding/word processing skills class at BHS, after the latter had finished their typing exercises:

Annabelle: [Smiling, inquiringly] OK, so what are we going to do now?

Learner #1: [Smiling, cheerful] Type one paragraph!

Learner #2: [Laughing] Type one sentence!

Learner #3: [Laughing, loudly] Type one word!

[Widespread laughter among learners.]

Annabelle: Um, no, actually we are now going to make our *own* tables, with a heading, a sub-heading, four columns, and ten rows! Remember, you can use data from the Almanac for the tables you make.

Learner #1: Why can’t I make a table in Excel and copy it into Word? It is easier!

Annabelle: That should be OK, but, you know, it is worthwhile to learn how to do it in Word.

Learner #1: But I already know how to do it in Word!

Annabelle: OK, then.

Learner #4: I’d like to do one with seven columns and seven rows, is that OK?

Annabelle: Yes, that is OK.

The utterances made by the learners in the previous conversation would suggest not only a significant confidence and comfort level with technology use in the classroom, but also a certain proactive spirit in terms of selecting tasks to accomplish and, in a larger sense, designing the classroom experience to meet their specific needs. The learners could be seen using the appropriate technical terminology—cell, split, merge, column, row, copy, paste, and so forth—when they referred to specific tasks/problems, or when they asked for help. A similar spirit was also visible in BHS technology teacher Trent’s office productivity tools class; note the following dialogue between Trent and one of the young Iñupiat learners taking the class:

Learner: [To Trent] What are we doing today?

Trent: Today we are learning Microsoft Word.

Learner: Oh, I already know that!

Trent: What do you know?

Learner: See, I know how to make tables. I also know how to write business letters.

Trent: OK, then there'll be somewhat of an overlap.

[Learner groans in mock exasperation.]

Trent: [Laughing] But you know what, that means it will be easier for you!

[Learner giggles as if highly amused.]

The previous two exchanges would also suggest a sure grasp, among the learners involved, of key concepts and principles related to the subject matter being taught. This attribute was also discernible in the following tête-à-tête between Trent and another of his learners:

Trent: What does a jagged red underline mean in Word?

Learner: That's a word spelled wrong!

Trent: But does Word know how to recognize names?

Learner: No.

Trent: So what do you do if you're going to use a particular name or other word often that Word does not recognize?

Learner: You can add it to the custom dictionary.

Trent: And what color is the line that indicates grammar errors?

Learner: Green!

Meanwhile, what was most interesting to this author was the fact that every single learner featured in the previous three conversations was an Iñupiaq female. Girls appreciably outnumbered boys in all the computing classes this author observed at BHS, with Liam's Shopbot class being the sole exception: there were 6 girls versus 1 boy in Annabelle's keyboarding/word processing skills class, 14 versus 3 in her yearbook/newspaper class, and 8 versus 2 in Trent's office productivity tools class. The Iñupiat girls invariably worked quickly—markedly faster than their male counterparts—and quietly, with little chatting or discussions among themselves. They seemed

very conscientious—often asking the teacher for feedback on their work—and deeply engrossed in the tasks at hand, much more so than the boys, and more so even than the occasional Caucasian or Filipina girls spotted in the classes. Most of the Iñupiat girls were done with the exercises/assignments given to them in record time, often taking just a few minutes to finish, and producing work of excellent quality nevertheless. It was particularly fascinating to watch them blaze furiously and accurately through the series of typing exercises within the *All The Right Type* software in order to get to the “reward” computer game offered by the program to learners that successfully completed their assigned exercise modules.

The few Iñupiat boys that were present in the computing classes this author observed put up a comparatively unimpressive performance when assessed against their female counterparts. They seemed less interested in what was going on in class, and less willing to do the work that was required of them. For example, one of the boys in Annabelle's yearbook/newspaper class was not working at all; he was instead busy playing a game on his computer. Another spent the entire class session lounging back in his chair, biting his thumbnail, and staring at his computer screen without doing anything. In Annabelle's keyboarding/word processing skills class, this author noticed the one boy present in the room working much more slowly in comparison with the girls, lounging around for a significant portion of the class period, and generally appearing rather bored and distracted. Meanwhile, the two boys who were signed up for Trent's office productivity tools class did not even show up to class the day the observations were conducted.

This author subsequently asked Isabel—since she was Iñupiat, had been in high school herself not so long ago, was young enough to still be “with it” in terms of current Iñupiat youth culture and behaviors, and was also currently teaching Iñupiat learners at BMS—what she thought about my observations. She nodded in confirmation,

explaining what was seen as being part of a more wide-ranging socio-cultural and gender dynamic among the Iñupiat:

...(T)his is really odd, I've found that women will get an education, it is more socially acceptable for a woman to get an education, than a male, for some reason, I've been thinking about this a lot, [laughing] I think a lot of it is based on, in the past, the men it is a more physical thing ... (among the Iñupiat men) technology like the snow machine is a big deal here, it's a huge deal, it's a social status, I hear kids today, was one kid's parents got a new snow machine, he was teasing another kid's parents because it was an old snow machine, you know, that kind of thing, it's become a social status ... the snow machine is like a huge deal here. Not so much computers, oddly enough, it's really odd, computers are not seen as a social status (among the men), but snow machines are, rifles, you know, things that can kind of border, sit between, straddle those two worlds, hunting, the gathering, and the technological world.

Trent told this author he noticed that the boys in his classes seemed to have very short attention spans for traditional classroom activities. However, in the same breath he noted that the boys seemed to prefer “hands-on activities,” and remarked “however, when they are out hunting or doing subsistence (activities) they show much more inclination to sit still and be patient and persevere!” He also related an interesting story dating from the 1990s. He was supervising his Iñupiat learners as they interacted with the educational game *Oregon Trail*, which involved players making strategic decisions while navigating their way across the North American continent in the footsteps of early Western colonists. Trent described how, when male learners got to the part where they had an opportunity to hunt wildfowl, they would proceed to spend all their time and material resources hunting ducks and geese. They would progressively sell all of their belongings in

order to buy more guns and ammunition so they could do more hunting. They just did not appear to want to move on to the final destination, which was the point of the game, they did not seem to care if their decisions eventually caused them to “die,” they rather would die hunting. Trent said it looked to him like this was not just a reflection of the usual desire among aggressive young boys to shoot things up like in an arcade game, but rather, as he explained, “they are hunters, that was what they wanted to do.” Trent even mentioned how one of the game’s developers came up to the school to visit, and when he saw what the boys were doing he was upset and protested that this was not what the game was supposed to be about at all!

Meanwhile, some technology educators this author met with also spoke about the apparent *superficiality* of the Iñupiat youth’s mastery over computer-based technologies. In their view, while a majority of the latter exhibited a strong penchant for, and remarkable mastery over, the *consumer* level of interaction with technology—electronic communication, online shopping, game playing, and so forth—very few, if any, seemed to exhibit significant technological skills at the *producer* level, such as programming, design, or hardware competencies; in fact, very few expressed even an *interest* in acquiring such proficiencies. As BHS technology teacher Abel revealed:

I look at what's happened with my classes in, you know, I'm providing that opportunity for that upper division, computer repair and networking, but the amount of kids that are in that are not as high as you would expect ... I would love to see programming as one of the things we do but you know, I've just got to develop that base interest first before we can go into it...

In the same breath, however, Abel also explained what he saw as the reason for this reluctance to acquire higher-level technology skills:

I will be honest with you, the biggest applications these students use on the outside would probably be the Office material, being able to work with Word, Excel, PowerPoint, Access, those types of basic job skills get their foot into the door when they get outside. These skills are relevant especially in the Boreal Slope, you look at the (county government), the highest number of jobs are available through (them), and you look at what kind of skills they need ... and they look for those types of things, you know.

This author also asked Jason—the BSSD technology coordinator—and Ryan to share their views in this regard, given the unique insights arising out of their vast experiences and responsibilities related to the district and its learners. Jason’s explanation for the phenomenon was “there are very few role models in the community who are proficient users of technology. Kids don’t see it being used at home, people at home don’t understand it, and therefore don’t appreciate it. Kids struggle therefore to find a place for it in their lives.” Ryan, meanwhile, provided a rich and detailed exposition of what he believed were the environmental factors inhibiting the development of young Iñupiat learners into accomplished technology producers:

I think, that’s what isolation, being in an isolated environment, inhibits ... (if the learners) are in a real technology environment, if you are in Seattle or Portland, there are these facilities right next door, and in their school, and there is partnership with schools, many of them have parents who are engineers and computer programmers and designers and systems engineers, it’s a language right in the home. So, I think that’s the reason, the isolation just doesn’t promote that. Who do we have locally here, occasionally we have a teacher, such a small population, and how deep do you go with it anyway? And then, what’s your model? What’s our model, to show why you want to go really deep? We have your system network,

we have your, some technology that is limitedly supporting our infrastructure. You know, you don’t have a Microsoft or an Intel. (Learners in the big cities of the ‘lower 48’) just have models to look and see. Everybody knows, you know, Portland, Oregon, has an Intel plant, Apple in San Jose, HP plants all over, you know, kids are very in tune with the technology, who the technology leaders are and where they are at. And so, who the technology players are and if you are important you do. In San Jose you do, in Boston. So I think, it’s just that everywhere you look it’s just technology ... And many of the kids here, some of them may want to go outside for a college degree, but many want to return here, specially the Iñupiat population. The majority, even if they go elsewhere to get an education, they see themselves returning and living here in Borealis. And so, you know, to say, I want to be a programmer, or system engineer or, there is a limited need for that here in Borealis, but it’s not a huge demand. Are any of their fathers or mothers any of those things? No. You know, I think, you know, we are typically inspired by much of our, you know, surroundings. You know, they love to dance, they love the whaling, it is huge, get out of school for a couple of weeks in Spring ... Kids are interested in that. I don’t know how at this level how we are going to get them interested and inspire them into being programmers or, you know, systems engineers. There are some Iñupiat kids who see themselves thus, but they don’t see themselves returning to Borealis.

Furthermore, there was also talk of inappropriate use of technology by the Iñupiat youngsters. Jason, for instance, described how he was forced to block the chat protocol on school computers because “the detriments outweighed the benefits;” as he explained, the chat feature “was being misused and abused. Kids were going to porn chat sites and chatting very inappropriately, sharing personal information. The kids were going to meet gentlemen in other states.” BSSD chief

librarian Tammie seconded Jason in this regard; as she described:

...(F)or instance we have the Internet here in the library and, of course, as an educator I would like to think that (the learners are) out there pursuing great thoughts and increasing their educational opportunities on the Internet, but generally speaking when I wander over to see what they're looking at, it's snowmobile sites, Tupac Shakur sites, Britney Spears sites. So if they are not on task for specific assignments, there's a lot of non-educational uses I guess, and so I wish they'd be more excited about learning, just inquiring about things, but I don't see an awful lot of that.

Tammie also mentioned copyright violations—unwitting or otherwise—resulting from learners' use of new media technologies as a potentially serious issue:

We also don't allow Napster-type downloading activities, primarily because of the amount of space on the pipeline that it takes, but also some of those things are just illegal and we cannot encourage that kind of activity. I don't see much awareness or interest among the kids in terms of the ethical-legal issues surrounding technology, copyright issues, plagiarism, I know teachers talk about it, I don't think they have a good grasp of these issues, it's becoming more and more of an issue though, for students that they need to realize that...

EXPLORING THE CULTURAL IMPACT OF WESTERN TECHNOLOGIES ON NON-WESTERN COMMUNITIES

One of the predominant themes that this author has hoped to explicate via this paper is the sense of Borealis as a community wedged between the realms of timeless Iñupiat tradition and of oil-

fuelled modernity; caught—literally—between whale hunting and online shopping, between skin-sewing and instant messaging. Now, while Borealis represents a particularly extreme and instructive case of this phenomenon, it is by no means unique in having to straddle two worlds at once in this day and age. Similar struggles to maintain a balance between indigenous traditions and Westernization—the latter usually occurring under the guise of “globalization,” “modernization,” or “progress”—are now taking place throughout most of the non-Western world, from indigenous communities across the Americas and Oceania, to the oil sheikhdoms in the Arabian Gulf, to the vast emerging economies of India and China, to the established “Asian Tiger” societies in the Far East. Technological catalysts like the information revolution and media convergence are currently playing a particularly powerful role in exacerbating cultural ferment and disjunction of this sort across vast swathes of the planet.

From stakeholder accounts obtained by this author, life seemed particularly challenging for Iñupiat youth, who were being exposed relentlessly to the latest technological and curricular offerings at school, and were yet expected by their community to retain an interest in their traditions. The multiple, competing priorities and constraints that acted upon those caught in such a situation were well expressed by some of the young Iñupiat learners at BHS whom this author spoke with. As Caleb explained, it was not easy when “our elders would like us to learn our traditional knowledge but in school we need to learn other stuff.” Kent added that “some parts are hard to manage, like learning how to do stuff on the computer and also how to put skin on the boat (frame) at the same time, and how to be good at both!” Delia in the meantime talked about how it was hard to balance mutually exclusive activities and expectations into one's schedule: “It's hard to go hunting and camping when you've got school and work to do.” Fabian summed it up eloquently when he described how managing expectations was “real

hard because ... you have to learn one way at school and another way in life.”

Meanwhile, Isabel, speaking from the perspective of a young Iñupiaq adult who had recently grown up facing the same pressures and had survived the additional cultural challenge of getting a higher education in the “lower 48” and then moving back up to Borealis to live and work, declared that while the BSSD schools were embracing technology-mediated learning, she nevertheless thought it went completely against Iñupiaq culture:

Technology in schools is becoming a bigger deal, we have the IAN (Instructional Applications Network) lab, they learn reading, and linguistics, through a computer, the teacher reads out loud to them and they go on a computer. It's becoming more and more accepted to learn from a computer ... but it is totally against our tradition, traditionally you learn from a person, not from a machine. It's barely Iñupiaq. I learned how to cut up a duck, and my uncle sat there, he rarely would say anything, he'd just say “Don't eat this!” [laughing] “you can eat this if you really want to,” “scrape this,” you know, that kind of thing. But that was how I learned it, just watching him do it four or five times and then trying it myself. That's how I learned to cook, I was horrible at it, burned a lot of things, but they let me try it over and over again until I learned it from making mistakes or whatever. But now it's if you press the right button, till you hit the right one, like a rat hitting a, trying to get a treat!

Many of the older Iñupiat this author met in Borealis seemed convinced that the pervasive, seductive, Western technology-based activities were affecting their younger generation's learning processes, and especially taking the latter's time and attention away from learning their traditional activities and native language. Parent and community member Erika declared that, in

her personal opinion, technology was “damaging” to the Iñupiaq youngsters:

I have two (younger) children that I am losing in the oral (Iñupiaq) language, because ... there's too much TV, there's the X-Box, the Nintendo, the PlayStations, and all those games. The games I don't approve of, I don't allow my children to buy and take it home, because I feel it's damaging to them, in terms of their lifestyle, because we Iñupiat, I myself was raised in a very strict world. If you are taught something, you are expected to learn it. And that's how I expected my children to be raised. And this is the reason why I mentioned about my two younger children, that today's technology is damaging. I have to repeatedly say Iñupiaq words to those two, in order for them to understand it. In comparison, my older children, they speak English about 75 per cent of the time, but they understand when I speak to them in Iñupiaq. Whereas the two younger ones, I have to repeatedly tell them before they can finally understand what I am trying to say ... Technology is bad because it will stop the process of the child's learning system, if you are not using it correctly. With a child in the home, it stops the learning process of subsistence lifestyle and oral language. I don't know how else to put it. That's my point of view, that's the way I see it in my home. Some families have a problem because their children are so into all this technology stuff that they don't want to leave their home, because they want to watch TV, they want to play the games. Their parents, their uncles or aunts or whoever wants to take them subsistence hunting, they say no, the game is more important than your subsistence lifestyle. It's getting to that point and there are quite a few families I think, that are like that now.

DBME secretary Hailey, meanwhile, felt that computer-based technologies—specifically games—might be making Iñupiat youth using them more prone to violence:

A lot of crimes are committed by the youth. They have computers, they have video games, and nowadays the video games are getting more and more violent. There is more blood, there is more gore, and some kids demonstrate it, and I have a grandson that I can testify to that, I mean, he gets really, he gets his whole body involved, he is four years old. And, you know, if he is not playing the video game he gets frustrated and that little spark just sets him off and he just starts punching into his sister, you know, and I can see how it affects him. Seeing that, on there, it's very easy. And, you know, he doesn't know what he's doing, I mean, he knows he's throwing the punches and what not, but he doesn't realize that he's grabbing it from that video game and it's implanted in his head that quickly.

Another Iñupiaq parent and community member who believed that modern educational technologies were taking young Iñupiat learners' attention away from their culture was Billie, a staff member in the Heritage Center's education program:

Technology is taking a little bit away from our traditional way of life and I wish they wouldn't emphasize it so much that you need to go to work, that you need to know all this technology. At the schools, that is what it's all about now, technology. I think the schools should emphasize less on technology and more on traditional cultural values, because pretty soon we are going to lose our culture. The more technology there is for the kids to learn, the less of the traditional way of life they will know. You will not have more hunters to hunt for a living.

When I spoke with native community leader and school board member Eva, she also alleged that modern communications technologies were adversely affecting the Iñupiat youth's native language skills, because, as she noted, "you are not communicating with a human being, you are

just communicating with something that doesn't talk back to you." Besides, she pointed out, "the medium of most of these programs is in English . . . so the more dependent you become on technology the more it makes you speak English"—at the expense of speaking Iñupiaq. Another Iñupiaq parent who said she believed technology was distracting her children from traditional native pursuits was IEP secretary Tina, who related how she had been trying to get her daughter involved in beadwork and sewing but the latter was not interested: "She wants to play in the computer, she wants to go and play with these little games that are battery operated, you know, computer games, the Game Boy, yeah." Meanwhile, local community leader Curtis also alleged that the younger Iñupiat's native traditions and language were being affected by computer-based technologies, and blamed the schools for getting them hooked on to the latter:

In many houses across the (region) the kids are going to school, they are getting exposed to computers and technology, they are forced to learn it, they are learning it, they are even getting to like learning it, they are surfing the Internet all day long and playing games, and when they go back home they don't have that there, their elders and parents don't have that exposure to that kind of technology, it is creating a distance between the kids and their elders. Grandma and grandpa's time to talk to you has been taken over by Game Boys and computers. The parents and grandparents are being removed from the child's world. Isolate them, that way you can regulate them easier. The language is slowly disappearing, the values we have on animals and how to treat them are disappearing, and they are being replaced by technology.

When this author asked BHS senior Georgina about all this, she nodded, agreeing that not very many Iñupiat youth of around her age in Borealis liked participating in traditional activities. When asked what she thought might be the reasons for

this, she replied “Because they have their snow machines, they have computers, they have other stuff to do, they want to focus on their school...” When asked further her if she thought technology was distracting the Iñupiat youth in today’s Borealis from their traditions, she agreed, saying “because it is just so much easier to get to know, we have a computer in almost every room or every house now.” She said technology appeared more attractive than traditional activities to modern-day Iñupiat youth “because it’s all around, everywhere, and it’s something new and their parents don’t know it and they want to do something their parents don’t know.” Fabian also agreed that technology was distancing Iñupiat youth from their cultural traditions: “Stuff like technology and computers, it takes a lot of time away from learning traditional activities ... The more people spend time with computers, the less time they spend on subsistence. Some of my friends don’t hunt but ... live an ordinary life.”

Meanwhile, Isabel felt the schools were doing a better job selling technology to the Iñupiat youth than the Iñupiat elders were doing selling their traditions; but then, as she saw it, it was so much easier to sell technology as compared to tradition, because knowledge of technology brought with it the promise of material gain:

The children seem much more sold on technology than on tradition. I think it is way easier to sell technology, when the world is based on technology. It’s really, really easy to say, well, if you know how to use Microsoft Word, you can get a job, you can get money. It’s easier to say that. Trying to explain to a kid why he should learn how to butcher a caribou, I think it’s a lot harder. It takes hours and it smells bad and it’s gross, [laughing] they don’t see it on TV, you know, they don’t see any kind of real need for it. Because you don’t see stuff like that on TV, you don’t have anybody saying that it’s important, and the people that are saying that it’s important just say you have to learn it without explaining why it’s important.

And it’s really tough to do that ... Even if you sat down and learned everything from an elder, it won’t help you get a job, it won’t help you get your new snow machine and new rifles, you know, the elders’ wisdom doesn’t get you money! It might bring you something else, but it’s still, why learn it, when you’re not going to get money, when you’re not going to be paid, when you’re not going to get the stuff that you want. It’s become obsolete, which is horrible, I mean.

Testimonies as provided by Curtis and Isabel suggest that the communicative distance—the so-called generation gap—between Iñupiat youth and their elders has been increasing in modern times, and that technological changes may have been in no small part responsible for hastening this process. Nita, the project manager for the local native Heritage Center, echoed exactly such perceptions, indicating technology and Western education as key causative factors:

I would think it’s kind of getting harder for the kids to relate to their elders, because they are learning a different way, like we still have our elders here, and you respect your elders and family members, especially your grandparents, and that still exists, it’s just the train of thought for the kids I would think when they’re going to school, they’re using just technology, technology, technology, and they have some classes that relate to the culture, the Iñupiaq classes in the school, but having that also, it’s not full-blown Iñupiaq all day long, it’s just for a half hour to an hour a day, and that’s kind of being lost in a way too, where the culture is slowly dying out, because of the way the education is taught it is more of an English, American history, and I don’t see big efforts being pushed for a lot of cultural things to be viewed for classroom papers...

Some of the younger Iñupiat I spoke with seemed to agree that the elders were no longer as important a source of knowledge as they were

in the days when traditional ways of knowing prevailed across the region. “Our elders don’t really know about the Internet or computers,” Caleb declared. Kent concurred, laughing: “Our grandparents don’t know about or use computers.” “They didn’t have computers back then,” Carla explained. “They can tell you all about their traditional things, but not about computers and stuff.” Caleb agreed: “They grew up hunting, no school, and all that kind of stuff.” Besides, this author also gathered from conversations with some of the Iñupiat informants that, from where they stood, it looked very much like the Western technologies were actively trying to replace Iñupiat traditions with alternative ways of living. As Isabel put it, “now we have the world telling us that information and, not only just information but *superior* information comes from technology, from sciences, from computers, you know, this kind of stuff [pointing around her classroom].” Curtis, in the meantime, elaborated on this issue with passion:

The role that technology plays in this culture is very negative, because it’s goal, it’s direction, is that it has to eliminate this culture in order to be the superior culture ... You know, in order for (the Westerners) to be an expert they have to remove someone like me. And once they remove me then they become the expert, with their limited knowledge. Now when you look at Western culture and its technology, that is exactly what it does. What it does is to remove traditional forms to knowledge in order to make room for itself ... Right now the whole school system is, technically speaking, physically removing our language ... And once you take a language away, its total educational structure has just been wiped out. Its knowledge has just been erased ... That’s how you destroy cultures.

Furthermore, Isabel also saw the modern, Western computer-based educational and com-

munications technologies as promoting a capitalist ethos among the Iñupiat:

(The Iñupiat youth) have a society kind of telling you that old things are bad, and mostly they get this through TV, old things are bad, old things are only for documentaries on the History Channel, [laughing] they’re not very exciting, new things are good, new snow machines, new computers, you know, new things are good, lots of them, and so you have capitalism, a very capitalist kind of ethos, and it’s seeping into the culture here. I think technology is a vehicle for capitalism, it’s not sitting there cramming it down our throats, but it is, some of the capitalism is from people coming in from other places, but most of it is through technology, it’s a vehicle, it’s not like technology is bad and it’s like a drug dealer [laughing] sitting there, but it is a vehicle, in several ways, I mean, TV is the obvious, really obvious place, the Internet, you get a lot of stuff on the Internet, I know that some kids who have access to it, they tell their friends that this is cool, [laughing] because everybody in California thinks it’s cool, but it is a way. I mean if you can imagine not having any technology or communication up here, it might just become like a time capsule, but stuff’s being poured in, it’s being poured in at a faster, faster rate...

Meanwhile, talking about how basic cultural values dear to the Iñupiat were being eroded in recent times, Tammie revealed how she sometimes felt modern computer-based technologies, with their emphasis on individual, competitive modes of learning and social action, were at odds with the Iñupiat’s traditional collective, collaborative ethos, and she wondered how that might be affecting the native learners as they worked with these technologies:

The traditional culture is all about sharing and cooperation and collaboration, while the mainstream culture is competition and privacy and patenting, ownership of ideas, I can imagine for

someone who comes from a tradition where everything is collaborative, to get used to the idea that everything is individual, that even information is privately owned. I don't know if they have really internalized that, it's interesting how that might be a real war of cultures there, because they are getting those two different messages definitely, within the community it is still very much that way, it is a community built on traditional principles of sharing an collaboration, I suppose when you're riding two cultures that's one of the things you've got to learn to do, it's you have to sort of figure out when those more traditional values are appropriate and when these other ones should take precedence ... and it's hard for (the Iñupiat youth) to sort of get it to where it meshes in their minds, get their brains around it...

Curtis agreed heartily, claiming that destroying the Iñupiat's culture of cooperation and collective action was part of the Western socio-economic and cultural system's larger plan to isolate, regulate, and culturally assimilate the Iñupiat:

In summertime ... you'll find us way out there on the ice, just enjoying life out there, and when we find each other we don't ask each other what they have in their boats, we go in their and find what we like and eat it. If it's in their boat, it's mine, if it's in my boat, it's theirs; our culture stresses cooperation and collaboration, for example the whale hunt, one man cannot do it, it takes an entire village to bring in one whale, and then the whale is distributed to everybody, shared. With computers, it's all one person to a computer. There's no collaboration anymore. Same thing with Christianity. Only you can save yourself, only you can take yourself to Heaven. There are great similarities between Western technology and Christianity, they both have the same goal; the goal of isolation. Isolate them, that way you can regulate them easier. Western culture has two engines, agents, its technology and its religion, and with the two of these they have managed to bring

about a significant change of mindset here among the Iñupiat. For a lot of the whaling captains we have today, it's the glory in the catch that they're after, which is just so wrong in terms of our culture. It's not "my desire to feed everybody," it's "the credit I'm going to get for catching it." That is a culture-killer. That is what came with the Western ethos, with Western technology; that change of mindset from cooperation to competition.

Taking the discussion regarding traditional cooperative values versus technology-inspired competition further, some of the Iñupiat informants spoke of a new "digital divide" arising among the Iñupiat of Borealis, one that manifested itself in multiple ways. For instance, Nita talked about a technological divide between wealthier and less wealthy individuals, relating how some of the craftspeople she worked with at the Heritage Center felt disadvantaged compared to others because they did not have access to computers and the Internet like the others did; for these people, lack of access was a barrier between themselves and commercial success. She also talked about another dimension of the digital divide, of inter-generational relationship issues provoked by unequal access to and proficiency with modern technologies, describing how "the younger generation for sure has a lot of knowledge of technology, a lot of access to the computers because of the schools, whereas the elders don't have access to that."

DISCUSSION/FUTURE TRENDS

The epic cultural conflict taking place in the Alaskan Arctic—between the hegemonic Western techno-centric, globalizing, commodifying, capitalist-consumerist socio-economic juggernaut with its gigantic ecological footprint (see Bowers, 2000; Bowers, Vasquez, & Roaf, 2000) on the one hand and the diametrically opposite native Iñupiat life-ways on the other—has clearly taken

its toll on Iñupiat communities across the region. As in many other parts of the world, here too, as Bowers et al. (2000) describe, Western science, technology, and ideas of “progress” have been used as the basis of a new ideology that justifies the extinction of the local culture if it fails to adapt to the expanding network of computer-mediated intelligence required by the global economy, as a result of which much local knowledge has been unceremoniously relegated to the junk heap of a past that is seen as being no longer economically useful. Curtis and Isabel—two of the Native informants for this study—hit upon this point when they described how, as they saw it, Western technologies were actively trying to replace Iñupiat traditions with alternative ways of living.

Meanwhile, as Bowers et al. (2000) explain, these ostensibly more “advanced” Western technologies have an ecological footprint that undermines the viability of the earth’s ecosystems; on the other hand, the traditional Iñupiat culture—which, like many other non-Western indigenous cultures, had taken an alternate pathway of development and had demonstrated the capacity to live in a long-term sustainable relationship with its harsh and challenging environment—was actually the one better adapted to its surroundings from an evolutionary standpoint. The new, computer-mediated modes of learning and living—as representative of a Western consumer culture that emphasizes building boundaries between people and nature—has unfortunately accelerated the process of the Iñupiat communities’ alienation from their natural milieu; and over the decades, the resultant losses of local knowledge and patterns of moral reciprocity essential to traditional Iñupiat community life has significantly affected the region’s cultural and ecological well-being (see Bowers et al., 2000).

Consequently, Borealis today is not a very happy place. It is no secret that the small native communities across the Alaskan Arctic currently suffer from some of the nation’s highest rates of alcoholism, drug abuse, domestic violence, and suicide—symptoms of the people’s heightening

sense of isolation, displacement, disorientation, and alienation brought about by the progressive breakdown of their traditional ways of living in the face of a relentless onslaught of foreign socio-economic and cultural influences. Curtis suggested that technological pastimes—along with alcohol and religion—were non-indigenous fixes that the Iñupiat, despairing over the erosion of their traditional culture life-ways, were turning to in their hour of loss:

... (W)e have a very unhappy society. You see a lot of cheerful people up in the front, but when you look in the side you see people never sobering up, and you go to the church and you see them extremists in their churches, you see children hooked on to television and video-games and the Internet. When you go extreme something else, that is not indigenous to you, you are unhappy. You might sing loud, and pray hard, and be a very good Christian, they’re hiding something, they’re trying to substitute something. They are substituting a lost way of life, a teaching mechanism, a self-regulating mechanism, you know, as a society, a culture, we were self-contained, we didn’t need anybody in the world, to feed ourselves and take care of ourselves. That’s what American technology does to our culture. The technology is responsible for this because the people here see a smarter culture than theirs that has taken their land away, their way of life, and regulate what they eat.

So what could the outlook be like for the current and future generations of Iñupiat caught between technology and tradition? To understand this, it might help to ask some of the local Iñupiat community leaders in Borealis to describe what *they* would define as “success,” in terms of the Iñupiat youth’s relationships with Western education and technology. When asked, Curtis mentioned his own children as examples of “successful” young Iñupiat in today’s world:

In my house we have a computer in every room, and all of my kids use them regularly. I have no trouble with that at all; if the world can use it, if they have better access to the world, great. They might be able to learn something out there yet. But when I take them out into the country, they know what to do. They know where the animals are, that they already know. That I have taught them. Any one of my kids can catch ptarmigan without shooting them, without traps. They know how to stop a caribou from running away. Computers and technology just gives them better access to the world. I don't feel access to the world as a threat. Because the values I want them to have are already in them and no one can take that away. On the one hand I have taught them how to live in the Arctic, their home. On the other hand, the world is theirs, too. They can go anyplace and survive, but at the same time they have solid roots here. I think I would call that a successful state of affairs. And that is what I would wish for the other Iñupiat kids as well.

Meanwhile, Erika emphasized true success as being able to go out to the world, get educated in their ways, and return to the Boreal Slope to contribute to the welfare of the local community, a view approximating a “think globally, act locally” type of ethos:

There are a few students who leave the Slope after graduating from high school to get a higher education so they can come back home to their community, and those are the ones that will be pursuing what they see is lacking in the community. If we can get the expectations of the students to fit into the shoes of those students who are going out to receive higher education, that would be a success for us.

One person who did seem to fit this ideal was Isabel, who had made the choice to leave the Slope, obtain a college education, and return home to serve her people as a teacher. But then,

as she explained, not many Iñupiat youth were eager to construct themselves in the identity of a Western-educated schoolteacher, because the latter usually came across to them as the “weird creature” that “came from Michigan, ... popped in and popped out and most of the time didn't stay for more than six months.” Besides, Erika alleged that the Iñupiat youth were discouraged from seeing themselves in the teaching profession due to the Western teachers “looking down upon the Iñupiat.” Isabel explained that the act of “becoming part of the system,” of “going over to the other side” was still “really hard to understand” for the average Iñupiat youngster. As she put it, “it's so far, from ... growing up traditionally, from (their) traditional past, in many ways. There's a huge gap, and who in the world's going to jump that gap? Why in the world should you jump that gap?” going on to add that “only now it's kind of becoming obvious that without that education, you know, you're on welfare!”

Nita, who was one of the Iñupiat who had obtained a higher education and taken up a job that involved using computer-based technologies, ardently emphasized the role of Western education and technology in ensuring the Iñupiat youth's future success:

I've seen how people come from out of town, get all the jobs, and I checked to see why people from out of town are getting jobs and we the Iñupiat people are not, there was just this education part, that you need to have college, you need to have your education to get a good job ... it was like a stumbling block, that education that you needed ... what I always stress to my kids is get your education. That's what you need ... education, even though the education that is available is not related to our culture, we still need it to survive, to pay for your food, to pay for your bills, for your electricity, for your homes, you need a job, and all the jobs that are open need that first step. You need to have at least a high school education, and if you don't have it your name will be at the

bottom of the list and never come up, and you also need to know how to use computers because they all have computers in the workplace, it is hard for employers to train someone new unless they understand you fully, what you want them to do on the computer, and there's always security and data loss issues that you could have if the person doesn't know what they are doing.

Curtis concurred: “(T)hey won’t hire you until you have a minimum of high school education, and then in any place that pays you need a college education. If you don’t have a college education you’re dead, as far as the dollar world is concerned.” The predominant notion of success that was expressed by the Iñupiat community leaders interviewed as part of this study thus featured the twin desires to simultaneously maintain tradition while continuing to enjoy the benefits of modernity. Curtis’s account of how his children were successfully managing to do just this was particularly intriguing, leading this author to wonder if such a state of affairs was common among the local families. But Curtis did not think it was:

The problem is, my kids are lucky and very much an exception. Many other Iñupiat kids do not come from a similar position of strength. Across all the communities in the Boreal Slope, you will find that over sixty per cent of the people cannot find work, there is no work. So they cannot afford things like this ... I am a geologist, my wife is a college graduate, my oldest girl is a college graduate, the second-oldest one on his last year, the next one is starting his second year. We are definitely not the typical Boreal Slope family. When a family has problems with society, or with the law, or being able to take care of themselves, they call this house, they call me, and I tell them what they have to do.

Isabel—who also would be considered as a “success” by the standards of many people, both Iñupiat and Western—concurred with Curtis

in that she admitted her familial circumstances were rather unusual for an Iñupiaq growing up in Arctic Alaska:

In my case, in my family, the teachers’ expectations and the parents’ expectations were the same ... which is really rare, my parents are both, they both have degrees, and Master’s and, they both had really good educations, so our expectations were completely different ... Probably around five per cent (have parents like mine), that’s just a guess, very rarely, and it’s usually somebody who has experience out of here. So it’s not a local, well they’re local but they’ve had experiences in the ‘lower 48’ (United States).

CONCLUSION

The cultural hegemony of the Western school system over the Iñupiaq community could be characterized as forming part of a wider-scale, historic cultural transformation of the Alaskan Arctic by impersonal socioeconomic forces that were larger than—and, for a variety of reasons, only tenuously comprehended by—individual educators and community members themselves. While, on the one hand, it might be possible to characterize the Iñupiat youth and community served by these schools as being helpless victims being buffeted by the inexorable forces of Westernization and globalization as embodied by the Western product and process technologies rapidly and insidiously infiltrating their sociocultural life, on the other hand they could also be recognized as active agents striving against overwhelming odds to create valid cultural forms in response to a barrage of complex social, economic, cultural, and technological stimuli. To this author, this act of “praxis”—referring to Willis’ (1977) expanded construct of praxis, which differs from the classic Marxian view of praxis by encompassing not just the act of work but the whole act of constructing one’s cultural identity in society—appeared to

reflect and be shaped by two sets of contradictory desires on the part of the Iñupiat: (1) to hold onto what was left of their precious traditional culture, and (2) simultaneously to reap the benefits accruing from the adoption of modern Western technological solutions.

In the midst of all this could be perceived a fundamental disjunction between the cultural expectations of the school and the cultural expectations of the local community in terms of the essential issues and goals related to the endeavor of educating the current and future generations of Iñupiat youth, further complicated by a lack of consensus among the Iñupiat themselves on these matters. As Lipka, Mohatt, and the Ciulistet Group (1998) explain in a nutshell, these conflicts have been “exacerbated by the historic context of colonization” of the Alaskan Natives, “the degree of cultural difference between mainstream and (Native) culture, and by issues of cultural continuity” (p. 4). The situation does not seem to be helped by the local community’s astonishing lack of ownership over the schooling of their children—by the fact that the native learners, wracked by pressing “internal” issues related to their besieged culture, were being served almost exclusively by imported Western-trained educators, who could but only offer “external” solutions, the effectiveness of which can often be a foregone conclusion.

The Iñupiat of Arctic Alaska, after enduring decades of shocking assimilationist treatment at the hands of Western missionaries and Bureau of Indian Affairs (BIA) boarding schools, fought hard for and finally won significant political and financial control over the schooling of their children by the late 20th century. Learning how to effectively exercise this control after decades of oppression and alienation is bound to be a slow and painstaking process. It is a process that, as Bowers et al. (2000) advocate, will need to involve efforts to ensure that subsequent generations of Iñupiat are educated to (1) understand the fundamental differences between the dominant Western

culture’s ways of knowing and value system reinforced by computer-based technologies and those characterizing their own indigenous cultural traditions; (2) distinguish between the appropriate and inappropriate uses of the technologies that fill their schools, workplaces, and homes; (3) realize how important aspects of community are transformed or lost when using these technologies as the basis of thought, communication, and problem solving; and (4) use these technologies in ways that recognize the culture gains and losses arising from their integral role within the destructive, culture-transforming cycle of media-controlled communication, consumerism, and identity formation.

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KEY TERMS AND DEFINITIONS

Culture: Culture refers to “the sum total of ways of living, including values, beliefs, aesthetic standards, linguistic expression, patterns of thinking, behavioral norms, and styles of communication” (Powell, 1997c, p. 15) developed by a particular group of people.

Diversity: Diversity, as used in this paper, refers specifically to differences based on culture—as defined previously—nationality, race, ethnicity, language, and religion. Additional aspects of diversity that are often considered by educators include age, gender, sexual orientation/preference, ability, geographical location, and socio-economic status.

Educational/Instructional Technology: Educational/instructional technology, as used in this paper, refers to the growing field of research and practice involving the application of interdisciplinary inquiry and emergent technologies towards the solution of instructional and performance problems.

Educational Technology (pl. Educational Technologies): Educational technology, as used in this paper, refers to the growing range of human-engineered tools—both products and processes—employed within educational contexts towards the ultimate goals of promoting and enhancing student learning.

Iñupiaq (pl. Iñupiat): Iñupiaq refers to the Arctic people who make their home in the north and northwest parts of the state of Alaska; the term *Iñupiaqt/Eskimo* is also sometimes used.

Additionally, Iñupiaq is the name given to the native language of the Iñupiat.

Non-Western: Non-Western, as used in this paper, refers to (1) peoples of non-European origin—tracing their roots instead to Asia, Africa, or indigenous populations of the Americas and Oceania; and (2) their diverse heritages of spiritual, intellectual, social, and material culture.

Western: Western, as used in this paper, refers to (1) peoples of European origin and their descendants settled across other continents, notably the Americas and Oceania; and (2) their common heritage of spiritual, intellectual, social, and material culture.

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Chapter 5.2

Cross–Cultural Learning Objects (XCLOs)

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INTRODUCTION

“Networked virtual organizations outperform competitors by responding more quickly to customers, collaborating better with partners to perform value added activities, and fully standardizing their business processes, data, and IT infrastructure” (Cisco Systems Inc., 2003). Thus, networked and virtual organizations (NVOs) depend heavily on the agility afforded by effective communications, ease of sharing information, and virtual integration of business functions. Such agility however, requires a trained workforce. In keeping with its reliance on technology, NVOs, especially those in the U.S. (Bersin, 2005; Rivera & Paradise, 2006; Sugrue & Rivera, 2005), frequently utilize e-learning as their source of training and education. In e-learning, there is a proliferation

of social and collaborative tools, mobile learning, and dynamic computing (EDUCAUSE Learning Initiative, 2006). These tools, coupled with the global reach of NVOs, will precipitate unprecedented contact between educators and learners from other cultures. Because e-learning is a cultural artifact—embedded with the nuances of the culture that designs it—e-learning will need to be translated, localized, and adapted in profound ways to suit the needs and preferences of learners in other cultures. *Localization* addresses obvious visual and textual differences found in other cultures, such as icons, symbols, gestures, and so forth. However, the deeper ramifications of culture, such as what people value, how they learn, solve problems, and so forth, will require approaches that are more sophisticated. *Reusable learning objects (RLOs)* are “plug and play” chunks of learning materials (content, teaching approaches, and so forth) that allow instructional designers

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to construct and modify e-learning in an easy, efficient, and effective manner that parallels the agility demanded by NVOs in business functions. RLOs are fast becoming the foundation of rapid e-learning development (EDUCAUSE Learning Initiative, 2006). However, *cross-cultural learning objects (XCLOs)* meet the additional challenge of creating e-learning that accommodates the more profound cultural differences of global learners, such as those generated by different values, national cultural dimensions, and even diverse levels of techno-literacy. This article describes XCLOs in more detail and illustrates how they can be used by NVOs to maintain their requisite agile workforce.

BACKGROUND

Technically, a learning object (LO) is a simple unit of instruction designed to achieve a specific learning objective. A variety of learning objects can be designed to achieve the same objective, allowing instructional designers to choose activities based on the demographics of learners, media, environments, and so forth. When one speaks of learning objects today, it is usually in the context of e-learning because LOs are digital and designed to be reusable (reusable learning objects or RLOs), which is accomplished by designing them to meet established standards for a specific data format, such as Sharable Content Object Reference Model (SCORM) and Aviation (all encompassing) Industry Computer-Based Training (CBT) Committee (AICC) (Wikipedia, 2007). A simple definition of an RLO is “[a] self-contained piece of learning material with an associated learning objective, which could be of any size and in a range of media” (Crawley, 2006).

NETg (2003) defines [RLOs] by three components that must be present: the object must have a measurable objective, it must have an activity that exactly matches this objective, and it must have an assessment. Wiley (2000) defines a learning

object as “any digital resource that can be reused to support learning.” Extensive databases, such as the Multimedia Educational Research for Learning and Online Teaching [MERLOT] (MERLOT, 2006), have been created to house these RLOs created by educators and to make them available to other educators.

The extensive coverage of reusable learning objects on Web sites such as <http://www.reusablelearning.org/> (Reusable Learning Project, 2005-2005) and Eduworks (2001-2005) are examples of how RLOs have grown in popularity and sophistication.

Reusable Learning Objects

Reusable learning objects represent an alternative approach to content development. In this approach, content is broken down into chunks. From a pedagogical perspective, each chunk might play a specific role within an instructional design methodology...

- Each chunk must be able to communicate with learning systems using a standardized method that does not depend on the system
- How a learner moves *between* chunks is controlled by the learning system.
- Each chunk must have a description that enables designers to search for and find the right chunk for the right job.

Such chunks are called learning objects. There is no standard for the size (or *granularity*) of a learning object (Eduworks Corporation, 2001-2005).

The primary benefit of using RLOs for rapid e-learning development, as well as for cultural adaptation, is that the needs of different groups of learners can be met by using these “chunks” to adapt existing courses instead of creating new ones for every different group of targeted learners. The major premise, while not entirely proven, is that the cultural characteristics of learners will need to

be “matched” to characteristics of the e-learning courses. The largest producers of e-learning are in Western cultures, but the largest and fastest growing consumer groups are in Eastern cultures (Van Dam & Rogers, 2002). Thus, as e-learning is further globalized, education and training professionals will be challenged to meet the culturally-based needs of these learners. Businesses, higher education, and e-learning producers are rapidly adopting RLOs in the instructional design of e-learning, [but] also, recognizing “[the] issues around re-use of e-content and cultural models of teaching and learning” (Selinger, 2005) and “how culture and IT skills influence development and delivery of e-learning materials” (Benson et al., 2005). Educators acknowledge that “Many objects are culturally-inflected, which is to say that they may not be appropriate at all for diverse learners in remote settings...” (Nash, 2005). They are also recognizing RLOs as cultural artifacts and the inherent socio-cultural differences presented (Berge & Fjuk, n.d.).

Cross-Cultural Learning Objects

However, the term *cultural learning object* (CLO) has already been coined. CLOs are digital representations of art, historical places, and other physical artifacts of the world’s cultural groups. An initial Internet search for *cultural learning objects* illustrates that, for the most part, these are reusable learning objects used in the cultural heritage industries, such as museums (DigiCULT, 2003; Giorgini & Cardinali, 2003). The concept of cultural learning objects came into existence with the proliferation of online museums, digitized art, and the need to move and store these objects for either display or for educational purposes.

Thus, in order to distinguish the CLOs used within the heritage industry from those used to create culturally adapted e-learning, an alternative moniker is needed. The term *cross-cultural* is defined as “...comparing or dealing with two or more different cultures” (Lexico Publishing

Group LLC, 2006), a definition that more aptly describes what instructional designers are trying to accomplish when in adapting e-learning for multiple cultural groups. This author contends that the term *cross-cultural learning objects* (XCLOs) better defines the characteristics of RLOs for globalized e-learning and, in addition, proposes that the e-learning industry adopt the term *cross-cultural learning object* [XCLO] into standard usage. Hence, the term would be distinguished from CLO, already coined by the heritage and museum industry.

MAIN FOCUS

So, how do XCLOs work and how should they be employed?

As a result of classical research and theories in industrial anthropology, Hofstede (1997), Trompenaars and Hampden-Turner (1998), and others, such as Edward T. Hall (1981), identified categories of characteristics across which members of cultures can be compared and contrasted at a national level called *cultural dimensions*. While each researcher categorized these dimensions differently, the concepts are similar: large groups of people within certain national groups (countries) tend to possess similar characteristics that differentiate them from members of other national groups. (For brevity, only segments of Hofstede’s and Trompenaars’ research will be used in this article; however, the reader should further explore the seminal works of Geert Hofstede (1997) Fons Trompenaars and Charles Hampden-Turner (1998), Edward T. Hall (1981), and the other theorists in the reference list).

Based on his research of more than 100,000 individuals in 54 countries, Hofstede created indexes (ratings from low to high) for four categories of characteristics used to describe cultural groups: power distance, individualism, masculinity, and uncertainty avoidance. The *power distance index* (PDI) is “the extent to which the less powerful

members of institutions and organizations expect and accept that power is distributed unequally” (Hofstede, 1997, p. 27). He defined *individualistic* (IDV) societies as those “in which ties between individuals are loose” (1997, p. 51). By contrast, *collectivist* societies are those “in which people from birth onwards are integrated into strong, cohesive *ingroups*, which throughout people’s lifetime continue to protect them in exchange for unquestioned loyalty” (Hofstede, 1997, p. 51). He also defined a dimension called “*masculinity* versus *femininity*” (MAS) in terms of how a culture socializes its members to perform gender roles. In a masculine culture, men are expected to be tough and assertive, while women are perceived as tender and modest. In a feminine culture, men and women are more likely to have similar roles; both are expected to be tender and modest, even if men also express some assertiveness. Lastly, *uncertainty avoidance* (UAI) is “the extent to which the members of the culture feel threatened by uncertain or unknown situations” (Hofstede, 1997, p. 113). Uncertainty avoidance is not risk avoidance; rather, it refers to a pattern of reducing ambiguity.

Not surprisingly, such characteristics are manifested by students and teachers and, consequently, within cultural artifacts (such as e-learning) as well.

Edmundson (2007c) describes two of Hofstede’s four cultural dimensions, *power distance* and *individualism*, as he related them to education:

In nations with a low-power distance index (PDI), teachers and students tend to be perceived as equals. Teachers are not authoritative subject matter experts, but rather are facilitators of student-centered education. In high-PDI nations, teachers are authorities, and students do not question their knowledge (Hofstede, 1997). Students in nations with a high-individualism index (IDV) expect to be treated as equals among peers and faculty, preferring to work as individuals and expecting recognition for individual merit. In contrast,

members of collectivist societies depend on social relationships and may expect differential treatment based upon their social class. Globally, collectivist societies are predominant. (Hofstede, 1997)

Thus, in the scenario above, an American learner (low PDI) would be accustomed to challenging and questioning the instructor; whereas, a learner from India might defer to the instructor’s authority position and not question him or her (high PDI). The presumption is that, to some degree, such differences will affect *learning outcomes* and need to be addressed. *Learning outcomes* were defined by Henderson (1996) as any results that reflect the acquisition of skills and knowledge, such as the effectiveness of instructional techniques, and as students’ perceptions or attitudes. The goal of instructional design is to ensure equitable outcomes for all learners. Most e-learning is designed by Western countries, such as the United States, which have the highest indexes of PDI and IDV among the nations studied; in contrast, Eastern and countries in developing areas tend to have low PDI and IDV indexes, posing challenges in both classrooms and e-learning. *Table 1* summarizes the different cultural dimensions indexes of American and Indian learners as shown by Hofstede (1997).

Classical theorists and researchers in education have long recognized the impact of culture on education (Gardner, 1989; Hall & Hall, 1977; Lave, 1988; Spindler, 1963, 1974, 1987; Vygotsky, 1997). Contemporary researchers and theorists (Downey et al., 2004; Edmundson, 2004; Henderson, 1993, 1996, 2007; Jaju et al., 2002; McLoughlin, 1999, 2000, 2007; Reeves, 1994) are finding that cultural dimensions have an impact on *how* people learn and/or how they *prefer* to learn specifically within *e-learning*. Dunn and Marinetti (2000-2004) were two of the earliest thinkers that recognized learning objects as a way to culturally adapt e-learning:

[Learning] objects are selected that to some extent tailor the experience to the cultural expectations of

Cross-Cultural Learning Objects (XCLOs)

Table 1. Summary of U.S. and Indian indexes for Hofstede's four cultural dimensions

Dimension (range of lowest to highest scores, using all countries)	PDI (lowest-11; highest-104)	IDV (lowest-6 highest-91)	MAS (lowest-5 highest-95)	UAI (lowest-8 highest-112)
USA	40	91	62	46
India	77	48	56	40

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the learner... The great advantage of object-based elearning is that once you have identified some of the key [cultural] dimensions for your major cultural areas, you can deliver the same objects to those who share similar traits.

Table 2 proffers an example of how a course developed in the United States (U.S.) might be adapted for learners in India. The suggested uses for XCLOs are highlighted in bold. Note that, while the need for adaptations are presumed, the author recommends several ways in which to determine (a) if any changes are needed and (b) other ways—beyond changes in instructional design—in which to adapt e-learning.

Marinetti & Dunn (2002) illustrated how XCLOs could be used in a course that was originally designed in the U.S. but adapted for Italian learners, based on the cultural dimension, *achievement v. ascription orientation*, a cultural dimension described by Trompenaars and Hampden-Turner (1998) that is similar to Hofstede's PDI.

According to Marinetti and Dunn (2002):

Achievement-oriented cultures judge people according to what they have accomplished. They make limited use of titles and respect to superiors is accorded depending on their knowledge and performance...[whereas] Ascription-oriented cultures attribute status depending on birth, kinship, gender, and age but also connections and educational record. They make extensive use of titles.

Italians have a high “ascription” score whereas the Americans’ score on this dimension is low. If the course were designed in America, for example, it might contain an introductory video of the course designer who, as a corporate professional in workplace performance, tells learners about the value of the course. However, the Italians may not give this professional much credence because he/she is unknown. As a solution, (presuming this proves to be the case), the introductory component of the course could be created as an XCLO. For high-ascription Italians, the introduction may be presented by a well-known, respected and titled authority in Italy.

As illustrated in this article, educational researchers and practitioners are becoming more aware of the need to adapt complex e-learning for use in other cultures: “The digital object should be appropriate culturally, and the meanings that it communicates within a cultural context should reinforce learning objectives,” and “understanding the cultural beliefs and values is critical in developing an instructional strategy that uses learning objects” (Nash, 2005, p. 416). Localization addresses obvious visual and textual differences found in other cultures such as icons, symbols, gestures, and so forth. However, the deeper ramifications of culture, such as what people value, how they learn, solve problems, and so forth, will require approaches that are more sophisticated. Using XCLOs will accomplish that goal.

Table 2. Proposed use of XCLOs, based on assessment of cultural dimensions for the U.S. and India

Course characteristics	Learner characteristics	Potential adaptations to consider	How to measure or evaluate impact/preferences
Use of American English	Taught in schools with British English	• Change words, idioms, colloquialisms • Provide learners with a glossary • Do nothing	Determine learner familiarity with American English and idioms, and other colloquialisms used in the course.
Use of American icons and brand names, such as Harley Davidson motorcycles	Highly educated, work for Americans and are frequently exposed to American culture through mass media, work, colleagues	• Replace with those known to Indian learners • Explain differences • Do nothing	Determine learner familiarity with American icons, pop culture, and other colloquialisms used in the course via focus group
Lacks cooperative activities and group work (except through simulations and post-course discussions)	Prefer cooperative activities and group work	• Use XCLOs ◦ to replace individualistic activities with more cooperative ones ◦ to offer a supplemental cooperative activity just for the Indian learners • Do nothing; learners may accept and/or adapt to individualistic activities	Pilot test the course for equitable learning outcomes; survey participants about reaction to activities provided
Embodies cognitive-constructivist educational paradigm	More accustomed to instructivist-didactic approach to teaching	• Use XCLOs ◦ To create course options based on paradigm to which the learners are accustomed, such as offering written, downloadable handouts of information in place of an interactive activity • Do nothing; learners accept and/or adapt to different paradigm	Pilot test the course for equitable learning outcomes; survey participants about reaction to activities provided

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FUTURE TRENDS

As discussed, several trends related to the growth of NVOs and other types of organizations with global reach indicate that the use of XCLOs is imperative. Outsourcing, offshoring, and out-tasking of business functions is growing, creating the need to rapidly train an agile, cross-cultural workforce. E-learning is more frequently the tool of choice for educating the virtual workforce. The design and use of modular learning objects and the logic of reusing content are top areas of focus for corporations, higher education, and e-learning vendors in the U.S. (The eLearning Guild, 2006). In addition, an average of 21% of those organizations wants to increase the global reach of their e-learning content (The eLearning Guild, 2006). Given these trends, reusable XCLOs will become

increasingly popular, collected and developed, and exchanged all over the world. The collection and creation of XCLOs will lead to the creation of new XCLO databases, similar to MERLOT or, alternately, XCLOs will be incorporated into existing databases as a subcategory of RLOs. In addition, the standards for their development – content-wise and technologically – will become more universal. Educational researchers and practitioners have begun to introduce ways in which to adapt e-learning for targeted learners in other cultures, from translation, to localization, to using RLOs. Practical models for adapting e-learning are being developed and tested (Dunn & Marinetti, 2007; Edmundson, 2007a, 2007b; Henderson, 2007; McLoughlin, 2007). However, the first step to integrating XCLOs into e-learning is to differentiate between the cultural learning

objects (CLOs) used in the heritage industries and the cross-cultural learning objects (XCLOs) used in e-learning.

CONCLUSION

NVOs rely on e-learning to maintain an agile, trained workforce globally. However, members of world cultures have different values, perspectives, and even ways of learning. RLOs can address the need for rapid e-learning development. Certain organizations such as MERLOT ("Multimedia educational research for learning and online teaching [MERLOT]," 2006) have built databases of RLOs for educators to use. However, no one has specifically addressed the need to use RLOs for *cultural adaptation*. To the author's knowledge, there is no organized effort to design XCLOs, nor are there any databases that house XCLOs. An Internet search for "cross-cultural learning objects" resulted in ONE hit, an almost unheard of result in today's Web searches: developing and compiling a repository of *cross-cultural learning object* makes sense in the discipline of e-learning, the educational tool of choice for globalized NVOs.

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KEY TERMS AND DEFINITIONS

AICC: The Aviation (All Encompassing) Industry CBT (Computer-Based Training) Committee [AICC] is an international association of technology-based training professionals. The AICC develops guidelines for aviation industry [that are being adopted by other industries, as well] in the development, delivery, and evaluation of computer based training, Web-based training and related training technologies (Wikipedia, 2007).

Cross-Cultural [XC]: Comparing or dealing with two or more different cultures (Lexico Publishing Group LLC, 2006).

Cross-Cultural Learning Objects [XCLOs]: Cross-cultural learning objects are reusable learning objects used to adapt e-learning for use by multiple cultures, based on the premise that learners in another culture will learn best by hav-

ing course characteristics and features meet their needs and cultural preferences.

Cultural Artifacts: An instructional design is a cultural artifact. It reflects, often in an inconspicuous or unintentional manner, the values, learning preferences, language, and worldview of the designer (McLoughlin, 1999).

Cultural Dimensions: Cultural dimensions are the mostly psychological dimensions, or value constructs, which can be used to describe a specific culture. These are often used in intercultural communication-/cross-cultural communication-based research. See also Hall (1981), Hofstede (1997), and Trompenaars & Hampden-Turner (1998). (Wikipedia, 2007).

Distance Education or Distance Learning: Distance education, or distance learning, is a field of education that focuses on the pedagogy/andragogy, technology, and instructional systems design that are effectively incorporated in delivering education to students who are not physically “on site” to receive their education. Instead, teachers and students may communicate asynchronously (at times of their own choosing) by exchanging printed or electronic media, or through technology that allows them to communicate in real time (synchronously) (Wikipedia, 2007).

E-Learning: E-learning is a general term used to refer to computer-enhanced learning. It is used interchangeably in so many contexts that it is critical to be clear what one means when one speaks of “e-learning” (Wikipedia, 2007). E-learning is a form of distance learning or distance education; however, the latter two are not neces-

sarily e-learning...they could be correspondence courses, and so forth.

Learning Objects [LO]: A learning object is a reusable unit of instruction for elearning. In order to use it in different contexts, the presentation has to be separated from the content, which calls for specific data formats. SCORM is such a format (Wikipedia, 2007).

Learning Outcomes: Results that reflect the acquisition of skills and knowledge, such as the effectiveness of instructional techniques, and as students’ perceptions or attitudes (Henderson, 1996).

MERLOT: The Multimedia Educational Research for Learning and Online Teaching (MERLOT) was built to house RLOs created by educators and to make them available to other educators (“Multimedia educational research for learning and online teaching [merlot],” 2006).

Reusable Learning Objects [RLO]: Reusable learning objects represent an alternative approach to content development. In this approach, content is broken down into chunks. From a pedagogical perspective, each chunk might play a specific role within an instructional design methodology [and can be interchanged and exchanged, depending on the needs or characteristics of the learners] (Eduworks Corporation, 2001-2005).

SCORM: SCORM stands for Shareable Content Object Reference Model. This is a standard for Web-based e-learning. It defines how the individual instruction elements are combined on a technical level and sets conditions for the software needed for using the content (Wikipedia, 2007).

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Chapter 5.3

Technology Integration Practices within a Socioeconomic Context: Implications for Educational Disparities and Teacher Preparation

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ABSTRACT

With the call for curricular and instructional reform, educational institutions have embarked on the process to reform their educational practices to aid the lower SES student in their quest to obtain quality education with the integration of technology. The study performed was to examine the socioeconomic disparities of teachers' technology integration in the classroom as it relates to implementing technology interventions to support quality teaching and active student learning. This chapter provides empirical evi-

dence of whether these disparities continue to exist, and their effects on student achievement in the classroom.

INTRODUCTION

The rise and use of educational technology in the 21st century has become one of the dominant issues and challenges facing diverse communities, business and industry, educational arenas and the larger U.S. society as a whole. Amidst the euphoria and craze over the power and the potential of information and communication technology has to transform the way we learn, the ways in

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which we communicate, and the ways in which society functions, there is an increasing debate as to who has access and the consequences of access to full participation in a democratic U.S. society. This debate has particular implication for classroom instruction. Educators concerned about the chronic underachievement of students often fall prey to the allure of technology as a tool for reversing the historical influences of poverty, discrimination, inequity, chronic underachievement, and lack of opportunity because technology has the potential to narrow the achievement gap, if equally distributed or widen the gap if only accessible to selected groups in the educational system (Waxman, Connell, & Gray, 2002; Edyburn, Higgins, & Boone, 2005).

SOURCES OF SOCIOECONOMIC DISPARITIES

Research studies have been devoted to socioeconomic disparity in technology integration and use in education (National Center for Educational Statistics, 2005; U.S. Department of Education, 2005). Becker (2001) found that students from higher income families have been found to use computers in school and in their homes more frequently than students from lower SES families. Students of color from urban schools have also been found to have less access to computers compared to Anglo-suburban students (National Telecommunication and Information Administration, 2006). More recently, lower SES schools are only half as likely to have high speed internet compared to high SES schools (Roblyer, 2006). Consistent with this idea of access are the issues within the digital divide itself. Despite the constraints on school funding in most states, schools have devoted an increasing percentage of their annual budgets to technology. The majority of the efforts of the educational community over the past decade to acquire hardware, software, and Internet access have been successful (Divid-

ing Lines, 2001). However, clear evidence of a digital divide, parallel to historical disparities, continues to distinguish urban schools from their affluent counterparts (Chen & Thielemann, 2001; Guttentag & Eilers, 2004; National Center for Education Statistics, 2004). Historical measures of digital equity have been based on the ratio of the number of computers divided by the number of students. A more recent measure involves determining levels of Internet access. Another dimension of this problem relates to questions about differences in home access to technology, therefore impacting urban student achievement.

A second source of disparity in technology use is how technology is used. Previous studies conducted by Becker (2001) and Finneran (2000) found that low SES schools are more likely to use technology for drill and practice, whereas high SES school uses technology in innovative teaching strategies (Becker, 2001; Finneran, 2000). This idea is consistent with the ideas of curriculum reform and reconceptualization put forth by Pinar (2004). Pinar (2004) suggests that the instruments of computer technology are used to drill and kill students into passing standardized test, not actually being integrated effectively into classroom instruction or pedagogical practice that promote quality teaching and active student learning. He further explains that the current use of computer technology in urban schools generally serve to turn its users (students) into disembodied and alienated subjects. Furthermore, as explained in Becker (2001), high SES students are more likely to use technology for school assignment, use e-mails, and use educational programs.

A third source of disparity in technology use deals with the nature of technology adoption and organizational change. A thorough analysis of major research related to technology and teacher motivation, adoption and usage uncovered important factors that are involved in determining their willingness to use such approaches in the teaching and learning process (Braak, 2001;

Solomon & Wiederhorn, 2000). The literature indicates that teacher's willingness to adopt and implement learning technologies for the teaching and learning process varies, but all share the same denominator—proper internal and external motivation (Braak, 2001; Mooji & Smoot, 2001; Solomon & Wiederhorn, 2000). The top reasons teachers choose to use technology for the teaching and learning process dealt with the notion of continuous training and development, proper technology support from technology personnel, encouragement from school administration, and an organizational structure that supported teachers using technology. While these are the key issues ascertained from the research study, the ideas of change management, technology adoption and innovation, self-efficacy and motivation, support, and the computing experience are relevant to this discussion. The American Council of Education (2003) report noted that the quest to optimize the use of technology in schools could not be fulfilled by the mere supply of more hardware and software. The report suggested that what needs to be addressed first are ways to identify, motivate, and equip teachers with the skills necessary for effective use of educational technologies in their classroom practices.

TEACHERS' PERCEPTIONS AND ATTITUDES TOWARD TECHNOLOGY

Ktoridou, Zarpetea, and Yiangou (2002) studied teachers' attitudes toward technology in the classroom. The study found that most young, novice teachers expressed a willingness to integrate technology in their lessons than more experienced veteran teachers. Moreover, the researchers implied that younger, less experienced teachers are more interested in learning how to use technology since they are more familiar with it, whereas; experienced teachers felt frustrated

by the new technology as it takes too much time to learn and use it. The teachers stated that they had a negative attitude towards technology because of their lack of training, lack of experience, and lack of time to prepare an extensive lesson plan, as well as the inability to acquire computer access. Bauer (2002) adds that a challenge for teachers is how to use technology along with the standards and teachers use the computer to augment regular curricular activity, but not as an integral transformative tool to assist in the teaching and learning process.

The use of technology in the classroom has moved through definable periods involving programming, computer-assisted instruction, problem-solving environments, personal productivity, web-based instruction, and hypermedia. Problems associated with limited opportunities for teacher professional development to learn about new innovations (Loneragan, 2001), as well as limited funds for new hardware and software, often result in the routine use of student learning activities that have been abandoned by high-performing schools (Guttentag & Eilers, 2004). Literacy educators have a responsibility to be aware of these disparities in technology access and education and to work to narrow gaps between the technological haves and have-nots (Bauer, 2002).

METHODS

The data for the present study was drawn from the base year of the Educational Longitudinal Survey of 2002-2004 (ELS: 02). The ELS:02 is a national survey administered by National Center for Educational Statistics to provide an overall picture of the present educational experience of high school students in the U.S. The survey has four sub components completed by students, teachers, parents and school administrators. The design used to collect the data was a two-stage, stratified national probability sample. The

survey included 1,052 public and private school representing about 12,000 students across the country. For the present study the teacher and administrator survey data was used. The total number of teachers that participate in the survey was about 7,322.

The teacher survey provided items used to measure how much training teachers had received in technology use. The items used to measure teacher training were the following: (a) received training in basic computer skills, (b) received training in the use of the Internet, (c) received training in integrating technology in the curriculum, (d) received training in software applications, (e) received training in use of Internet, (f) received training in use of other technology and, (g) received follow-up or advanced training. The outcome measures for these items were dichotomous, yes or no.

The teacher survey also measured Internet and Technology use in Instructions. The item provided on the teacher survey to measure this outcome were the following: (a) how often do you use the computer to create class presentations, (b) how often do you use WWW sites to plan lessons, (c) how often do you access model lesson plans from internet, (d) how often do you do research teaching on the internet, (e) how often do you take professional development courses on the internet, (f) how often do you download instructional software from the internet, (g) how often do you use the computer to give class presentations and, (h) how often do you use the computer to prepare multimedia presentations. The outcome measures for these items were also a four point likert scale, ranging from “never” to “more than once a week.”

Finally, the teacher survey measured how often teachers used technology to communicate between parents, students, and for administrative duties. The item provided on the teacher survey to measure this outcome were the following: (a) how often do you take professional development

courses on the Internet, (b) how often to you use the computer to communicate with colleagues, (c) how often to you use the computer to communicate with parents, (d) how often to you use the computer to communicate with students, (e) how often do you use the computer for administrative records and, (f) how often to you use the computer to post homework and other information. Again, the outcome measures for these items were also a four point likert scale, ranging from “never” to “more than once a week.”

In order to measure the socioeconomics level of the school involved, the administrator survey was used. In this case school administrators were asked the report the percent on students at their school that were eligible for a free lunch program. School percentages were then ranked according to eligibility. The distribution of these percent values were divided into three quartiles, ranging from lowest to high SES schools. The total number of teachers that represent the three SES levels were about 3933 teachers from low SES schools, 2324 from middle SES schools and about 1065 teachers from high SES schools. To determine if an association exist between technology training and use by teachers in the school with different socioeconomic status a Pearson’s chi-square test was used.

RESULTS

Table 1 reports the percent of teachers who received training on technology preparation and the ability to integrating technology in the curriculum they teach. Eighty three percent of the teachers indicated they had received training in basic computer skills. Similarly, almost eighty percent of the teachers indicated they had received training on software applications (78.7%), use of the internet (78.6%) and integrating technology in curriculum (77.0%). Finally, less than fifty percent of the teachers indicated that they had

Table 1.

Teacher Training N= 7322		
	Yes	No
Received training in basic computer skills	83.0%	17.0%
Received training in software applications	78.7%	21.3%
Received training in use of Internet	78.6%	21.4%
Received training in use of other technology	45.7%	54.3%
Received training in integrating technology in curriculum	76.4%	23.6%
Received follow-up or advanced training	43.2%	56.8%

received training on the use of other technology (46.4%) and follow-up or advanced training on technology use (43.2%).

Table 2 reports how often internet and computers are being used by classroom teachers. The most frequent use of the computer by classroom teachers was to create class presentations. About eighty percent of the teachers (80.7%) indicated that used computer to create instructional materials more than several times a week. Seven percent (7.0%) of the teachers indicated they

used computers to prepare multimedia presentations more than once a week. Similarly, about seven percent (6.5%) of the teachers indicated they used the computer to give class presentations and to prepare multimedia presentations more than once a week. The most frequent use of the internet was to use www sites to plan lessons. Forty five percent (44.5%) of the teachers indicated they used a www site more than once a week. The second highest use of the internet was to access model lesson plans. Only sixteen

Table 2.

Internet and Technology Use in Instructions N= 7322				
	Never	Less Than Once a Month	Between one a week and once a month	More than once a week
How often use computer to create class presentations	2.4%	3.3%	13.6%	80.7%
How often use WWW sites to plan lessons	6.3%	16.1%	33.0%	44.5%
How often access model lesson plans from Internet	28.7%	30.8%	25.0%	15.5%
How often research teaching on Internet	25.4%	34.3%	27.4%	12.9%
How often did teachers take professional development courses on Internet.	88.5%	8.5%	2.0%	1.1%
How often was download instructional software from Internet used in the class	59.1%	26.5%	11.9%	2.5%
How often use computer to give	37.1%	33.7%	22.7%	6.5%
How often use computer to prepare multimedia presentations	38.2%	34.1%	20.7%	7.0%

percent (15.5) of the teachers indicated that they used the internet to access model lesson plan more than once a week. Similarly, thirteen percent (12.9%) of the teachers indicated they used the internet more than once a week to research teaching. Finally, less than 10% of the teachers indicated they used the internet more than once a week for the remaining items, download instructional software and take development courses on the internet.

Table 3 reports communication use of the computer and internet by classroom teachers. The most frequent use of the computer in communication was for administrative purposes. Seventy nine percent (78.6%) reported using the computer for administrative purposes more than once a week. The second most frequent use of the computer by teachers was for colleague discussions. Fifty three percent (52.9%) of the teachers indicated that they used the internet for colleague discussions more than once a week. Similarly, almost fifty three percent (52.6%) of the teachers indicated that they used the internet for colleague discussions and to communicate with colleagues more than once a week. Twenty-six percent of the teachers indicated that they used the computer to communicate with students more than once a week. One fifth of the teachers

(20.8%) indicated that they used the computer to post homework/information more than once a week. Finally, less than twenty percent (18.8%) of the teachers indicated that they used the computer to communicate with parents.

Table 4 compares teacher training on computers and technology use across socioeconomic school levels. The results indicated that several differences ($p < .001$) exist in technology training teachers have received in high, median and low SES schools. Teachers from high SES school indicated a larger percent of them had received training in basic computer skills. Eighty four percent (84.1%) of the teachers from high SES school reported receiving training in basic computer skills compared to seventy nine percent (78.6%) of the teachers from low SES school. There was a significant difference ($p < .001$) exist on the percent of teachers that received training on software applications across the three SES environments. In this case teachers from Middle level SES school had the highest percent 85.3%, compared to 80.6% and 80.9% for Low and high SES teachers respectively. When asked if they had received training in the use of the internet there was a significant difference ($p < .001$). Eighty four percent (83.7%) of the teachers from high SES schools reported they had received

Table 3.

	Less Than Once a Month	Between one a week and once a month	More than once a week	Less Than Once a Month
How often use Internet for colleague discussions	17.4%	14.6%	15.0%	52.9%
How often use computer to communicate w/colleagues	18.2%	14.3%	14.8%	52.6%
How often use computer to communicate w/parents	41.9%	17.0%	22.3%	18.8%
How often use computer for administrative records	10.7%	4.5%	6.0%	78.6%
How often use computer to Communicate w/students	43.6%	16.5%	14.0%	25.9%
How often use computer to host homework/information	63.6%	9.4%	6.2%	20.8%

Table 4.

Professional Development and training in basic computer skills N=7322			
	Yes	No	Chi-Square
Received training in basic computer skills SES N = 3933 Low N = 2324 Middle N = 1065 High	78.6% 81.7% 84.1%	21.4% 18.3% 15.9%	24.5***
Received training in software applications SES N = 3933 Low N = 2324 Middle N = 1065 High	80.6% 85.3% 80.9%	19.4% 14.7% 19.1%	28.1***
Received training in use of Internet SES N = 3933 Low N = 2324 Middle N = 1065 High	77.2% 82.4% 83.7%	22.8% 17.6% 16.3%	45.2***
Received training in use of other technology SES N = 3933 Low N = 2324 Middle N = 1065 High	41.2% 42.2% 42.0%	58.1% 57.8% 58.0%	.4
Received training in integrating technology in curriculum SES N = 3933 Low N = 2324 Middle N = 1065 High	72.6% 77.1% 75.6%	27.4% 22.9% 24.6%	10.2*
Received follow-up or advanced training SES N = 3933 Low N = 2324 Middle N = 1065 High	45.5% 45.1% 44.4%	54.4% 54.9% 55.6%	.7

training compared to about seventy seven percent (77.2%) of the teachers from low SES schools. A little over eighty percent (82.4%) of the teachers from middle SES school reported receiving training. When asked if they had received training in integrating technology in curriculum teachers from middle class school indicated they had received the most. In this case, 77.1% of the teachers from middle class schools compared to 75.6% and 72.6% for teachers in high and low SES schools. There were no other significant differences across the three SES groups on if teachers had received follow-up or advanced training.

Table 5 compares teacher internet and technology use in Instructions across socioeconomic levels. The results indicated that several differences exist ($p < .001$). The highest use of computers across all three SES groups was how often the use computer to prepare multimedia presentations. Teachers from middle SES schools reported the highest percent usage. Eighty percent (80.4%) of these teachers reported using computer to prepare multimedia presentations more than once a week. Seventy seven percent (76.8%) of the high SES teachers and seventy five percent (75.3%) of the low SES teachers reported using computer to prepare multimedia presentations

more than once a week. Teachers from high SES school indicated a larger percent of them use computers to create class presentations. Sixty

four percent (64.4%) of the teachers from high SES school reported using computers to create class presentations more than once a week. Re-

Table 5.

Internet and Technology Use in Instructions N=7322					
	Less than once a month	Between once a week and once a month	More than once a week	Less than once a month	
How often use computer to create class presentations SES N = 3933 Low N = 2324 Middle N = 1065 High	6.1% 4.3% 4.3%	11.2% 9.8% 8.9%	24.8% 27.8% 22.3%	57.9% 58.1% 64.4%	52.1**
How often use WWW sites to plan lessons SES N = 3933 Low N = 2324 Middle N = 1065 High	21.0% 18.5% 17.0%	34.2% 35.0% 30.3%	30.2% 27.6% 34.9%	2.9% 6.4% 5.1%	58.5***
How often access model lesson plans from Internet SES Low Middle High	52.7% 47.1% 46.4%	35.8% 34.8% 38.1%	12.8% 15.9% 19.0%	3.5% 6.4% 4.4%	75.8***
How often research teaching on Internet SES N = 3933 Low N = 2324 Middle N = 1065 High	47.9% 43.0% 38.5%	35.8% 34.8% 38.1%	12.8% 15.9% 19.0%	3.5% 6.4% 4.4%	91.0***
How often take professional development courses on internet SES N = 3933 Low N = 2324 Middle N = 1065 High	88.1% 86.1% 87.6%	9.6% 10.2% 10.1%	.9% 1.9% 1.9%	1.4% 1.8% 1.2%	11.9
How often download instructional software from Internet SES N = 3933 Low N = 2324 Middle N = 1065 High	77.5% 74.2% 75.4%	11.1% 12.8% 11.9%	4.8% 7.5% 6.8%	6.6% 5.5% 5.8%	16.5
How often use computer to give SES N = 3933 Low N = 2324 Middle N = 1065 High	59.7% 56.5% 49.3%	29.8% 30.2% 34.9%	9.0% 11.4% 12.6%	1.4% 1.9% 3.2%	65.7***
How often use computer to prepare multi-media presentations SES N = 3933 Low N = 2324 Middle N = 1065 High	13.5% 10.5% 9.6%	4.7% 3.0% 3.8%	6.5% 6.0% 9.8%	75.3% 80.4% 76.8%	63.9***

garding teachers from low SES school about fifty eight percent (57.9%) of the teachers reported using computers to create class presentations more than once a week. Similar, fifty eight percent of the teachers from middle class schools reported using computers to create class presentations more than once a week. The group that reported using WWW sites to plan lessons the most were teachers from middle SES schools. Nineteen percent of the middle school teachers indicated they used WWW sites more than once a week. Eighteen percent (17.8) of the teachers from High SES schools reported using WWW sites more than once a week. Fifteen percent (14.6%) of the teachers from low SES schools reported using WWW sites more than once a week. When asked how often they accessed model lesson plans from the internet, teachers from low SES schools were less likely to do so. Over fifty percent (52.7%) reported never accessing model lesson plans from the internet. Forty seven percent (47.1%) of the teachers from middle SES schools and forty six percent (46.4%) of the teachers from high SES schools reported never accessing model lesson plans from the internet. Almost fifty percent (47.9%) of the teachers from low SES schools compared to thirty nine percent (38.5%) of the teachers from high SES school reported never doing research teaching on internet. Forty three percent of the teachers from middle SES schools reported never doing research teaching on internet. There was a ten percent decrease in usage of the computer to give when comparing teachers from High and low SES schools. Close to sixty percent (59.7%) of the Low SES teachers and forty nine percent of the teachers from high SES schools reported never used the computer to give. Fifty seven percent (57.3%) of the teachers reported never using the computer to give. There were no other significant differences for the remaining usages of the computer.

Table 6 compares teacher internet and technology use for communication across socioeconomic levels. The results indicated that several differences exist ($p < .001$). There was a significant difference in the using the computer to communicate with colleagues. Fifty-five percent (54.7%) of the teachers from high SES school and forty seventy percent (47.3%) of the teachers from low SES schools reported using computer to communicate w/colleagues more than once a week. Similar, fifty four percent of the teachers from middle SES schools reported using computer to communicate w/colleagues more than once a week. There was a significant difference in the using the computer to communicate with parents. Almost three times as many teachers located at High SES schools reported using the computer to communicate with parents more than once a week compared to teachers in low SES schools. The percentages were 26.7% and 9.4% respectively. Thirteen percent (13.4%) of the middle SES teachers reported using computer to communicate w/parents more than once a week. There was a significant difference in the using the computer to communicate with students. Thirty percent (30.4) teachers from high SES schools compared to twenty five of the teachers from low SES schools reported they used computers to communicate with students more than once a week. Twenty one percent (20.8%) of the teachers from middle SES schools reported using the computers to communicate with students more than once a week. Finally, there was a significant difference in the using the computer to post homework and information. About twenty two percent (21.7%) of the teachers from high SES schools compared to twenty percent (20.4%) of the teachers from Low SES schools used computers to post homework and information. Eighteen percent (18.2%) of the teachers from middle SES schools reported using computers to post homework and information.

Table 6.

Communication Through Technology N=7322					
	Less than once a month	Between once a week and once a month	More than once a week	Less than once a month	
How often take professional development courses on internet SES N = 3933 Low N = 2324 Middle N = 1065 High	90.6% 90.2% 84.0%	7.0% 8.0% 11.6%	1.8% 1.1% 2.3%	.6% .7% .21%	57.3***
How often use computer to communicate w/colleagues SES N = 3933 Low N = 2324 Middle N = 1065 High	17.3% 14.9% 18.0%	16.3% 13.8% 14.5%	19.1% 17.5% 12.8%	47.3% 53.9% 54.7%	53.7***
How often use computer to communicate w/parents SES N = 3933 Low N = 2324 Middle N = 1065 High	67.0% 42.0% 33.0%	13.0% 19.5% 14.3%	10.6% 25.1% 25.8%	9.4% 13.4% 26.9%	707.8***
How often use computer to communicate w/students SES N = 3933 Low N = 2324 Middle N = 1065 High	45.2% 49.3% 36.2%	18.4% 12.7% 19.7%	11.4% 17.2% 13.7%	25.0% 20.8% 30.4%	177.6***
How often use computer for administrative records SES N = 3933 Low N = 2324 Middle N = 1065 High	13.3% 10.1% 10.2%	4.3% 4.2% 5.3%	7.2% 5.5% 5.8%	75.2% 80.3% 78.6%	16.8*
How often use computer to post homework/information SES N = 3933 Low N = 2324 Middle N = 1065 High	66.7% 67.3% 60.6%	8.8% 7.5% 11.1%	4.1% 7.1% 6.6%	20.4% 18.2% 21.7%	52.3***

The results also indicated several significant differences exist at the .05 level. There was a significant difference in the using the computer for administrative records. Seventy nine percent (78.6%) of the teachers from high SES school and seventy five percent (75.2%) of the teachers from low SES schools reported using computers for administrative records more than once a week. Similar, eighty percent of the teachers from middle SES schools reported using computers for administrative records more than once a week.

DISCUSSION

The use of technology in the classroom has been a main focus in improving student learning outcomes. Technology not only can provide visual learning in the classroom, it also opens the door to improve higher level thinking skills. However, for technology to have its greatest effect there must be equal access and teachers must be well equipped to utilize there potential. The first important finding in the present study relates to

the descriptive results that summarize teacher's training on technology use. The results suggest that majority of the teachers are receiving training on the basic use of technology. This training includes receiving training in basic computer, software applications, training in integrating technology in curriculum and use of Internet. These teachers however were less likely to have received training in the use of other technology and follow-up or advanced training.

The second important finding was the summary of teachers' Internet and Technology Use in Instruction. Teachers were more likely to use the computer to create class presentations. On the other hand these teachers were less likely to use technology for classroom presentations. Furthermore, only a small number of teachers used the internet to receive professional development or to download instructional software from Internet on a consist bases. The most common use of technology for communication purposes was for administrative purposes. Teachers also reported they commonly used computers and the internet to communicate with colleagues on regular bases. Only a small number of teachers reported using computers to communicate with parents and students.

Comparing technology use and training across school environments indicate that socioeconomic status of the school still plays an important role in how well teacher are trained and their ability to use integrate technology in the classroom. In this case teachers from low SES schools are less likely to have received training in basic computer skills and internet use compared to teachers from high SES schools. This leads to less use of technology by teachers from low SES schools to create class presentations. Finally, teachers from low SES schools are less likely to use technology for communication purposes. This includes communication between teacher and student, along with teacher-parent communications.

IMPLEMENTING TECHNOLOGY IN URBAN SCHOOLS

One of the major concerns for urban teachers when integrating educational technology in the classroom is the identification of appropriate principles that help achieve high student learning outcomes. Recent research synthesis efforts by National Center for Education Statistics (2004), the International Society for Technology in Education (2004), and Roblyer (2006) provide principles for appropriate ways to use education technology in urban schools as supported by the education technology research. Research in educational technology has also shown that the effective use of educational technology occurs when the application directly; (a) supports the curriculum objectives being assessed; (b) provides opportunities for student collaboration and project/inquiry based learning; (c) adjusts for student ability and prior experience, and provides feedback to the student and teacher about student performance; (d) is integrated throughout the lesson; (e) provides opportunities for students to design and implement projects that extend the curriculum content being assessed; and (f) is used in environments where the organization leaderships supports technological innovation (National Center for Education Statistics, 2004). Some examples of the strategies that have proved successful in influencing student academic performance include students working in pairs on lessons at the computer assisted instruction through social interactions and teamwork (Brainbridge, Lasley, Sundre, 2004), digital video clips, audio, and graphics to supplement instruction (Boster, Meyer, Roberto & Inge, 2002); mathematics curricula focusing on mathematical analysis of real-world situations supported by computer assisted instructional software program (Koedinger & Anderson, 1999; Cuban, 2001); multimedia creation involving research skills to locate content resources, capability to apply learning to real world situations, organizational

skills, and interest in content (Cradler & Cradler, 1999); software programs that allow students to be aware where they are in the inquiry process and to reflect upon their own and other students' inquiries (White & Frederiksen, 1998); word processing software that utilizes writing prompts; and online feedback among peers who know one another allows learners to feel more comfortable with and adept at critiquing and editing written work (Coley, Cradler, & Engel, 1997).

CONCLUSION

As we look to the future, technology is often viewed as an enticing means of closing the achievement gap. The current literature has implies that innovative approaches used in teaching with technology leaves students with a more effective learning environment that promotes quality teaching and active student learning. Consequently education planners and policy makers must think beyond providing more hardware, software, and connecting schools to the Internet, but instead thinking about keeping urban schools and teachers well-informed and trained in the effective use of technology for educational purposes. One of these investments is meaningless without the other. High-speed connections, complete digital services, and modern computers are basic to every professional workplace and are essential to student learning in the 21st century. However, technology will fail to meet its educational promise if we neglect to equip teachers with the skills they need to understand and use it and transmit this knowledge and skills to the urban learner. Adhering to these procedures, educators will be able to grow as practitioners in the field and use educational technology to support quality teaching and active student learning. The research examined in this discussion provides teachers with a relevant framework to understand the factors that affect the urban learner and the

power of technology in the teaching and learning process can offer the urban learner, thus leading our educational system to fulfill the promise of providing quality teaching and student learning for a more consistent and dynamic educational learning environment that continues to support the ideals and concepts of the great American education system.

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Chapter 5.4

Assistive Technology for Individuals with Disabilities

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INTRODUCTION

Census 2000 figures indicate that more than 19% of the U.S. population aged five and older are people with disabilities (Goddard, 2004). Technology has the great potential for improving the education and quality of life of individuals with special needs. Blackhurst (2005) identifies six distinct types of technology impacting education: (1) *technology of teaching* (instructional approaches designed and applied in very precise ways); (2) *instructional technology* (videotapes and hypermedia); (3) *assistive technology* (AT) (devices designed to help people with disabilities); (4) *medical technology* (devices which provide respiratory assistance through mechanical ventilation); (5) *technology productivity* tools (computer software and hardware); and (6) *information technology* (access to knowledge and resources).

AT (also called “adaptive technology”) can particularly help balance weak areas of learning with strong areas of learning for students with disabilities (Behrmann & Jerome, 2002). There is a growing recognition that an appropriate up-to-date preparation of teachers/tutors and other educational professionals working with students with disabilities has to focus on information and communication technology (ICT), especially on AT (Feyerer, Miesenberger, & Wohlhart, 2002).

Since educational attainment can enhance occupational attainment, individuals with disabilities (mobility impairment, visual impairment, hearing impairment, speech impairment, and learning disabilities) should be encouraged to participate in higher education. AT for students with disabilities increases options for assisting students with a variety of exceptional learning needs, allowing them to accomplish educational goals that they could not accomplish otherwise in the same amount of time or in the same manner (Rapp, 2005).

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BACKGROUND

AT was practically unknown in 1975, the year of landmark legislation establishing equal educational rights for students with disabilities (and personal technology tools for education were in their infancy at that time); in 1997, the Individuals with Disabilities Education Act (IDEA) amendments required AT consideration in every student's Individualized Educational Program (IEP) (Dalton, 2002). IDEA is the nation's special education law, originally enacted in 1975 (Boehner & Castle, 2005): "The Act responded to increased awareness of the need to educate children with disabilities and to judicial decisions requiring states to provide an education for children with disabilities if they provide an education for children without disabilities" (p. 1).

The late 1970s and early 1980s saw the introduction and refinement of the micro-computer; the 1980s also witnessed an increased emphasis on AT and the emergence of technology literature and computer software targeted directly at special education; and major technology advances such as the evolution of the Internet occurred during the 1990s (Blackhurst, 2005).

The first significant law dedicated to AT was the Technology Related Assistance for Individuals with Disabilities Act (TRAID) of 1988 (Public Law 100-407), which established a definition and criteria for those in the field of AT (Campbell, 2004):

The legislation's primary accomplishment was to provide grant funding for states to establish AT resource centers.... Although many regard AT (such as computer software) as high tech, this definition is all encompassing. The law also provides for low-tech devices, such as pencil grips, weighted writing implements, and magnifying glasses.... In 1998, the federal government passed the Assistive Technology Act (ATA) (Public Law 105-394), which reaffirmed the government's commitment to AT. (p. 168)

With the implementation of these federal laws, institutions of higher learning are able to utilize state agencies in the development of technology programs based on a universal design model.

In 2001, the American Library Association Council approved the AT policy that libraries should work with people with disabilities, agencies, organizations, and vendors to integrate AT into their facilities and services to meet the needs of people with a broad range of disabilities, including learning, mobility, sensory, and developmental disabilities (Goddard, 2004).

ASSISTIVE TECHNOLOGY FOR INDIVIDUALS WITH DISABILITIES IN THE INCLUSIVE EDUCATION SYSTEM

Over the past two decades, for instance, the enrollment of students with disabilities and the demands for related services in higher education have greatly increased (Christ & Stodden, 2005). Online programs have worked to make Web sites accessible to deaf and blind users particularly by providing closed-captioned text and textual descriptions of graphics, even though experts have found out that online programs often lack accommodations for students with learning disabilities such as dyslexia and attention-deficit disorder (Carnevale, 2005).

Inclusion and AT Devices

Inclusive education (the practice of keeping special education students in regular classrooms as much as possible and feasible) is part of the regular school system in many European countries, and inclusive teachers should be able to reach the special educational needs of all students (Feyerer, 2002). ICT can facilitate this challenging task, and AT has the enormous potential to improve access to education and employment for disabled individuals. AT also has the potential to ensure

that computing is as *effective* and as *comfortable* as possible for all learners.

AT devices include: books on tape for a student who cannot read; word processors, laptop computers for a student who has a problem with writing; augmentative communication devices for a student who has communication problems; and a large monitor for a visually impaired student. A vast array of application program software is available for instructing students through tutorial, drill-and-practice, and simulation; AT can be combined with instructional programs to develop and improve cognitive, reading, and problem-solving skills (Behrmann & Jerome, 2002).

Students with disabilities often need adaptations made for them so that they can be successful in school. AT can give learners the help that they need by providing “low” technology strategies (switches, writing devices, or software applications), and “high” technology strategies (those that use sophisticated devices or software applications for students with mild and severe disabilities that enable them to access information) so that they can perform tasks that they would otherwise be unable to do (Lewis, 1998). Inclusive teachers should be able to reach the special educational needs of all learners, and AT should be part of inclusive teacher training (Feyerer, 2002).

Current Applications and AT Resources

AT is divided into two categories: (1) any item, piece of equipment or product system, whether acquired commercially-off-the-shelf, modified or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities; and (2) any service that directly assists a university’s teacher education programs to provide future teachers with knowledge of AT and its importance in helping students learn (White, Wepner, & Wetzel, 2003).

The typical AT products or devices for individuals with learning needs are outlined in Table 1. Table 2 describes valuable AT Web sites for students with disabilities.

Challenging Questions, Universal Design, and AT Research

The primary goal of AT is the enhancement of capabilities and the removal of barriers to performance. Five Guiding Principles for Assistive Technology (2004) planning are quite useful: (1) AT can be a barrier; (2) AT may be applicable to all disability groups and in all phases of education and rehabilitation; (3) AT is related to function, not disability; (4) assessment and intervention involve a continuous, dynamic process of systematic problem solving; and (5) AT does not eliminate the need for social and academic skills instruction.

Challenging Questions

Teachers face challenging questions: Are there simple tools that might be incorporated with the student that would provide enough support so that referral to special education would not be necessary? And would these provisions allow the student to remain in the regular education classroom? That is why the perceived usefulness of AT by teachers and their perceptions of ability positively affect students, and their understanding of inclusion, in serving students in inclusive settings; thus various in-service AT training sessions are extremely important.

Technology should be used by individual students who are entitled to special education services if it is needed to access the general education curriculum; recently, there has been a strong commitment on the part of audiologists and educators to improve the acoustic environment for all students through the development of national standards that can be used in the construction and remodeling of schools (Marttila, 2004). Any tech-

Table 1. AT products or devices for individuals with learning needs

Alternative keyboard	It is different from standard keyboards in size, shape, layout, or function. It offers individuals with special needs greater efficiency, control, and comfort.
Captioning	A text transcript of the audio portion of multimedia products, such as video and television, which is synchronized to the visual events taking place on screen.
Digitized speech	Human speech that is recorded onto an integrated circuit chip and which has the ability to be played back.
Electronic pointing devices	It allows the user to control the cursor on the screen using ultrasound, an infrared beam, eye movements, nerve signals, or brains waves.
Joysticks	It may be used as an alternate input device. Joysticks that can be plugged into the computer's mouse port can control the cursor on the screen.
Keyboard additions	A variety of accessories have been designed to make keyboards more accessible.
Onscreen keyboard	These keyboards are software images of a standard or modified keyboard placed on the computer screen by software.
Optical character recognition (OCR)	OCR software works with a scanner to convert images from a printed page into a standard computer file.
Pointing and typing aids	A pointing or typing aid is typically a wand or stick used to strike keys on the keyboard.
Screen reader	A screen reader is a software program that uses synthesized speech to "speak" graphics and text out loud.
Switches and switch software	Switches offer ways to provide input to a computer when a more direct access method, such as a standard keyboard or mouse, is not possible.
Talking word processors (TWP)	TWPs are writing software programs that provide speech feedback as the student writes, echoing each letter as it is typed and each word as the spacebar is pressed.
Touch screens	This is a device placed on the computer monitor (or built into it) that allows direct selection or activation of the computer by a touch of the screen.
A telecommunication device for the deaf (TDD)	TDD is a device with a keyboard that sends and receives typed messages over a telephone line.
Voice recognition	Voice recognition allows the user to speak to the computer instead of using a keyboard or mouse to input data or control computer functions.
Voice synthesizer	Under control of the screen-reader software, voice-synthesizers can vary the rate, pitch, volume, and language of the information.
Word prediction programs	They enable the user to select a desired word from an on-screen list located in the prediction window.

Source: The Family Center on Assistive Services and Technology (n.d.)

nology that is necessary to aid a student in meeting IEP goals and objectives qualifies as an AT, and students who are entitled to special educational services access AT through the IEP process. The purpose of the IEP is to design an individualized education program to ensure that students with disabilities have adequate educational planning to accommodate their unique instructional needs and that these needs are met in appropriate learning environments; IDEA requires that each student's IEP be reviewed at least annually by IEP team members including parents (Copenhaver, 2004).

Universal Design

The Americans with Disabilities Act (ADA) of 1990 requires that AT be provided as an accommodation to students with disabilities, and one way to ensure equal access to all students is to utilize a universal design model (Campbell, 2004). Universal design principles and guidelines for AT, which are defined by the World Wide Web Consortium (W3C) that make it possible for people with disabilities to use electronic resources easily make those resources more accessible to a wide

Table 2. AT Web sites for students with disabilities

Alliance for Technology Access (ATA) (http://www.ataaccess.org/)	This is a national network of 41 technology resource centers which help children/adults with disabilities, parents, teachers, and others to explore computer systems, adaptive devices, and software.
Assistive Technology for People with Mental Retardation (http://thearc.org/faqs/assistqa.html)	This fact sheet describes devices that are used by children/adults with mental retardation and other disabilities to compensate for functional limitations and to enhance learning, independence, mobility, communication, environmental control, and choice.
Center for Electronic Studying (http://ces.uoregon.edu/)	Funded by the U.S. Department of Education, the Center has launched three projects blending portable computer technology with instruction on computer-based study strategies.
Closing The Gap (http://www.closingthegap.com/)	This is an organization that focuses on computer technology for people with special needs through its bi-monthly newspaper, annual international conference, and extensive Web site.
Disability & Technology: A Resource Collection (http://home.nas.net/~galambos/tech.htm)	Most sites will refer to assistive/adaptive devices that are computer-based and/or related to computer access.
DREAMMS for Kids, Inc. (http://www.dreamms.org/)	DREAMMS (Developmental Research for the Effective Advancement of Memory and Motor Skills) is a non-profit parent and professional service agency, which specializes in AT-related research, development, and information dissemination.
EASI – Equal Access to Software and Information – K12 Connection (http://www.rit.edu/~easi/)	The philosophy behind this Information Technology Centre is to ensure that students and professionals with disabilities must have the same access to information and resources as everyone else.
Early Connections – Technology In Early Childhood Education (http://www.netc.org/earlyconnections/)	Connecting technology with the way young children learn: resources and information for educators and care providers.
LD Resources (http://www.ldresources.com/)	This site contains resources for people with learning disabilities, with a focus on the use of AT to help individuals with learning disabilities become successful.
Literacy Instruction Through Technology (LITT) (http://edweb.sdsu.edu/SPED/ProjectLitt/LITT)	This is a research project focusing on the use of technology to improve the reading skills of students with learning disabilities. Project LITT is located at San Diego State University.
Speaking to Write (http://www.edc.org/spk2wrt/)	This is a federally-funded project which explores the use of speech recognition technology by secondary students with disabilities.
Tools for Understanding (http://www.ups.edu/community/tofu/)	This site is for educators who teach mathematics and are interested in integrating common technologies into their daily instruction.

Source: TheFamily Village School (2006)

variety of devices, such as handhelds (Goddard, 2004). Universal instructional design is “the design of instructional materials and activities that make the learning goals achievable by individuals with wide differences in their abilities to see, hear, speak, move, read, write, understand English, attend, organize, engage, and remember (Burgstahler, cited in Campbell, 2004, p. 167). Colleges should not restrict the use of AT to those students being serviced by disability service providers (Campbell, 2004): “Often there are individuals who benefit from AT that do not have disabilities or have disabilities and have not registered with

service providers. Universal design makes room for users of all abilities” (p. 172).

AT Research

Hetzroni and Shrieber (2004) investigated the use of a word processor for enhancing the academic outcomes of students with writing disabilities in high school. Their research indicated the clear difference between handwritten and computer phases. In paper-and-pencil phases, students produced more spelling mistakes, more reading errors, and lower quality of organization and

structure in comparison with the phases in which a computer equipped with a word processor was used (the word processor could be considered a writing tool for those students who have writing difficulties where compensation for disabilities becomes more appropriate).

According to Sharpe, Johnson, Izzo, and Murray's (2005) research, students with disabilities ($N = 139$) identified the following AT products or devices that they were generally satisfied with: scanner (35%), talking books (20%), portable note taking (17%), text help software (15%), optical character recognition (14%), specialized tape recorders (12%), voice recognition (12%), mouse/switch options (10%), adapted workstation (10%), word prediction software (9%), talking dictionary (8%), screen readers (6%), adapted keyboard (6%), screen magnification-software (5%), real-time captioning (5%), screen magnification-devices (4%), pointer (4%), talking calculators (3%), Braille note takers (3%), assistive listening devices (3%), speaker phones (3%), video captioning (3%), hearing aides (1%), and augmentative communication (1%).

FUTURE TRENDS

Currently, AT is used primarily as an equalizer—a compensatory tool—and on occasion applied *universally*. As institutions of higher learning become more willing to develop a universal design approach to educating, the need to provide separate accommodations for those individuals with disabilities will diminish (Campbell, 2004). One of the principles with respect to AT that can be applied universally, it is important to develop a *technology curriculum* that is based on universal design principles (to improve skill areas, such as reading, writing, organization, note-taking, and using the Internet particularly); doing so definitely sets the educational foundation for all learners within the classroom environment (Copenhaver, 2004).

Colleges and universities could develop an interdepartmental curricula and students from each target audience could attend and learn how interdependent they are in serving the AT needs of students and adults, and, according to Osborn (2006), this would insure that participating students: (1) gain an awareness of AT services and devices, (2) understand the principles of universal design, and (3) know about federal and state laws that impact rights to AT devices and services. In the near future, knowledge of AT may become a requirement for licensing.

Telematic multi-disciplinary AT is essentially ICT or e-learning (video conferencing and the Internet, for example) and offers to many the solution to common obstacles associated with attending educational courses, such as classroom and lecture availability, and lack of adequate transportation. Traditional higher education will increasingly adopt greater components of e-learning. As Turner-Smith and Devlin (2005) maintain, e-learning has enormous potential for use as a component of AT education; AT will be increasingly recognized as an umbrella term for any device or system that allows individuals to perform a task they would otherwise be unable to do, and that increases the ease and safety with which the task can be performed.

CONCLUSION

Currently there are over 20,000 items classified as "AT devices," for all disabilities, all ages, and all levels of functioning; AT can help individuals *talk, write, move, see, read, and hear* for themselves (Center for Innovations in Special Education, 2002). The devices range from low-tech supports (large pencils for writing, and calculators for building math skills) to high-tech supports (specialized software, and voice-output communication devices). Since each student's technology needs are unique, the support necessary for implementing technology requires a variety of

types of AT awareness training for teachers and other educational professionals. Such awareness training could be provided as a staff in-service training under the institution's comprehensive system of personal development plan under IDEA (Copenhaver, 2004).

In the final analysis, a major challenge is to move decisions about technology applications to the point where they reflect a state of the science; such technology applications must be studied continuously in objective ways so that educators can make informed decisions about their AT selection to best meet the needs of individuals with learning disabilities (Blackhurst, 2005).

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KEY TERMS AND DEFINITIONS

Adaptive Technology: The use of hardware and software to assist individuals who have difficulty accessing information systems using conventional methods. It often refers to assistive technology.

Early Intervention Services: A program of activities and services, including assistive technology, required by the Individuals with Disabilities Education Act for children from birth through age two.

Learning Disabilities: Conditions that cause people to understand and process information more slowly than average. These individuals may require information to be presented in multiple formats before they completely understand it.

Multisensory Learning: An instructional approach that combines auditory, visual, and tactile elements into a learning task. Tracing sandpaper numbers while saying a number fact aloud would be a multisensory learning activity.

Prereferral Process: A procedure in which special and regular education teachers develop trial strategies to help a student showing difficulty in learning remain in the regular classroom.

Special Education: Specially-designed instruction to meet the unique needs of a student with disabilities including but not limited to instruction conducted in the classroom.

Universal Design: Designing programs, services, tools, and facilities so that they are usable, without additional modification, by the widest range of users possible, taking into account a variety of abilities and disabilities.

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Chapter 5.5

Cognitive–Adaptive Instructional Systems for Special Needs Learners

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ABSTRACT

This chapter provides a perspective on the problems, challenges, and unique opportunities faced by instructors and designers of information technology in helping students who are differently-abled learn more effectively in online environments. The proposed solution is provided in the form of a cognitive-adaptive instructional system. This system provides menu-driven adaptive options or online assessments that evaluate a student's cognitive and sensory needs. These needs are translated into cognitive-sensory profiles, which are linked to compensatory and remedial actions. These actions render content automatically and dynamically in ways that provide adaptations that compensate for a student's special-needs while complementing their strengths.

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CHAPTER OBJECTIVES

This chapter should help the reader:

- Better understand the nature and extent of the problems faced by special needs learners
- Better understand the interrelationships between cognitive and sensory impairments and their potential impact on participation in online learning communities
- Understand the importance of integrating adaptive instructional capabilities into online instructional models
- Understand the key technical concepts underlying the cognitive-adaptive instructional system and identify potential applications

INTRODUCTION

Recent decades have seen significant advances in the design and implementation of hardware and software for delivering online and computer-assisted instruction. Educational applications of information technology are increasingly integrated into a diverse array of devices, from personal digital assistants and cell phones, to laptop and desktop computers. They are deployed in a dizzying variety of forms, ranging from broadband distance learning to CD-based instruction and digital textbooks. Information technology is increasingly the primary instructional vehicle for a number of application areas including basic skills training in companies, educational telemedicine, military training, and, of course, the delivery of K-12 and college curricula.

At the same time that this technological infrastructure is developing, our understanding of the pedagogy of online and computer-assisted instruction is rapidly increasing. As a result, more and more individuals participate successfully in innovative learning environments that are partially or wholly computer-based and increasingly delivered online. As we learn more about how students learn online, we can develop increasingly sophisticated and effective instructional models to inform and guide more effective instructional information system design. One population at risk in this new digital learning environment is students who have inherited or acquired cognitive and sensory impairments. These impairments may interfere with a student's ability to access and learn subject matter in both traditional and in digital information rich environments. These special needs students will challenge our ability to translate educational and cognitive remediation theory into practice and into the design of more intelligent online educational technology systems.

Therefore, the goal of this chapter is to provide a context and rationale for the need to develop and use adaptive instructional systems in order to help students, especially those with learning

disabilities (LDs) or deficiencies in basic skills or academic achievement, to learn more effectively. In order to achieve the goal of providing effective online instruction to diverse user populations, a cognitive-adaptive instructional system that uses adaptive hypermedia is proposed. The ways in which this system can be used to accommodate a diverse range of cognitive and sensory impairments and skill deficiencies will be described. In explaining how this system can be implemented, new Web-based information technologies will be discussed. In addition, examples of online applications of adaptive models will be provided in order to demonstrate that such a practice-based system can help meet the learning needs of special students.

BACKGROUND

Special needs individuals at risk in digital learning environments are of all ages and at all developmental stages. They become cognitively "differently-abled" due to the effects of aging, accidents (e.g., traumatic brain injury), disease, or specific developmental or inherited neurological conditions. Many of these individuals are often left behind in traditional classroom environments. The failure to provide for their information processing and learning needs in online and other digital environments will only widen an educational and social participation gap that already threatens their full inclusion in 21st century life. If we do not address the problems and special needs of such differently-abled users, we will help promote the development of a generation of digitally disenfranchised individuals who are not able to participate equitably in technology-mediated educational, cultural, social, and economic communities. The effectiveness with which issues relating to the accessibility and utility of digital environments by the differently-abled are addressed will critically impact the role that information technology will play for these populations now and in the future.

Instructional models and information architectures for learners with special needs must provide mechanisms that dynamically adapt the information delivery interface as well as the organization and presentation of instructional content to the learner's unique cognitive-sensory impairment profile. Such "cognitive-adaptive" instructional information systems have the potential to optimize information delivery for such users and maximize the efficacy of instruction to the greatest extent possible. A significant issue in online instructional modeling for special needs populations will be creating adaptive online instructional systems that integrate clinical and educational evaluations of a learner's cognitive and sensory impairments with instructional heuristics. These heuristics will then drive specific adaptive and "compensatory" information system behaviors at the human computer-interface.

Learning Disabilities in Context

Cognitive-adaptive instructional systems must be understood against the background of an increasing use of digital resources for educational purposes and an increasing population of special needs learners with low academic achievement, basic skill deficiencies, and learning disabilities associated to cognitive impairment. The impact of digital information delivered via the Internet to all students is dramatic. Ninety seven percent of 12- to 18-year-olds use the Internet, with 61% reporting the Internet "very" or "extremely" important as an information source compared with 60% for books and 58% for newspapers (UCLA, 2002). Moreover, "having access to the Internet and its rich resources...is having a positive impact on student achievement" (eSchool News, 2003).

However, the number of students diagnosed or classified with specific learning disabilities has also increased by 34% since 1990-91 (OSEP, 2001). Learning disabilities can occur in one or more areas of language development, reading, memory, mathematics, reasoning, and problem

solving. Impairments contribute to lower levels of school achievement than would be expected based on intelligence. The prevalence of LDs in the United States is estimated to be up to 6% of the school children aged 6-18 (Lewitt & Baker, 1996), translating into approximately six million children. Given that 11 million children and adults have learning disabilities, it is one of our most prevalent developmental disabilities (Reiff & Gerber, 1994). Overall, learning disabilities cost the nation an estimated \$50 billion in the 1999-2000 school year alone (Chambers, Parrish, & Harr, 2000). Fifty one percent of students receiving special education services in public schools have learning disabilities (OSEP, 2001), and almost one in three college freshmen with disabilities report a learning disability (Henderson, 1995). The National Institute of Child Health and Human Development (NICHD) longitudinal studies indicate that of children who are reading-disabled in the third grade, 74% remain reading disabled at the end of high school. In other words, learning disabilities can impact performance in and out of the classroom throughout a person's lifetime.

Educational models for dealing with special-needs students are sometimes driven by instructional, diagnostic, and assessment techniques that emphasize deficits rather than the creative abilities and resources special needs learners already possess. Talents and abilities are simply not recognized. The interventional efficacy of deficit-oriented techniques is low (Coles, 1987; Poplin, 1988a, 1988b). As early as 1983, Gardner widened our view of intelligence to include the idea of "multiple intelligences" (e.g., linguistic, logico-mathematical, musical-rhythmic, visual-spatial, bodily-kinesthetic, interpersonal, and intra-personal). Among students with learning disabilities, four areas of multiple intelligence strength have emerged: conceptual writing, divergent thinking, computer aptitude, and musical ability. In divergent thinking skills, LD students are at least as able as students with no learning disabilities (NLD), as measured by the test

of divergent thinking and the test of divergent feeling. In some cases, LD students have scored higher than their NLD counterparts on measures of figural and verbal creativity, such as the Torrance test of creativity and the alternative uses test (Tarver, Ellsworth, & Rounds, 1980). Stone, Poplin, Johnson, and Simpson (1992), reported no difference between elementary school LD and NLD students with LD students actually scoring higher than NLD students on many of these measures.

These areas of multiple intelligence strength, especially computer aptitude, create a promising foundation for educational intervention models for special needs learners using computer-assisted and online technology. On tests of computer aptitude that do not require complex linguistic skills, such as the computer aptitude, literacy, and interest profile (Poplin, Drew, & Gable, 1984), Hearne, Poplin, Schoneman, and O'Shaughnessy (1988) reported that students with LD had computer "aptitudes" equivalent to those of their non-disabled counterparts with no gender differences noted. This is relevant to cognitive-adaptive systems, as it suggests that having learning disabilities due to cognitive-sensory impairments will not necessarily preclude a student from using and benefiting from instructional systems. However, as computer systems are increasingly used in online learning environments, more complex cognitive operations and skills will be needed in order to effectively use these learning tools.

Cognitive Impairments, Learning Styles, and Instructional Technology

The development of adaptive instructional systems can be especially challenging in certain populations (i.e., older people) because they are less likely to have computer experience (Czaja & Sharit, 1998) and may lack the knowledge and skills required for interacting with computer search engines (Morrell, Mayhorn, & Bennett, 2000). Acquired neurological injuries, developmental

conditions, or declines in memory and reasoning skills due to aging can all adversely impact online information-seeking (Park, 1999) and digital library searching (Rousseau, Jamieson, Rogers, et al., 1998), resulting in less efficient search strategies (Mead, Spaulding, Sit, et al., 1997). Czaja, Sharit, Ownby, Roth, and Nair (2001) reported relationships between search and retrieval performance in older participants and cognitive abilities (e.g., processing speed, memory, and verbal speed). Westerman, Davies, and Glendon (1995) reported that older participants were slower than their younger counterparts in retrieving information (perhaps attributable to difficulty in recalling previous links and page information). Moreover, participants with low spatial ability also took longer in retrieving information. These challenges are not restricted to the elderly. Younger people (e.g., college students) with a variety of learning disabilities can exhibit similar impairments in information processing, working memory, and attention (Henderson, 1995). Glisky and Schachter (1988) demonstrated that by using self-paced and vanishing cue techniques even individuals with profound memory impairments could learn how to use computer-based systems (although they might not remember the specific learning episode afterwards).

The areas of memory, attention, executive function, information processing, and higher-order thinking skills are emphasized in the cognitive-adaptive approach because these cognitive domains involve skills that mediate student success in school-related tasks that require information manipulation and processing. In other words, these skills are used in reading and textbook comprehension, attending to class lectures, writing and thinking effectively, and using instructional and information technology tools. Thus, effective approaches for modeling user behavior in impaired individuals should involve educational and clinical assessments of these cognitive domains and result in compensatory actions whose effectiveness can

be demonstrated empirically to have an effect on the performance of learning behaviors.

Helping Special Needs Students Learn: Meeting the Challenge

The challenge is that the cognitive impairments that impede students' academic progress in the classroom can also impede their ability to effectively use more complex information technology tools and resources. However, as previously stated, we can build on some of the demonstrated strengths in computer use exhibited by special learners, but we must also be cognizant of the challenges. For example, school-aged children with mild to moderate learning disabilities exhibit impairments in working memory compared to children of average ability. Impairment is more severe with increases in task and content complexity (Bayliss, Jarrold, Baddeley, & Leigh, 2005). The generalized working memory deficit in LD students has been attributed to storage constraints in the executive system (Swanson, 1993). Inefficient decoding and word recognition skills during the reading process can also reduce attention and memory resources, with comprehension impeded by poor verbal recall (Stothard, 1994). Problems in speed of processing, processing verbal and visual-spatial material, organizing information, and multi-tasking can have a devastating impact on functioning both in and out of the classroom, but especially in the use of complex information displays and user interfaces.

TOWARDS THE SOLUTION

If special needs learners are going to be able to use information systems in educational contexts, including digital libraries, learning object repositories, and widespread educational technology delivery systems such as Blackboard, WebCT and Vista, we must develop systems that are adaptive enough to respond to specific learning disabilities.

Educational materials and information delivery systems are generally not designed to meet these special needs. If an instructional application for learners with cognitive impairments and sensory impairments is properly designed, it should be able to quickly and effectively provide personalized information display and educational content packaging. This information would be reflective of the learner's cognitive strengths as well as their impairment profile so that the learning environment can fully or partially compensate for deficiencies in cognition through dynamic system adaptation of content and display. The following sections provide a more technological discussion of current information technologies that will be used to design and build a more flexible and adaptive instructional system.

Accessibility and Adaptive Systems: Current Technologies

The impetus underlying the development of cognitive-adaptive instructional systems is that implementation of compensatory information delivery techniques will enhance educational outcomes for learning-disabled users. Recent developments in the core Web protocols and data formats including the extensible markup language (XML), cascading stylesheets (CSS), extensible stylesheet language (XSL), scalable vector graphics (SVG), and the synchronized multimedia integration language (SMIL) have provided a technological infrastructure capable of supporting innovative new information delivery systems for learning disabled populations with cognitive impairment.

Many of these protocols (XML, SVG, SMIL) are "markup languages." A markup language is a way of using simple text-embedded codes to describe the structure and semantics of documents. XML, for instance, provides a generic mechanism for describing the content of almost any kind of document, while SVG is oriented toward describing, creating, and controlling the appearance of

online graphics. SMIL allows for the integration of multimedia properties with XML and SVG documents. Documents containing markup codes can also be attached to “stylesheet languages” (CSS, XSL) that provide instructions that tell computers how to handle and display the contents of a marked-up document. A basic objective of markup languages is the separation of content from display. A document’s content may be described just one time using XML, but then presented in multiple different presentation formats simply by assigning new stylesheets to it. In addition to greater flexibility in the presentation and display of documents, a new level of interactivity and dynamism can be added to digital documents through the use of the “document object model”(DOM). The DOM is an Internet browser technology that allows for the attachment of server and client-side scripts (small programs) to documents. For example, the DOM allows an instructional designer to assign a script creating a popup message to a section of a document. The message would appear whenever a mouse is moved or clicked over the section. The combination of scripts and DOM can dynamically access and update the content and structure of HTML (hypertext markup language) and XHTML (extensible hypertext markup language) and XML documents. The new World Wide Web Consortium (W3C) XML-Events specification makes the online document interface even more dynamic, providing for the association of specific DOM document behaviors with XML-based markup languages and content, thereby separating document content from scripting.

These technologies for separating content from on-screen behavior, presentation, and display can be used to specify how to render underlying content markup for multiple information appliances and multiple user groups “on the fly.” The modality specifications (which information appliance) and presentation specifications (organization and appearance) for the document are provided at the moment the document is invoked. The document perceived by the user at the human-computer

interface is “rendered” dynamically in real time. This on the fly capability is particularly critical in the development of adaptive online systems since it allows for the dynamic tailoring of Web content to individual needs.

Many of the new protocols also include so-called accessibility features. For instance, the newest CSS specification includes several accessibility features such as dynamically generated content, aural stylesheets, and access to alternative representations of content that could be used to great effect with differently-abled populations. One interesting example of how current online technology helps address users with special needs is the W3C recommendation XHTML+Voice Profile that combines the VoiceXML markup language with XHTML and XML-Events to allow voice output from Web pages and voice reaction to page events. If these technologies are used in combination with cognitive adaptive models, they offer the instructor the capability to alter content, presentation, and pedagogy in flexible ways that respond to individual student needs, strengths and weaknesses. Taken together, it seems clear that the foundation for more accessible and adaptive systems has been established.

A Global Perspective

In fact, there are a number of initiatives that have tried to address the issues of online information accessibility for those with cognitive and sensory impairments. For instance, in addressing the needs of those with sensory impairments the CAPS (Communication and Access to Information for Persons with Special Needs) project of the European Union’s Directorate for Telecommunications, Information Industries and Innovation focused on visual (reading) impairment by providing broader access to digitally distributed documents, especially newspapers, books, and public information. The follow-up HARMONY (Horizontal Action for the Harmonization of Accessible Structured Documents) project tried to improve the quantity

and quality of documents accessible to the reading impaired by focusing on standardization issues, for example, population needs and compensatory actions that could or should be taken by information systems.

The Federal Government of the United States is also increasingly committed to improving the accessibility of information technology and Web-based information (i.e., Section 508 guidelines from the Architectural and Transportation Barriers Compliance Board of the U.S. Federal Government). In addition, the World Wide Web Consortium has launched a large-scale Web Accessibility Initiative (WAI), and there have been numerous calls for information system and software design to subscribe to “universal design” principles—the notion that design methods can be developed and applied so as to make “products, communications, and the built environment” more usable by more people (Aslaksen, 1997). The W3C recognizes accessibility barriers for the deaf, the blind and those with physical disabilities, and argues that “people with cognitive or neurological disabilities may have difficulty interpreting Web pages that lack a consistent navigation structure or that lack visual signposts” (Chisholm, Vanderheiden, & Jacobs, 2001).

This is an implicit recognition that the next step in online document design and online instructional modeling is to deal with the more “invisible” cognitive impairments associated with learning disabilities. Over the last decade, the hypertext markup language-based World Wide Web has become the nation’s premiere educational resource. However, using simple HTML documents as educational tools poses serious accessibility problems, particularly if documents need to be displayed using alternate modalities (Flammia, 1997). The mere digitization of documents does not ensure their accessibility or utility. Solving accessibility problems can involve difficulties in any number of areas including extracting content from format (a necessary first step in alternative presentation) and exerting finer more dynamic

control over non-textual content (audio, video, images). New technologies, such as XML and XSL, provide more opportunity for overcoming these obstacles to accessible design than simple HTML can offer.

While the European initiatives have focused on visual processing impairments, they emphasized two important issues with broader implications for cognitive-adaptive design: (1) the increasing “digitization” of information previously delivered in document form (including Braille for the vision impaired) has created online accessibility problems, and (2) the need to develop standard protocols and formats for representing and displaying digitized information.

Developing and Implementing Cognitive-Adaptive Instructional Systems

The great potential of cognitive-adaptive systems derives from the integration of advances in applied cognitive and clinical neuroscience with recent developments in online information technology. What design considerations need to be addressed in order to combine these two areas of research to benefit special need populations?

We argue that information can be made more accessible if several conditions are satisfied in the information delivery system: (1) educational content is separated from presentation and display information and stored as “user neutral” learning objects in an object library, (2) there are methods for acquiring and protocols for representing relevant cognitive impairment data in XML-based cognitive user profiles, (3) there are standard protocols for attaching cognitive user profiles to sets of adaptive and compensatory actions that systems should make when rendering educational content at the human-computer interface, and (4) appropriate online technologies exist for implementing the adaptive actions implied by the profiles.

Design Elements of a Cognitive-Adaptive Instructional System

The recent appearance of World Wide Web Consortium standard core protocols like XML and XSL makes a learning-adaptive Web increasingly possible by satisfying the previously mentioned fourth condition. It remains only to satisfy the first three conditions. The first design element of a cognitive-adaptive system involves the creation of learning objects via decomposition and metadata description. Learning objects have several unique characteristics: (1) they are atomic and self-contained, decomposed from objects of greater complexity, (2) they are reusable “in multiple contexts for multiple purposes,” (3) they can be recombined to create larger, more complex structures including lessons, courses and curricula, and (4) they are described with metadata about their educational function, physical characteristics, semantic content, and other relevant properties (Chitwood, 2005). Once created, learning objects are stored in an object library (OL) as a set of elementary resources capable of dynamic recombination with other objects under the influence of the rules of an instructional model.

Some objects may already be atomic, with little or no internal structure and may not be decomposable into smaller information units. In these cases, it is sufficient to describe the resource, for example, a particular image, with metadata and store in the object library. Many other existing instructional objects, on the other hand, are information containers, with both a complex semantic structure and a complex internal “document” organization. That is, they are structurally and semantically decomposable. An example of educational content that would have to be decomposed for use in a cognitive-adaptive system might be an online biology lesson whose organizational structure would consist of headings, paragraphs, figures, tables, and graphics, and whose content would have to be decomposed into special vocabulary or terminology, concepts, concept relations, proper

names, and a myriad of other semantic properties and relationships.

Even as the educational materials are stripped of formatting information to become as user and culture-neutral as possible for display purposes (Cannataro, Cuzzocrea, Mastroianni et al., 2002), they are enriched with both educational metadata and content description metadata. Educationally relevant metadata can be provided by an object schema such as the IEEE LTSC 1484.12 Learning Object Metadata (LOM) protocol. This metadata specification provides a rich set of descriptors for describing the core characteristics of the resource (identifier, title, author, description) as well as a wide range of other characteristics from rights management through educational uses, to technical information. The LOM specification also provides a rich annotation mechanism to allow users of the library to add commentary to the resource record as well as a relationship mechanism that allows any given LOM-described resource to be linked to other resources (Shreve & Zeng, 2003).

Content Description

Content description of the objects in an object library can be accomplished with metadata derived from existing or custom domain-specific semantic markup languages. The domain specific markup languages chosen to describe content elements in a cognitive-adaptive system would be dependent, once again, on the pragmatics of object library use, that is, what the library’s user communities expect to do with the resources and what functions they expect the resources to serve. The tag names, attributes, and document type descriptions or schema provided by a markup language directly reflect a domain-specific semantics and pragmatics. Markup languages are the single most important way that an explicit semantics can be applied directly to natural language and multimedia resources (Shreve & Zeng, 2003). Cognitive-adaptive systems will undoubtedly leverage many existing semantic (content) markup

languages, depending on the field of the educational materials to be delivered (for instance, MathML the mathematics markup language or GML (geography markup language). Markup languages to represent the user profiles and other elements of the cognitive-adaptive system will have to be borrowed or customized.

User Profiles: Determining Individual Learning Needs

Assuming an object library is successfully created, the next step in designing a cognitive-adaptive system would involve acquiring and storing user models or profiles. Current research in adaptive hypermedia systems (De Bra, 1999), user modeling (Brusilovsky, 1994; Fink, Kobsa, & Schreck, 1997; Hothi & Hall, 1998), and Web accessibility (Velasco & Mohamad, 2002) has provided useful guidance in designing systems to make instructional content more accessible to learning disabled students. This research emphasizes the importance of coupling user profiles with adaptive information system design. Current adaptive approaches typically modify navigation support and document content for individuals or target populations based on a user model most often developed empirically by observing patterns of use and browsing behavior (De Bra, Brusilovsky & Houben, 1999; Wu, de Kort, & De Bra, 2001). However, because this approach implicitly presumes that cognition is within normal limits, it cannot account for and differentiate user behaviors that are due to cognitive impairment, as opposed to simple preference or idiosyncratic work style.

We propose an approach based on specifying a set of empirically-derived “best practice” adaptations (a *prescription*, if you will), offered by cognitive and educational remediation experts after evaluating the results of educational and neuropsychological assessments. This prescription can (and should) be later refined with a customization wizard and modified with data gained from

the empirical observation of the actual behavior of cognitively impaired user-learners.

It is not uncommon for sensory impairments to be dealt with by information system actions based on user profiles. For instance, “visual profiles” for low-vision computer users meet the need to account for visual impairments of acuity, contrast sensitivity, color perception, and field of view when designing human-computer interfaces (Jacko, Rosa, Scott, et al., 2000). Although existing systems can use profiles to alter elements of the user interface including site navigation, organization, and content to support visually impaired users, more flexibility, and innovation is needed in order to remediate less visible cognitive impairments. Few if any studies have focused on building systems that integrate more complete and complex cognitive impairment user profiles with online information systems.

Successful cognitive-adaptive systems are dependent on robust user profiles to generate the parameters for determining the specific compensatory modifications to be made at the computer-human interface, for example, the architecture of the presentation or display, as well as to control the re-packaging of educational content delivered in digital documents. Cognitive user profiles could be based on combinations of online and in-person clinical and educational assessments of learners diagnosed with cognitive impairments and specific learning disabilities. The assessments, consisting of neurocognitive and educational screens, will measure, among other capacities, memory, executive function, and cognitive information processing. The assessments could also include measures of mood, anxiety, computer aptitude, and creative or divergent thinking.

Automated User Profile Development

A significant issue in the design of adaptive systems is determining exactly what remedial or compensatory actions to take for a given set of impairments and how to derive the actions and

their representations in a practical, automatic manner. Initial test systems will have to rely heavily on standard educational and clinical empirical research with prototypes in the hope of gathering data that can be used to establish principles that would enable systems to do online assessment, generate user profiles, and then automatically generate action models.

User profile acquisition could be accomplished by the development of a modeling wizard to acquire additional user cognitive/sensory impairment data from online dialogs and/or browser modeling and represent it in a machine-usable XML-based metadata format. The wizard could elicit educational and clinical profile information to supplement the data collected in off-line assessments. The wizard would also process the data in off-line assessments and convert it to XML data. The profiles generated by the wizard provide a basis for determining optimal adaptive information delivery and display. The wizard might also include some “exemplars” of differently presented or formatted online information to gauge user reactions and preferences. An important research objective will be to determine the optimal requirements and content for a cognitive profile wizard including the correct mixture of cognitive-sensory assessment and exemplar presentation.

The results of neurocognitive and educational assessments would be stored in an XML-based user profile, using, where possible, data elements derived from the clinical document architecture (CDA) (Health Level Seven, 2002). In cases where appropriate data elements do not exist, they would be developed as subsets or extensions to the CDA. In any case, an ongoing area of research in cognitive-adaptive systems will be working with the neurocognitive and educational assessment community to develop a markup language to represent the relevant data.

The representation and storage of user profiles are well discussed in the literature (Fink, Kobsa, & Schreck, 1996; Kules, 2000; Velasco & Mohamad, 2002) and a variety of approaches are offered. We

adopt the broad model described by Velasco and Mohamed, who suggest storing user profiles as XML schema, with the exception that we specify CDA conformance. The authors also suggest merging user information with device information in a single schema that follows, where possible, the guidelines for device profiles.¹

Action Models and Compensatory Action Heuristics

Once a user profile is generated from an assessment battery, it remains to specify the set of adaptive compensatory actions the system should take for specific configurations of impairment or skill deficiency. The pairing of neurocognitive assessments with information system action is a complex scenario referred to as a cognitive-adaptive “action model” and characterizes the relationship between cognitive impairment and remedial or compensatory system actions (Diamond, Shreve, & Johnston, 2001).

The heuristics of the cognitive-adaptive action model are represented as rules. In the database they are stored as XML statements that express the relationship between configurations of educational assessments and compensatory action in general production rule form: **IF***this-educational-result***THEN***this-adaptive-action*. The head of the rule is an XML-expressed cognitive impairment pattern and the tail is a set of actions also expressed in XML, including attachment to XML-Event behaviors, CSS, XSL and other stylesheet rendering technologies. The use of production rules for this purpose is an adaptation model as described by Cannataro and his colleagues (2002).

The action recommendations in the action models are linked to specific adaptive system actions via the adaptive control language (ACL), (i.e., the set of conventions that express the production rules). The heuristics underlying the action models are stored in cognitive adaptation (CA) and sensory adaptation (SA) databases that contain action instructions describing generic system

actions and adaptations addressing impairments in a variety of cognitive/sensory domains. These adaptations provide instructions for how learning objects are to be expressed, organized, configured, formatted, and manipulated for the benefit of a specific class of user impairments or disabilities. There are also instructions that inform the system how to react to particular events in the document/user interface.

The ACL connects the results of the cognitive profiles generated by the user profile wizard to the adaptive heuristics of the CA/SA databases and to the set of educational objects (resources) to be displayed. The heuristics are expressed by the ACL at the system level by XSL (eXtensible Stylesheet Language) transformations of XML-based object/action representations derived from the CA/SA databases as modified by the profile wizard. The ACL produces system responses such as reorganization of the user interface; changes in rate of presentation of visual materials; dynamic selection, presentation, and linking of content; alteration in the configuration and organization of “information units;” and so on.

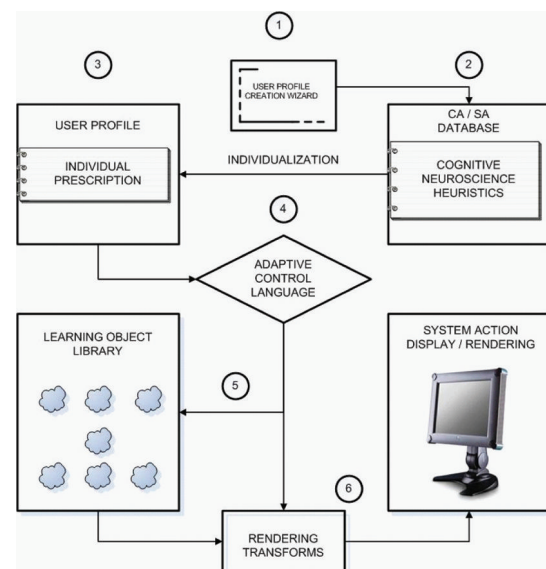
Taken together, the ACL specifies the relationship between cognitive, sensory or functional impairment and remedial or compensatory system actions (Diamond, Shreve, Bonilla, et al., 2003; Diamond et al., 2001). To the extent that users with similar impairments may require similar adaptations, it should be possible to group adaptive rules into categories reflective of clusters of recommended actions for particular user groups, creating what Brusilovsky has called user stereotypes (1996). To this point there has been little attempt in the user modeling community to address automated mechanisms for deriving adaptation models appropriate for complex cognitive and sensory impairment conditions. Other approaches that could be applied include deriving stereotypes (Rich, 1979) and inferring dynamic modeling rules from the data using acquisition heuristics as discussed by Ardissono and his colleagues (Ardissono, Console, & Torre, 1999).

Compensatory Actions, Cognition, and Educational Applications

Individuals with short-term memory impairments, for instance, could be expected to experience difficulty in memory of previously-visited links or for the content of dropdown menus and their submenus. A CA-stored instruction for such cases would spell out the “performance implications” of this class of impairment and detail the general system steps that could be taken, such as alternative presentations for links or dropdown menu information.

In order to help improve learning and accessibility, the relationships between impairments and the ability to use an information system need to be delineated. Diamond et al. (2003) demonstrated that there are important relationships between the severity and nature of cognitive impairments and the ability to use information technology. The most important finding in their study was that while all participants learned how to use a telerehabilitation system (referred to as the VRC or Virtual Rehabilitation Center), the rate of learning or the number of “trials to acquisition”

Figure 1. Schematic of an adaptive system



varied among participants with traumatic brain injuries. Individuals who needed more trials to acquisition were more impaired in visuo-spatial construction, reasoning-similarities and language repetition. Interestingly, 50% of those individuals who required fewer trials to acquisition and 75% of those who required more trials to acquisition exhibited impairments in memory. Thus, memory impairments were pervasive, but memory alone did not account for all of the differences in learning and accessibility.

The relationship between identified areas of cognitive impairment and performance on the VRC may be due to the implicitly normative information architecture of the VRC and other internet and computer-based systems that require impaired users with deficits in working memory and executive function (e.g., reasoning and organization) to process and store visual and auditory information (i.e., text, graphics, embedded or streaming audio and video) using displays that are ill-suited to them. Overall, the authors found that impairment in cognitive domains reflecting visual-spatial integration, memory, language processing, and executive-type functions inhibited learning efficiency and accessibility. The work underscored the need to link system design intended for differently-abled populations to individualized adaptations and compensatory actions.

Recent research has supported the contention that adaptations informed by clinical and educational assessments can be effective in improving task performance. Diamond, DeLuca et al. (2000) showed that using special software individualized processing speeds could be computed and used to help older adults achieve levels of performance accuracy that did not significantly differ from that of younger adults. These results demonstrated that a cognitive neuroscience-derived software tool could be used to help suggest efficacious compensatory actions that enhanced the ability of seniors with moderate cognitive and sensory impairments due to age, to process information more efficiently. Similar optimal processing

speeds could be integrated into computer-based learning systems so that information could be presented to student users in ways that enhance their processing and performance accuracy.

The REY-organizational and extended memory (R-OEM) protocol (Diamond, DeLuca, & Kelley, 1997) used an “executive prosthetic” (i.e., a cognitive assistive technique) that helped individuals with learning and executive impairments learn and recall complex visual information. This assistive technique helped enhance performance. It did so, by first guiding the decomposition of text, images, and graphics into simpler, more atomic elements, and then providing organizational structures or schemas for re-organizing the graphic and textual information in new ways that more effectively tap explicit and implicit memory. Generally, the decomposition of complex objects or behaviors, with the subsequent reintegration and synthesis of the parts into a whole, increases instructional effectiveness in treatment subjects and predicts the magnitude of treatment outcomes for higher-order cognitive functions (Swanson, 1999). In clinical tests, the R-OEM generated alternative displays of information that allowed amnesiacs to retain information over a 30-minute delay, a performance comparable to that of non-amnesiacs (Diamond et al., 1997).

In a cognitive-adaptive information system, analogues of R-OEM-based techniques could be used to implement a stylesheet-based “executive function” facilitator that displays complex text and images dynamically by building them up from simpler graphic and textual elements. These decomposed learning objects, stored as XML data, could then be rendered by an XSL stylesheet to produce a synchronized multimedia integration language (SMIL) document where relative positioning, and attributes and tags such as *begin* and *<sequence>*, as well as SMIL events (begin event, end event) could be manipulated to dynamically construct more complex presentations according to the results of the protocol. SMIL presentations, essentially dynamically constructed multimedia

presentations, could dynamically present information in the manner prescribed by an R-OEM-type informed representation schema.

Another example of adaptive, computer-based techniques derived from cognitive and clinical neuroscience work are the auditory threshold serial addition test (ATSAT), visual threshold serial addition test (VTSAT) and the dual task (DT) protocol (Diamond et. al., 1997; Diamond, DeLuca, et al., 2000). These protocols quantify processing speed while controlling accuracy and they have been implemented with clinical populations (stroke, traumatic brain injury, chronic fatigue syndrome, and multiple sclerosis). These programs measure speed and accuracy and determine the optimum speeds at which both visual and auditory information can be presented while maintaining a given level of performance accuracy. Dual task software is used to measure a subject's ability to process simultaneous streams of information presented in both the visual and auditory modes. Taken together, these programs assesses the impact of the single and dual processing of information streams on working memory, sustained attention, accuracy of performing arithmetic operations, and on reaction time. These techniques could be used to enhance a user's processing speed and accuracy by incrementally altering the computed optimum speeds and stimulus parameters of, for instance, the presentation of text online or the speed at which voice or video information is displayed. In other words, information could be both visually and aurally presented at individualized and optimized speeds of presentation, thus enhancing processing efficiency. The dynamic adaptation of a display, including speed/duration of text, graphic, or auditory information display could be controlled by using XSL stylesheets to generate multimedia SMIL documents and then controlling the value of the SMIL *duration* attribute for individual page elements to control how long they appear on the screen.

Adaptive action models based on semantic activation techniques also arise out of research

in the fields of neuropsychology and behavioral neurology (i.e., prosopagnosia and visual agnosia, or the inability to recognize familiar faces and objects, respectively). Diamond and his colleagues describe another adaptive approach using the semantic activation protocol (SAP) protocol, where faces or objects drawn from similar semantic categories helped enhance and activate aware memory in a prosopagnosic patient (Diamond, Valentine, Mayes, & Sandel, 1994). In this research, it was shown that clustering faces/objects according to semantic categories induced a sense of familiarity and recognition. Similar types of semantic activation techniques could be used in educational systems to optimize learning and memory.

For example, a cognitive-adaptive information system could enhance memory for images and objects by visually clustering or navigationally linking information stored in XML-based semantic network representations or content schema. Using XSL stylesheet-generated SMIL documents, items could be dynamically clustered in visual regions of a presentation using the SMIL <layout>, <root-layout> and <region> tags. Similarly, semantic categories (semantic information would have to be stored in the content schema) could be used to organize links between dynamically created displays to capitalize on semantic similarity.

Perceptual priming protocols can also play a role in cognitive-adaptive systems. These protocols are based on the observation that information (words or images) that have been previously experienced can exert an effect on subsequent behavior or physiology (Diamond et al., 1994). Thus, while the specific learning episode may not be remembered, information can still be encoded and subsequently alter performance (i.e., perceptual fluency) (Johnston, Dark, & Jacoby, 1985). Improvement in performance as a result of prior exposure can be measured by reaction time protocols that indicate changes in saliency of learning (i.e., faster reaction time with learning) or faster relearning of material. In a cognitive-

adaptive system, a priming reaction time (PRT) protocol could be used to measure the saliency of implicit and explicit learning as well as the speed of making perceptual-semantic decisions by determining if RT decreases or information processing speed increases following instruction. The results could be used to create XSL-generated “priming pages” for important content elements, which over repeated presentation and display could assist special needs learners in representing and storing information.

There are also modality-based processing differences between individuals that have an important bearing on the design of adaptive systems for the cognitively impaired learner. Some individuals display faster visual versus auditory processing speed and some display reverse patterns (Diamond et al., 2000). A cognitive-adaptive system could provide modality-specific options. Similar content could be presented as text, as image, or as speech using the relevant multimedia SMIL tags and attributes. For instance, using the SMIL <parallel> tag, parallel text and voice streams could be simultaneously presented in a document and selection between modalities could be offered to the user.

An Online Educational Scenario

Clearly, a variety of tools and technologies are currently available for use in online instructional communities. These technologies, implemented in a cognitive-adaptive instructional system, can significantly enhance the responsiveness and adaptability of online learning environments to special needs students. Systems could allow instructors to provide dynamic control over most aspects of an online display, including: (a) speed and duration of information unit presentation; (b) organizational structure or layout of the page; (c) placement and clustering of visual or typographic elements; (d) sequence of presentation of visual elements; (e) adaptive navigation and linking to other content/displays; (f) graphic or typographic features: size,

color, font, and so on; (g) modality: text, image, voice, and (h) dynamic selection of page elements from underlying content. The system could also alter the rate at which information is presented; select memory and executive prosthetics; and alter the manner in which content and learning objects are to be expressed, organized, configured, formatted, and manipulated. The following is an example of an online scenario:

A student who is taking an online course in biology has had a mild brain injury. The current topic is the concept of *action potential* (AP). This topic includes information involving a variety of constituent concepts described in text (e.g., ion movements, resting potential, electrophysiological and concentration gradients, threshold of excitation, depolarization, hyper-polarization, and channels/gates), numerical and statistical information (tables, calculations), and visual material (images, movies, animations). The events that constitute the AP process occur in a specified sequence, and the event is usually described in narrative and then illustrated schematically in the typical textbook or Webpage. This static and normative presentation might not be the optimal display for a brain-injured student.

However, if the AP lesson document is first decomposed and described using an XML-based markup language, it would be possible to gain control of the appearance and presentation of the material in the lesson down to the level of individual words, sentences, paragraphs, illustrations, text, images, tables, and animations. This enhanced level of control could be used to optimize the individual learning experience if then connected to individual user profile information. The user profile information would allow: (a) for system presentation adaptations that would dynamically organize the visual and textual material in the lesson in ways that would compensate for executive dysfunction (i.e., deconstructing information into simpler units); (b) compensate for visual-conceptual integration deficits (i.e., simpler arrangement and sequencing of information via

alternative schematics or custom animations); (c) alter the modality of textual presentation in order to compensate for reading disorders (i.e., use auditory-based text); (d) alter the rate of information presentation (visual and auditory) in order to compensate for slower processing (often observed in individuals with learning disabilities and brain injury) or ; (e) provide linkages to specially designed learning objects with built-in memory cues (i.e., clustering of semantically-related objects) to compensate for deficiencies in working memory. Overall, control over these elements would provide a range of compensatory and remedial actions to help improve the educational performance of students with special needs.

CONCLUSION

Adaptive information systems provide an opportunity to broaden the participation of certain classes of differently-abled populations in learning environments that depend heavily on information technology, such as Web-based and distance learning. The challenges in developing instructional models for online adaptive systems serving special needs learners with cognitive and sensory impairments are considerable. The instructional models must deal not only with the diverse learning problems such users confront in “traditional” classroom environments, but also with the new challenges presented by online instruction. Adaptive systems must integrate new online technologies in ways that provide unique opportunities to enhance individual instruction and learning through the use of highly personalized pedagogical models.

Adaptive online instructional systems achieve the goal of personalizing the content and delivery of information to the needs of individual learners by integrating educational and clinical evaluations of a user’s cognitive and sensory impairments with instructional heuristics. The combination of specialized heuristics and clinical assessment

data drives specific adaptive “compensatory” information system behaviors at the human computer-interface. Such adaptive interfaces act dynamically to modify information architecture and display in ways that address higher level cognitive processing deficiencies as well as altering formatting and presentation in order to address sensory-based needs. Using adaptive information systems to deliver educational content and services can make online learning environments and communities more accessible to individuals with inherited or acquired learning problems.

The implementation of an adaptive approach to instructional modeling offers a number of additional advantages. It affords both instructor and students a great deal of flexibility. The approach is practical and cost-effective from a technology standpoint. That is, the system can be implemented on any information system that implements the core World Wide Web (W3C) data formats and protocols. Because content is not rigidly linked to format, once heuristics and cognitive user profiles are developed, instructional content of all types can be automatically and dynamically adapted to an individual user’s special needs.

Overall, the cognitive-adaptive approach we have described enhances and expands our understanding of how computer-assisted and online instructional systems can be more effectively designed for special needs learners. As such, it makes a new contribution to an important area of online instructional modeling for special populations. Cutting-edge, cross-disciplinary work will help inform the development of instructional models that enable cognitively impaired learners to acquire, remember, and manipulate information more effectively. Such systems will broaden the participation of this underrepresented group in education and in knowledge-based communities. In this age of global communication, educators have an obligation to equip as many individuals as possible with the tools that will allow them to participate in the educational, social, and political fabric of contemporary societies. By integrating adaptive instructional system concepts into the broader area

of online instructional modeling, we can help empower differently-abled individuals to more fully use information technology and participate in an increasingly global educational community.

FUTURE RESEARCH

Future research must address a number of multi-disciplinary issues involving clinical research with special populations, accessible information system design, and models of online instruction for special needs learners. Scholars in cognitive neuroscience, neuropsychology, and online and special education need to conduct empirical research focusing on information technology usage and the human-computer interface. The research should detail how cognitive and sensory deficits associated with a variety of inherited and acquired neurological and learning disorders might be mitigated by adapting the organization, navigation, and display of digital information in specific ways. Clinical insights into the mechanisms, course, and impact of learning and sensory deficits are needed in order to develop more effective remedial and compensatory strategies for employment in adaptive information systems. Research should especially be directed at developing more valid, reliable, and economical online assessments of cognitive and sensory deficits that are accompanied by appropriate age, education and culturally-adjusted norms. These assessments must be represented in a markup language format that can be integrated with rule-based instructional heuristics that act to guide a system's adaptive responses. Adaptive system designers need to communicate more effectively with brain and behavior scientists and educational and rehabilitation specialists in order to translate research advances from diverse fields into effective heuristic algorithms that would satisfy a wide array of special user needs. Software application researchers must continue to develop standard software mechanisms, using available Web-based protocols and markup languages such as XML and XSL, to integrate clinical findings and

assessments, compensatory heuristics, and adaptive system action. Application research needs to focus on the goal of incorporating "universal access" principles that will help foster greater inclusiveness and system accessibility for special needs user by allowing for the creation of localized, personalized information system interaction and display. Finally, empirically based, randomized placebo controlled (RPC) trials need to be developed and executed in ecologically valid environments in order to evaluate the efficacy of adaptive models and identify areas of future research and development.

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ENDNOTE

- ¹ As given in the W3C guidelines for Composite Capability/Preference Profiles at <http://www.w3.org/TR/1999/NOTE-CCPP-19990727>.

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Chapter 5.6

Animated Computer Education Games for Students with ADHD: Evaluating Their Development and Effectiveness as Instructional Tools

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ABSTRACT

Children and adolescents with Attention Deficit Hyperactivity Disorder (ADHD) have difficulty maintaining attention, controlling their activity level, and they typically demonstrate poor interpersonal relationships skills. Because of their challenges, educational performance tends to suffer. Paradoxically, when seated in front of a videogame or computer program they enjoy, the performance of individuals with ADHD becomes similar to non-ADHD peers. The purpose of this chapter is to present a conceptual framework for understanding the factors that affect the outcome of individuals with ADHD, and to demonstrate how instructional design models can be used to guide the design and implementation of animated computer education games as instructional tools

for this population. Specifically, the FIDGE model and Gagné's Nine Events of Instruction are evaluated for their contributions to understanding the unique technological needs of the ADHD learner.

INTRODUCTION

Current estimates indicate Attention Deficit Hyperactivity Disorder (ADHD) affects 4% to 12% of U.S. children (Froehlich et al., 2007). Longitudinal studies suggest children who are diagnosed with ADHD continue to have difficulties with organization, time management, impulsive thoughts and actions, stress management, emotional regulation, interpersonal relationships, and academic skills such as reading, studying, and test taking as adolescents and as young adults (Barkley, Fischer, Smallish, and Fletcher, 2006). Children and adolescents with ADHD often struggle in

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traditional classrooms. Many fidget and have difficulty remaining in their seats, thus causing disruption to the classroom as well as to the child's own education. Even when children with ADHD are able to sit quietly, they often require multiple repetition in order to retain information they hear. Most teachers cannot pause to emphasize each individual fact to a child with ADHD while the rest of the class has grasped the material and moved on. As a result, adolescents with ADHD are more likely to drop out of high school and fail to complete college compared to their non-ADHD counterparts. Lower educational achievement often leads to underemployment, poor social adjustment, and decreased overall quality of life. To address these problems, a more engaging and personalized education format is necessary for children and adolescents with ADHD.

According to DuPaul and Stoner (2003), students with ADHD are educated more effectively if multiple mediators (peers, computers, and parents) are involved. They also recommend the intervention strategies be individualized particularly since the ADHD population is heterogeneous. According to the Centers for Disease Control and Prevention (September 2, 2005), 56% of all children ages four to 17 years diagnosed with ADHD were taking stimulant medications. Though medication is the most widely used treatment for ADHD, a combination of self-monitoring and self-reinforcement may have longer lasting effects. Barkley, Copeland, and Savage (1980) found this combination improved task-related attention, academic accuracy, and peer interactions. DuPaul, Rutherford and Hosterman (2008) suggested the use of self-monitoring and self-reinforcement particularly at the secondary level because there are fewer opportunities for this age group for token reinforcement, contingency contracting, or response cost.

Technological advances and the increased availability of technological resources afford most schools the ability to incorporate different types of instructional technology into the classroom. For students with ADHD, educational tools that

involve computerized technology offer a wider range of options for learning. The benefits of computerized presentation of information include the use of multiple senses, the breakdown of material into smaller pieces, provision of immediate feedback, and the limitation of unnecessary, distracting features (DuPaul & Weyandt, 2006). According to several studies, children and adolescents with ADHD are more attentive to computerized programs or interventions than to traditional instruction methods (Shalev, Tasal & Mevorach, 2007; Farrace-Di Zinno et al., 2001; Carroll & Bain, 1994). They also seem to respond better to interactive instruction than when they serve in more passive roles as listeners or viewers (Shaw & Lewis, 2005; Klingberg et al., 2005). Shaw, Grayson & Lewis (2005) found students with ADHD performed better and were more engaged by information presented in a game format than by regular computerized instruction. In addition, Farrace-Di Zinno et al. (2001) observed how students with ADHD were more similar to their peers without ADHD with regard to the amount of motor movement and distractibility during computer video game play.

According to Fister (1999), computer games can be used for primary learning of different subjects rather than just for review and reinforcement. Ota and DuPaul (2002) evaluated the effects of a game-based math software program on the performance of ADHD students. They found increased math performance, decreased off-task and disruptive behavior, and increased active engagement in the computer-based instruction compared to the traditional classroom lesson. Mautone, DuPaul, and Jitendra (2005) found similar math improvements in ADHD students. Oral reading fluency has also been the target of research using computer-assisted technology with ADHD students. Clarfield and Stoner (2005) found improvements in oral reading fluency and subsequent engagement in the activity when a computer-assisted reading program was used. While data suggest students with ADHD may

benefit from the use of computerized educational tools, it is important to understand what and how to appropriately integrate gaming technology into the classroom to improve learning outcomes for these students. In addition, it is imperative educators evaluate the appropriateness of such technology for use with all students. In this chapter, a conceptual framework for understanding the intervening factors that affect outcomes for people with ADHD will be discussed along with models to help educators design and evaluate the quality of computerized games for education purposes.

THE “GAME GENERATION”

Prensky (2001a) describes the most recent generation of children who integrate videogames into their daily activities as the “game generation.” He also coined the term “Digital Natives” to describe this generation’s approach to learning. Digital Natives routinely manage large amounts of information at one time, find alternative ways to acquire knowledge, and seek solutions through different means previously unavailable. Prensky (2001b) compared the digital natives to previous generations, who he named “Digital Immigrants”. The primary differences between the groups lie in how they approach learning. Digital natives prefer to multi-task. They prefer to “leap around” as they learn rather than sequentially process information (Prensky, 2001c). According to Prensky (2001c), children of this game generation “have been adjusting or programming their brains to the speed, interactivity, and other factors in the games” (pp.3). This generation of learners has also been referred to as “Generation M” for the group between the ages of 8-18 years who have never known a time without media (Rideout, Roberts, & Foehr, 2005). Other labels given to this generation of learners include “Generation I” to represent the influence of the internet in their lives or “Generation Z” to denote the generation following Generation Y (Schmidt & Hawkins,

2008). Despite their nomenclature, the generation of learners today is vastly different from previous generations. Prensky developed ten cognitive traits (Table 1) to describe the differences between children of the game generation and children of previous generations.

Twitch speed refers to the fast speed at which the game generation wants information presented. Classroom lectures and independent seatwork that occur at a slower pace can be frustrating and boring to this group who are accustomed to rapid presentation of information. Parallel processing refers to the randomness of responding, such as surfing the internet or completing game challenges in no specific order. The historic rules of reading textbooks and conducting research follow a sequential order and require systematic approaches. The game generation of children can become inattentive and disruptions may result. Graphic representations stimulate the game generation, while reading text may provide little inspiration for learning. The game generation wants to be connected at all times and they often feel as if they are a part of a community of gamers rather than lone players. This sense of interconnectivity can also stimulate negative behavior, such as cheating in school, because of the diffu-

Table 1 Differences in cognitive traits between children of the game generation and more traditional learners (Prensky, 2001a).

Game Generation	Traditional
Twitch speed	Conventional speed
Parallel processing	Linear processing
Graphics First	Text First
Random access	Step-by-Step
Connected	Stand alone
Active	Passive
Play	Work
Payoff	Patience
Fantasy	Reality
Technology as friendly	Technology as foe

sion of responsibility that accompanies. They are active participants who can impose change on their environments, and can become easily frustrated when placed in an environment where they have no control. Within the game environment, they experience immediate payoff, and many of these activities are fantasy-based. They do not simply use technology as a tool—they are immersed in it as an extension of themselves. Educators who are born of generations past (Digital Immigrants) have to engage the game generation with a different set of tools than what they learned in school (Prensky, 2001a).

Students with ADHD have always used cognitive traits similar to those described by Prensky. Yet, their approaches were viewed as disruptive to the learning environment. Twitch speed was considered hyperactivity and impulsivity. Parallel processing was viewed as disorganization. Connectedness was seen as attention-seeking. Play was considered inattention. Children with ADHD needed more from the learning environment than was available. Now, the needs of the game generation may actually be consistent with the needs of children with ADHD.

Caution has been stressed to adults who are interested in using gaming technology to teach children. There have been negative effects associated with video game use reported in the research. Increased aggression has long been associated with the degree of violence in the game (Gentile & Anderson, 2003; Gentile, Lynch, Linder & Walsh, 2004; Porter & Starcevic, 2007). Gentile et al. (2004) found children who play violent video games are more prone to increased aggression, confrontation with teachers, fights with peers, and decreased academic achievement. However, in a meta-analysis of the effects of violent video-game playing, Ferguson (2007) found no evidence to link playing violent video games with increases in aggression. Additionally, Ferguson et al. (2008) found that when family violence was controlled for, there was no correlational or causal effect of violent video games on aggression. The authors

concluded that aggressive personality types and exposure to family violence were greater predictors of violence than simply exposure to violent video games.

The largest concern associated with video game play seems to be the addictive properties associated with it. Chan and Rabinowitz (2006) found a positive correlation between the amounts of time spent playing video games daily and the number of ADHD symptoms present. Furthermore, Bioulac, Arfi, and Bouvard (2008) found increased addictive tendencies for video games in ADHD children compared to their non-ADHD peers. Results suggest children who play video games for extended periods of time may be prone to more complications and more ADHD symptomology than those who play them less frequently.

Several positive effects from video game play have also been noted. Okagaki and Frensch (1994) found positive effects associated with repeated play of the game Tetris™. Adolescents involved in the study enhanced their visual-spatial and visual reasoning skills through playing the game. They suggested game playing may actually influence performance IQ scores. Ferguson (2007) confirmed these findings and concluded that playing violent video games can actually increase visuo-spatial cognition. Other positive effects include increased problem-solving, increased motivation, and accelerated learning (eg., de Freitas & Levene, 2004; Garris, Ahlers & Driskell, 2002; Gee, 2003; Hays, 2005).

These benefits could level the playing field for children and adolescents with ADHD. Educators who use gaming technology can more easily accommodate many different types of learners. Games can adjust to the skills and needs of their players, allowing the same product or software to meet the needs of all students. However, before educators adopt the “one size fits all” policy for educational games, they need to understand the specific learning styles associated with the ADHD learner.

ADHD LEARNERS AND EDUCATIONAL GAMES

Mediating Factors that Challenge the ADHD Learner

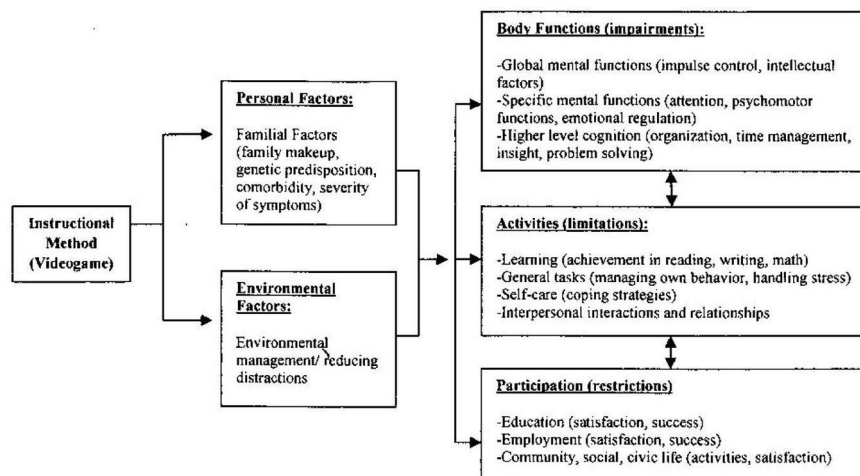
Students with ADHD have difficulty because their core symptoms of inattention, impulsivity, and hyperactivity affect their ability to manage daily life. ADHD affects the person at three interacting levels: (a) body functions, (b) activities, and (c) participation in society. The impact of ADHD on these three interacting levels is also moderated by environmental and personal factors. A conceptual framework (Figure 1) adapted from the International Classification of Functioning, Disability, and Health (ICF) developed by the World Health Organization identifies how symptoms of ADHD can impede school, social, and home functioning (Ustun, 2007).

The ICF framework provides the basis for understanding the learning and behavioral needs of the students with ADHD.

Intervening Factors:

- **Personal factors** are features of life that are not a part of ADHD but can impact other levels of function. Some personal factors are not amenable to change such as gender, race, social background, familial factors, comorbidity, severity of symptoms, and predominant learning styles. Other personal factors such as knowledge of the disorder and medication use can be affected by intervention. While stimulant medications are effective in decreasing the primary symptoms of ADHD, few adolescents take them routinely (Marcus, Wan, Kemner, & Olfson, 2005). Since games are adaptable to the needs of the individual students, they can be implemented as educational interventions regardless of personal factors. An estimated 30% of students with ADHD have reading or math disabilities (Capano, Minden, Chen, Schachar, & Ickowicz, 2008; Faraone, Biederman, Monuteaux, & Seidman, 2001). Learning becomes more challenging for this large minority of students. Games can be presented in high text formats (where users

Figure 1. Conceptual framework for ADHD students adapted from the International Classification of Functioning, Disability, and Health Conceptual Model (Ustun, 2006)



must read a substantial amount to complete) and low text formats (where users navigate more through pictures and limited reading) thereby reducing the need for assistance by special educators with reading and comprehension of the material.

- **Environmental factors** consist of physical, social, and attitudinal factors in which people live and conduct their lives (Ustun, 2007). A major focus of ADHD management for young children is modification of the classroom environment in order to improve behavior and performance. Research indicates that during videogame play, hyperactivity and impulsivity decrease for students with ADHD while attention and learning increase (Farrace-Di Zinno et al., 2001). Providing opportunities for integrating videogame technology into the learning environment is a simple way to address the behavioral and academic needs of these students.

Outcome Factors:

- **Body functions** are defined as physiological and psychological functions, and they include the core symptoms of ADHD—inattention, hyperactivity, and impulsivity (American Psychological Association, 2000). Neuroimaging studies indicate differences in the size and activation of the prefrontal cortex during cognitive processing tasks in individuals with ADHD compared to those without ADHD (Epstein et al., 2007; Konrad, Neufang, Hanisch, Fink, & Herpertz-Dahlmann, 2006). Secondary impairments of ADHD, such as verbal and nonverbal working memory, emotional regulation, and behavioral reconstitution (Barkley, 1997), are also considered body functions according to ICF coding. Behavioral reconstitution is the ability to shape behavior or learn new behavior patterns based on cues provided by models in the environment, and it allows

individuals to learn vicariously. According to Barkley (1997), individuals with ADHD have difficulty with behavioral reconstitution. They frequently have to experience the consequences of their own behavior in order to shape new behavior patterns. Videogames can allow the player to become the character in the game; therefore, the player serves as his or her own model for behavior change. Bandura in his social learning theory (1971) emphasizes people can learn by observing a model. Seeing the self successfully perform a skill provides information about how to best perform that skill, strengthens self-efficacy, and reinforces learning.

- **Activities** are defined as the execution of tasks or actions. General activities of daily living are included in this category, such as learning and applying knowledge, general tasks and demands, communication, mobility, self-care, and interpersonal relationships. Symptoms of ADHD are known to cause inconsistency and persistent problems in adaptive functioning for general activities of daily living. Research indicates the symptoms of ADHD significantly impact academic performance and learning. Frazier, Youngstrom, Glutting, and Watkins (2007) conducted a meta-analysis that included 72 studies of academic achievement in children and adolescents with ADHD and found moderate to large discrepancies between achievement scores of those with and without ADHD. Adolescents with ADHD have persistent problems with adaptive communication skills (Clark, Prior, & Kinsella, 2002) as well as difficulties with interpersonal relationships and social situations (Barkley, 2006; Maedgen & Carlson, 2000). Computer technology and virtual reality can be used to create social situations and model interpersonal relationships in order to shape behavior and reinforce learning.

- **Participation** is defined as involvement in life situations, which include education, employment, and community activities. Typically, compared to their peers without ADHD, adolescents with ADHD experience more difficulty moving through and succeeding in educational programs, obtaining and retaining work, and even being involved in community, social, and civic life (Spencer, Biederman, & Mick, 2007). Games that simulate real-world situations could teach these students how to participate by providing them with immediate feedback about their actions without having to expose them to potentially harmful situations.

Students with ADHD need educational opportunities that are purposeful yet fun and engaging. The advancements in gaming technology, as they relate to the instructional environment, are promising. However, the quality, format, and purpose of technological mediums vary widely and it is important to evaluate and select the most appropriate medium for the desired learning outcomes.

EDUCATIONAL GAMES VS. EDUCATIONAL SIMULATIONS

Research differentiates between educational games and educational simulations. According to Price (1990), the purpose of an educational video game is to teach and provide practice. A simulation, on the other hand, has been described as something that mirrors real life and requires the player to act (Tessmer, Jonassen, & Caverly, 1989, p. 89). According to Gredler (1996), games are typically linear, requiring correct responses before advancing to the next level. Simulations are non-linear, allowing for flexibility in movement within the modules based on decisions made previously. Prensky (2001a) expanded on Gredler's interpretation of games and simulations by sug-

gesting games are viewed as fun, have specific goals, provide structure through rules, and include a competitive component that assumes the player will either win or lose. Using this interpretation, Prensky suggested that simulations can also be games if they are designed as such. He went as far as to say simulations "simulate" reality, which could be boring to the player. By adding game-like components to the simulation (components that are unrealistic), players may enjoy playing and at the same time be able to generalize the skill to an aspect of real life (Prensky, 2001a). Educators must be mindful of these differences when introducing an educational game or simulation into the lesson. A game may be fun with limited learning associated with it. A simulation may have the potential for learning, but it may not be fun. Prensky suggests the best situation may be to give the player real choices, but to "include enough humorous or even outrageous possibilities" to make it fun (Prensky, 2001a). The goal is to keep even the most inattentive and distractible players interested and motivated to continue.

VIDEOGAME PERFORMANCE OF CHILDREN WITH AND WITHOUT ADHD

Research has found mixed results regarding videogame performance of children with ADHD compared to their non-ADHD peers. Continuous Performance Tests (CPT) are typically used to evaluate speed of responding, sustained attention level, motor movements, and executive functioning in individuals with ADHD. These computer-based assessments require individuals to respond to a correct target sequence and refrain from responding to an incorrect target sequence or distractor. People with ADHD are more restless, inattentive, and talkative than their typically developing peers when completing CPTs (Barkley, Grodzinsky, & DuPaul, 1992). In addition, children find them aversive (Smith,

Barkley, & Shapiro, 2007). These assessments lack the criteria suggested by Prensky that would engage and motivate the individual during the task. Tannock (1997) conducted an assessment of motor movement in boys with ADHD using the Pacman™ videogame; a two-dimensional, repetitive, restricted player-interface game with a non-variable background, and also found a pattern of restlessness, inattention, and talkativeness compared to boys without ADHD. To paraphrase Prensky, these tasks are not fun and are not based on real-life experiences.

Farrace-Di Zinno et al. (2001) and Lawrence et al. (2002) designed their studies for children with ADHD around an interactive adventure videogame (Crash Bandicoot™, 1996), which requires response inhibition, motor control involving visiospatial skills, and eye-hand coordination skills. The videogame requires the player to negotiate hazards along a jungle path while viewing the journey from the character's perspective. The game depends on the player's ability to move quickly under some circumstances and to refrain from responding when certain hazards are presented. Rolling wheels, killer skunks, snapping plants, and the risk of falling off cliffs are some of the challenges the player faces during the adventure. The player must apply the rules in order to get from the beginning of the path to the end. These tasks mirror real-life skills, but include fun and unrealistic components. Unlike earlier studies involving CPT and Pacman™, the researchers found children with ADHD were more similar to children without ADHD during the interactive adventure videogame. They attributed the variability in results to the differences in the videogame presented to the children. The adventure videogame provided the player with immediate visual and auditory feedback and the responses were self-paced. Children could slow down or speed up the action depending on their individual needs. CPTs and games like Pacman™ are not so adaptable.

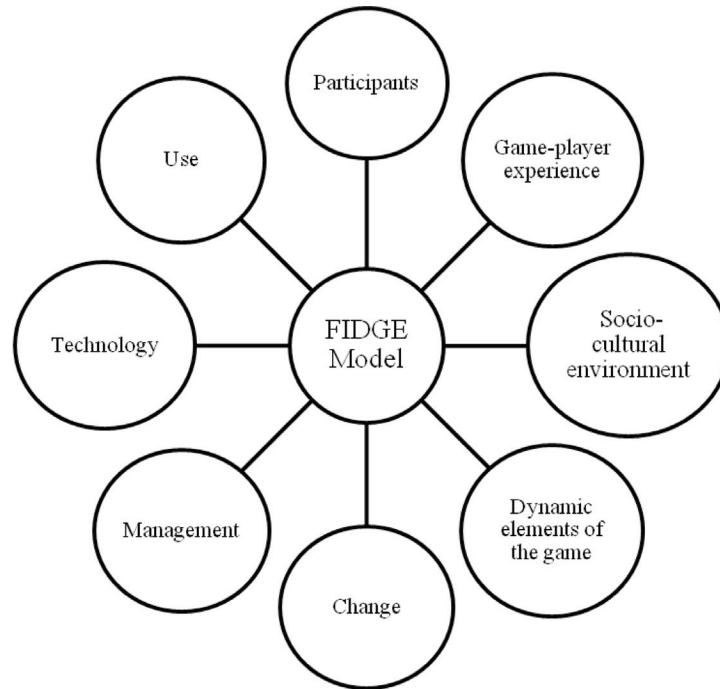
EVALUATING INSTRUCTIONAL GAMES AND SIMULATIONS

Instructional development has been the term most used to describe the activities of educators. With the increased need to integrate educational games into the instructional environment, educators are taking on more instructional design responsibilities. Design models help educators understand how to create and evaluate the quality of a game or simulation. Educators can use the design models to understand the needs of ADHD students as well as those of the game generation. One useful design is the FIDGE model (Akilli & Cagiltay, 2006).

FIDGE stands for "Fuzzified Instructional Design Development of Game-like Environments." Ironically, the word *fidge*, or in more current vernacular, *fidget*, means "to move restlessly" or "a condition of restlessness manifested by nervous movements" (American Heritage College Dictionary, 2000). The model was designed to address the eagerness and physical tension associated with the game player. The model is non-linear and includes consideration and evaluation of several components: (a) participants; (b) game-player experience; (c) socio-cultural environment; (d) dynamic elements of the game; (e) change; (f) management; (g) technology; and (h) use. An example of the application of the FIDGE model for educators would be the design of a computer game to teach a concept to elementary students using a simple PowerPoint application.

- **Participants** are the users of the game and the experts involved in the development and evaluation of it. The ADHD learner and peers who are members of the game generation are similar, but the added challenge of potential learning disabilities could create a unique set of challenges for educators in the presentation of curricula. One way educators can ensure the needs of the ADHD learner and other subpopulations of learners

Figure 2. The eight components of evaluation for computer games or simulations. (Akilli & Cagiltay, 2006) recommend educators evaluate the needs of their learners and the presentation of the game to ensure there is a match before introducing the game to the players



are included in the curricula is to develop focus groups. Educators may not understand the unique digital needs of the learners, but the learners know what appeals to them. By creating focus groups to help educators choose educational games or simulation material, educators may better understand the needs of the learners. In the example of creating a computer game for teaching the Bill of Rights, educators would first select a heterogeneous group of students from their classes to serve as the focus group. This group would discuss their needs in regards to the learning environment. Such discussions may include what the group identifies as interesting or boring. The responses may differ significantly for the ADHD learner group compared to the non-ADHD counterparts.

- **Game-player experience requires** the need to consider the differences in styles of

learning and skill levels of players. Providing multi-sensory experiences can support a diverse group of learners. de Freitas (2004) found that games and simulations can significantly support differentiated learning. When selecting game-like environments for learning, educators need to ensure the quality of the game or simulation is adaptable to all learning styles represented. The use of PowerPoint does not limit the multi-sensory experiences available. Sound, visual cues and touch if a Smart board or touch screen computer is used will add to the learning experience for these students.

- **Socio-cultural environment** involves an understanding of the environment in which the game will be played, the change in relevance from year to year, and the transfer of skills from one activity to another. Educators are creating games that are important to the

current student population, but they do not want to have to re-create these instructional tools from year to year. When developing your PowerPoint presentation, you may need to find links, sounds, or graphics that can transition from one group to the next. It's probably not a good idea to choose current trends as examples.

- **Dynamic elements of the game** include challenge, fantasy, and creativity. Research indicates a similar abnormal brain pattern in creative individuals (Herrmann, 1981; Torrance, 1984) and individuals with ADHD (Hynd, Hern, Voeller & Marshall, 1991). In fact, Shaw (1992) found ADHD children use a magnitude of imagery in problem-solving similar to creative individuals. By including dynamic elements in the games, educators can stimulate not only the attentional needs, but also the creativity needs of the ADHD learner. Integrating video clips, puzzles, or competition into the presentation can enhance the learners' interest in it.
- **Change** refers to requirements for growth and the need for continuous evaluation components built into the game curriculum. As students demonstrate understanding of certain components, the game should provide more advanced curricula. Hyperlinks within the slides can allow for previous responses to guide future ones. It could also provide different ways of addressing the same construct if the student fails to grasp it correctly on the first try. ADHD students may not respond correctly because of how the information is presented rather than from a lack of knowledge about the information.
- **Management** includes the player's degree of control over time, characters, and pace. As previously stated, the opportunity for the students to select their character increases the modeling effect. Given the characteristics of the "game generation," the management of the game is critical to its success. Providing

choice in characters can enhance the observational learning opportunities (making the behaviors of the characters more identifiable with the players).

- **Technology** relates to the compatibility with systems and suitability within the educational environment. Due to budgetary issues, schools face difficulties remaining apace with the most current technological advances. For students to be able to access programs, the programs should be compatible with the technology utilized by the preponderance of schools.
- **Use** refers to the actual implementation of the game. One limitation of this model is a lack of research support for how individuals with challenges in self-regulation (i.e., attention, hyperactivity, or impulsivity) respond to games designed using this model.

Though the FIDGE model was developed for designers of computer games, educators can benefit from understanding its unique instructional design components. Since the thoughts of the game generation and the ADHD learners jump from idea to idea, they require flexibility in approaching their curricula in the same mode. The FIDGE model can serve as a guide for educators as they prepare their digitally-based instructional materials.

CHOOSING INSTRUCTIONAL GAMES AND DEVELOPING LESSON PLANS FOR THE ADHD LEARNER

Gagné's "Nine Events of Instruction" theory of design development for instructional games (1985) is based on learning and instructional principles. The areas included in the theory are: (a) gaining attention (reception), (b) informing learners of the objective (expectancy), (c) stimulating recall of prior learning (retrieval), (d) presenting the stimulus (selective perception), (e) providing

learning guidance (semantic encoding), (f) eliciting performance (responding), (g) providing feedback (reinforcement), (h) assessing performance (retrieval), and (i) enhancing retention and transfer (generalization). The FIDGE model addresses the components developed, whereas the “Nine Events of Instruction” assess how interesting and functional the program will be to its users.

The ADHD learner has difficulty maintaining attention, remaining still and focused, or both. These children can make impulsive decisions, and require additional attention from teachers, staff, and peers. When making choices about ways to present a concept, teachers are trained to consider the needs of the learners. Gagné’s Nine Events of Instruction can support teachers’ efforts to evaluate these needs when the presentation of material is technology-based. Specific to the ADHD learner, these nine events can target how material should be presented to engage and motivate the student, and assess the mastery of the information:

Event 1: Gain Attention

With any task, gaining the attention of the ADHD learner is critical to the success of the instructional medium. Since inattention is a major challenge for most individuals with ADHD, gaining their attention can be difficult. Gagné suggests adding color or sound to the material that highlights specific information and does not overshadow that which must be learned (Gagné, Briggs, & Wager, 1992). Shaw and Lewis (2005) found children with ADHD demonstrated more on-task behaviors when animated stimuli were presented rather than simple text. Computerized animation can provide a wealth of options for stimulating the attention of these learners.

Event 2: Inform Learners of the Objectives

This event addresses the need to provide a learning map of the material. Ogle (1986) developed

the K-W-L instructional design to help learners identify what they already **Know** about the subject, what they **Want** to learn about the subject, and what they actually **Learn** as they study the material. The development of a graphic organizer helps the learner chart this information. Computer-mediated instruction offers learners a playground where they can attach websites, pictures, sounds, video, and more to their knowledge base about the topic. Titles and topic headings can be presented using *Flash* technology so they stand out to the reader. Informing learners of the objectives can be more interactive, thereby stimulating the interest of individuals with ADHD.

Event 3: Stimulate Recall of Prerequisite Learning

Individuals with ADHD can have difficulty retaining information. According to Barkley (1997), deficits that would impair an individual with ADHD from retrieving previously learned material to solve new problems include those involved in executive functioning. Working memory, activation, arousal, and effort, and complex problem solving are critical to processing new information. Skowronek, Leichtman, and Pillemer (2008) found individuals with ADHD demonstrate strengths in long-term episodic memory. This means when they have to retrieve information based on personal experiences they perform better than average. Attaching meaning to information could enhance the learning for individuals with ADHD. Animated computer education games can allow users to choose a character that represents them. The events can be organized in such a way so they simulate real life experiences, thus improving the chance they will be retained. Zentall, Cassady, and Javorsky (2001) suggest using voice-overs to ask users to recount previous social situations relevant to the material to help improve problem-solving strategies. This strategy capitalizes on the use of sound to maintain attention and episodic memory to enhance retention and recall.

Event 4: Presenting the Content

The presentation of content should vary according to the learning style and age of the user. Learning should be focused on showing the learner how to organize the information in the correct sequence. According to Kataria, Hall, Wong, and Keys (1992), the use of rehearsal, mnemonics, imagery, and organizational strategies can improve retention. The developmental stage of the learner would influence the sophistication of the mnemonics and the detail involved in the imagery. Mayer (1987) suggests that younger children may require support to create the image since they have fewer experiences on which to draw.

Event 5: Providing Learning Guidance

Learning guidance can be provided for the ADHD learner through clearly labeled navigational tools, verbal instructions are repeated throughout the activity, and interactive help menus. The appealing nature of videogames is the technology-driven emphasis rather than staff-driven. More students receive one-on-one learning guidance without requiring more teachers or paraprofessionals to be present. ADHD learners respond to one-on-one instruction where the material introduces the use of multiple senses, the breakdown of material into smaller pieces, provision of immediate feedback, and the limitation of unnecessary, distracting features (DuPaul & Weyandt, 2006). An example of learning guidance that meets these criteria is the use of interactive case studies where users must experience a scenario familiar to them, problem-solve responses to the scenario, and receive feedback as to their accuracy at the end of the presentation.

Event 6: Eliciting the Performance

Inattention can increase response time. The goal is to get a response to the material so the learner

can practice the skill. Teachers may struggle with motivating ADHD learners to start tasks, let alone getting them to complete the tasks. However, we have learned when individuals with ADHD are interested in the material, they are more likely to elicit a response. Opportunities for active learning will increase the likelihood of a response.

Event 7: Providing Feedback

As stated previously, immediate feedback can improve the task performance of ADHD learners (DuPaul & Weyandt, 2006). Furthermore, Codding, Lewandowski, and Eckert (2005) found feedback increased performance when the students actually set their own performance goals. Videogames and other computer education games can allow users to set realistic goals and receive immediate feedback on their performance.

Event 8: Assessing Performance

Any lesson plan should include methods for assessing learning. For ADHD learners these methods should occur frequently and not only assess learning of material, but also assess on-task behavior. Computer education games are capable of tracking responses of the user and adjusting the presentation of material to accommodate the user's specific needs.

Event 9: Enhancing Retention and Transfer

When individuals can take what they have learned and apply it to new situations, learning has taken place. The skills learned during videogame play (planning, organization, problem-solving, adaptability, and processing speed) can easily transfer to other tasks. Since many ADHD learners have deficits in many of these prefrontal activities, it is encouraging that a medium of task presentation can generate skill growth in these areas. A bonus may

be lowered levels of hyperactivity and impulsive responding, and increased on-task behavior.

By using Gagné's Nine Event of Instruction, educators can choose computer games that offer the best chance for success in teaching the material to the ADHD learner. They also guide educators in lesson plan development by dividing the lesson into measureable goals; i.e., from preparing the student for learning to generalizing the skills to new material.

FUTURE RESEARCH DIRECTIONS

Animated computer education games developed using the criteria discussed in the FIDGE model is essential. Data suggest a non-linear approach to developing "game-like environments" will suit the specific needs of the ADHD learner. However, the model has not been previously discussed in this context and no research exists to support its use. Instructional games are being developed commercially and by educators for use in their classrooms. Yet, there are no empirical studies that demonstrate whether the games meet the needs of the ADHD learner. Additionally, research to evaluate existing educational games to see if they meet Gagné's criteria for an appropriate instructional tool for ADHD learners is needed. Lesson plan development could also be evaluated to see if learning occurs when the Nine Events of Instruction are followed compared to traditional lesson plan development.

CONCLUSION

This chapter has provided a theoretical framework for understanding the ADHD learner and the importance of using instructional design models to guide educators through the development of appropriate animated computer education curricula for them. Computer gaming technology offers significant promise for the education of individuals

with ADHD. The unique challenges of the learner and educators to create a fertile and stimulating environment that individualizes the learning needs of those with ADHD and limits the distractions for non-ADHD students can be daunting. Animated, dynamic elements of computer education games are ripe for meeting those demands. Educators willing to improve their technological skill-sets and integrate computer games into the instructional environment in a purposeful way offer the best chance for the ADHD learner to succeed.

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Chapter 5.7

Barriers to and Strategies for Faculty Integration of IT

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INTRODUCTION

At most institutions of higher education, faculty members wear many “hats.” Among other responsibilities, they are expected to teach, conduct research, and participate in institutional and public service. Within the teaching realm, faculty members have always had multiple responsibilities. For example, in addition to being content experts, they may need to become course design, assessment, communication, community or interaction experts. Instructors can be described as architects, consultants, resources, reviewers, and role models (Oblinger & Hawkins, 2006). It is primarily (though not exclusively) in the teaching realm where instructional technology (IT) is relevant. The more that faculty utilize IT, the more the non-content aspects of teaching become salient.

Depending on level of faculty expertise, asking them to increase the time and effort they put into their teaching might reduce the time and effort they can devote to research, service, and other institutional requirements and responsibilities. Why should they, especially if there is very little acknowledgment or tenure/promotion credit given for incorporating IT into their teaching? This is, in part, why many faculty members may have to be dragged “kicking and screaming” into using these technologies.

BACKGROUND

To address the predicament faced by faculty, it would be helpful to provide some guidelines on how to balance multiple roles (and the time and effort required). However, there do not appear to be any models that deal with this challenge. One

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way to help understand the process of IT adoption is to consider the different roles or positions of individual faculty members. For example, non-users of IT face a much steeper learning curve than do instructors who have partially or fully integrated IT into their teaching. Learning to use IT might, therefore, be thought of as a socialization process.

In their model of socialization to groups, psychologists Moreland and Levine (2000) highlight the importance of the processes of evaluation, commitment, and role transition. In particular, in order to acquire a new identity as a group member, an individual must pass from being a prospective member to a new member to a full member. This passage is a function of how both the group and individual evaluate each other, their respective levels of commitment to each other, and the eventual transition in roles as the individual passes into and through the group.

For purposes of this chapter, we assume that higher education faculty go through a similar socialization process with IT integration. In particular, they must first evaluate the IT options available to them and determine if using those options is feasible. If their commitment to integrating IT into their teaching is high enough, they may begin learning about those options, depending on the support and resources of their institution. This learning process might shift the instructor's role from a prospective user to a new user and eventually to a full user of IT. The barriers to IT integration vary depending on the user roles that faculty play in this socialization process, how they evaluate IT, their own and their institution's levels of commitment to its use, and their IT learning

curve. Table 1 presents a developmental model of faculty integration of IT loosely based on Moreland and Levine's (2000) group socialization model.

Both non-users and prospective users of IT may not adopt it for several reasons. They may negatively evaluate the use of IT, lack the time and effort necessary to commit to its use, or fear the steep learning curve that awaits their efforts to integrate IT into their teaching. New IT users are more likely to evaluate its use favorably and to have more commitment to using it, yet will still have a steep learning curve. Of course, if new users' initial experiences are negative, they will be less likely to increase their commitment to and use of IT. Experienced users will typically show positive evaluations, high levels of commitment, and less steep learning curves. However, with each of these roles, there are potential barriers that limit the initial or continued integration of IT into faculty members' teaching.

PERCEIVED BARRIERS

Even assuming adequate levels of training, support, and access, there are many barriers to faculty members' adoption and integration of instructional technologies. Table 2 lists some of the major technology-related and academic-related barriers to IT use in higher education.

Prospective IT users may have the misconception that they should learn about and use IT because it makes teaching and learning more convenient. This may be true to some extent, but it is no more true than the claim that instructors use a textbook

Table 1. Developmental model of faculty integration of IT

Role	Evaluation	Commitment	Learning Curve
Non-user	Negative or neutral	Low	Very Steep
Prospective user	Negative, neutral, or positive	Low to medium	Very Steep
New user	Negative, neutral, or positive	Medium to high	Steep
Experienced user	Positive	High	Moderately steep

Table 2. Major barriers to IT integration in higher education

Technology-Related	Wide range of IT Options
	Role Conflict
	Pace of IT Improvements & Innovations
Academic-Related	Time & Effort
	Academic Quality of Courses
	Incentives & Compensation
	Tenure & Promotion
	Job Security

for convenience. In this sense, there is nothing special about new instructional technologies. Whether one is talking about a pencil, a textbook, a whiteboard, or a 21st Century classroom, these are all tools along a continuum. Even if faculty members do not see it this way, their Net Generation students increasingly look at many of these new technologies as “pencils” (Oblinger & Oblinger, 2005), and those students use the technologies for multiple purposes (Donlevy, 2005). However, for faculty, this is one of the most obvious barriers when facing emerging technologies—the ever increasing, wide range of options. Even when they evaluate the use of IT favorably and are committed to integrating it into their teaching, they quickly become alarmed at how many different pencils they need to sharpen! The fear of failing to master these applications is also quite real (Beggs, 2000). Even for instructors who are experienced IT users, learning to use additional existing or new technologies can be a formidable challenge.

The content realm is probably valued most highly by the majority of faculty members. However, when new technologies are added to the changing characteristics of students, non-content aspects of teaching become more important, and attention is diverted from the content focus. Faculty might accept the fact that proper IT integration ideally results in a shift from faculty-centered instruction (passive learning) to constructivist or

student-centered learning environments (active learning) (Duhaney, 2005; Groves & Zemel, 2000). However, the dual role required of them has proven daunting for many. Exactly what is the faculty’s role—IT or content expert? There is no clear definition of the roles required to teach a course that takes the emerging technologies into account. Important questions to consider include to what extent and how often a faculty member revises and re-designs a course and who helps with those processes. This potential role conflict or role ambiguity may inhibit non-users from transitioning to prospective IT users. New IT users will need to negotiate their new roles actively. On the other hand, most experienced users have probably resolved the conflict or ambiguity associated with the new roles required by the integration of IT.

Closely related to these issues is the constantly changing nature of IT. With technology changing often and quickly, why should faculty spend time and effort learning something that may be radically changed or even obsolete in a few years? For example, an institution may be moving from individually created faculty course web pages to the adoption of a common learning management system (LMS) platform. Alternatively, there may be a conversion to a different LMS platform or to a new version of the existing one. Finding the time to stay current in their discipline, to bring in new material, or to update to a new text is made more difficult when time must also be devoted to staying current with instructional technologies (Beggs, 2000). Recognizing the need to adjust to IT improvements and innovations might decrease the likelihood that prospective users will increase their evaluation of and commitment to using IT. This barrier is also an issue for experienced users who may need to learn to use revisions of the IT that they have already mastered.

In addition to these technology-based barriers, there are several faculty-related barriers to integrating IT. Investment of time and effort pose one such barrier (Beggs, 2000). In fact, this expenditure is at least implied within all the barriers

ers we discuss. From training, to decision-making about which IT options are applicable to a specific discipline, to actual implementation, becoming proficient enough to use IT effectively calls for a significant commitment. “Why,” ask faculty, “should I make this investment?” Even the most committed new and experienced IT users, who know the answer centers around improvements in learning, are aware of the heavy costs in time and effort. This barrier probably has the strongest negative effect on the evaluation and commitment of non-users and prospective users.

Some faculty also worry about the academic quality of courses that integrate IT (Davis, 2005; Duhaney 2005), with suspicions of bells and whistles being used for their sake alone. Barone (2005) suggests that “Some traditional academics feel that the habits of the Net Generation result in a superficial grasp of their discipline and do not embody the gravitas of an ‘educated’ person” (§ 9). Duhaney (2005) points out that even more careful planning is required for a course that integrates technologies than for a traditional course. In addition, most higher-education faculty are not specialists in course design. They are teaching because of their content expertise. In many disciplines, it is uncommon for faculty to receive pedagogical training while they are graduate students. Determining how to integrate IT forces faculty to examine curricular design, something that they are often not used to doing. Because of this state of affairs, non-users may resist integrating IT because it also requires that they specify learning objectives and outcomes of their courses.

Another important barrier to faculty’s willingness to embrace IT integration is the perceived lack of substantive incentives and compensation. While release time, grants, and awards (if available) are a good start towards helping faculty get started and feeling that their efforts are recognized and respected, they are often not sufficient to offset the necessary amount of time and effort invested in training and implementation. Sometimes, even when such incentives are offered, prospective

users may be unable to take advantage of those opportunities due to teaching load, departmental, or other university demands. Additionally, when materials using IT are created, issues of intellectual property and uncertainty created by loosely defined copyright policies (Duhaney, 2005) present yet another issue for faculty.

All these barriers culminate in concerns over the tenure and promotion (T/P) process, an issue of utmost importance for faculty. It is widely held that efforts in IT integration, although undeniably linked to teaching, do not fit into the traditional teaching, research, and service categories of the T/P process (Davis, 2005; Hagner & Schneebeck, 2001; Seminoff & Wepner, 1997; Young, 2002). Many faculty are waiting for tangible recognition for the substantial time and effort investment required for IT integration, and it can come in no other way than by “having a positive impact on tenure, promotion, and salary decisions” (Hagner & Schneebeck, 2001, p. 4).

Closely related to the T/P issue, and equally important, is faculty concern over job security. Many higher education institutions have moved towards the creation or development of master courses by ranking, qualified faculty. These courses are then taught in multiple sections by individuals with or without tenure, often receiving lower salaries and no benefits. Some faculty feel that this trend heralds the erosion of the academic profession as faculty currently know it. It could also be viewed as a challenge to the traditional notion of faculty autonomy, a privilege faculty will be very reluctant to give up (Hagner & Schneebeck, 2001). As Beggs (2000) puts it, “devaluation of their profession and the possible elimination of their job” (§ 9) constitute a serious suspicion about and obstacle to faculty involvement with IT.

OVERCOMING BARRIERS

What can be done to overcome these many barriers and to encourage faculty to participate in

the “new academy” (Barone, 2005)? As Mitterer (2006) notes, the explosion of digital technologies represents “a veritable Trojan horse of pedagogy” (p. 60) for higher education. Non-users and prospective users need to be convinced of the wisdom and necessity of incorporating IT into their courses. As the list of barriers indicates, this is a very challenging task. Table 3 presents an overview of key strategies to attain greater faculty engagement with and use of IT.

First, IT is not a single thing that can be used in the convincing process. Different faculty will be interested in different kinds of technologies (Beggs, 2000). Thus, one strategy might be to provide faculty with very general overviews of the different technologies and what can be done with them, especially within their disciplines. Faculty who are exposed to this information might convince themselves of its worth and pursue more-specific training on those technologies that

are most relevant to their interests, expertise, or discipline. If the general overviews could be delivered by experienced faculty users within the department (or if there were an IT support person familiar with the discipline), new users may more readily see how technology fits into their and their discipline’s values. Because they are often not familiar with a faculty member’s discipline, IT trainers and consultants may have a more difficult job when they lack the credibility of a faculty member’s peers.

To reduce the learning curve for and time needed with the new technologies, faculty who are inexperienced with IT could be encouraged to simply use those tools. Trying to integrate them into their course more fully could be something that occurs later. By taking “baby steps,” these faculty might not get as frustrated or overwhelmed by the time and effort demands, yet they still might begin to see some advantages and opportunities that those

Table 3. Strategies for overcoming the major barriers to IT integration in higher education

	Barriers	Strategies
Technology-Related	Wide range of IT Options	Provide General Overviews of Options
		Encourage Small Steps
		Support for basic as well as advanced technologies
	Role Conflict	Foster Support & Training from Peers
		Departmental Roundtables
	Pace of IT Improvements & Innovations	Emphasize Student Need & Demand
Academic-Related	Time & Effort	University & Departmental & Course-Specific LMS Templates
		Departmental Standards & Requirements
	Academic Quality of Courses	Greater Emphasis on Pedagogy
		Emphasis on Course Design & Redesign Using IT
		Peer Review of Courses Using IT
	Incentives & Compensation	Increased Reward Structure for IT Integration
	Tenure & Promotion	Increased Guideline Definitions & Clarity
		Greater Emphasis on Quality Control
	Job Security	Greater Value, support, & reward for collaboration

technologies offer (Villano, 2006; Beggs, 2000). At the same time, IT support staff could calibrate their efforts to teach the basic technologies to new users and the more advanced technologies and integration possibilities to experienced users. Working around faculty members' schedules (rather than having set times for training) would also increase receptivity to learning about new technologies.

With regard to the potential role conflicts that can inhibit the integration of IT, experienced users can assist in clarifying the roles that new technologies enable or require. One strategy to combat role conflicts might be to hold regular roundtable discussions within departments to help faculty identify and articulate discipline-specific ways to achieve academic and IT integration. Another option is to create intra-departmental training programs that rely on experienced IT users helping prospective or new users (Clayton, 2005; Efaw, 2005). These approaches might show faculty how they can gain knowledge or expertise without taking on a new teaching role. It is also possible that experienced faculty members within departments will assume specific technology-related roles. These departmental experts can be an important source of support and training for both new and experienced users.

Because so many faculty members consider themselves to be instructional technology novices, efforts to increase IT integration must focus on encouraging and nurturing the non-users and prospective users. Efaw (2005) described a 3-phase approach to facilitating faculty integration of technology. The phases include learning about and becoming more favorable towards available technologies, practicing with and receiving feedback on those technologies, and continuing to develop expertise through workshops, discussions, and mentorships. In each phase, this approach relies heavily on the experiences, modeling, and feedback of veteran technology users in the socialization of new users.

To some extent, students are the force of change for faculty members (Donlevy, 2005). As more instructors utilize IT in their courses, students will come to depend on those technologies and might also complain about it when instructors do not include them. Thus, as more faculty and students rely on IT, the demand for incorporating IT into courses escalates. Faculty will increasingly find that they must begin incorporating these technologies, or they will figuratively, or literally, lose their students. A good strategy might be to recruit students to increase faculty use of IT. For example, survey data (e.g., Kvavik & Caruso, 2005) can be used to show faculty what students like or expect. Students should be encouraged to be more proactive regarding their education, at least in terms of how their instructors integrate technology into courses, by requesting specific technologies or applications from their instructors (Hagner & Schneebeck, 2001), particularly those that prepare them for the workplace (Beggs, 2000). They could also participate in IT roundtables and serve on IT-related committees at their institutions.

When turning to the more academic-related barriers, ways of overcoming the issue of time and effort becomes a prominent question. One simple solution is the development of departmental and course-specific templates within the institution's LMS platform (Clayton, 2005). Such templates allow less-experienced faculty members to minimize their learning curve with the LMS. They would also allow student access to standardized resources and materials for multiple sections of a course.

Another possible route to overcoming the time and effort barrier is the development of university and departmental standards or requirements (Seminoff & Wepner, 1997). For instance, some institutions have begun to identify the minimal technology tools that all faculty members need to have. It may be that faculty members do not need to become technology experts. Some could argue, for example, that because the IT support staff are the experts, instructors do not need to learn the new technologies. However, if faculty

will be using these technologies, there most likely needs to be some minimal level of understanding in order to troubleshoot and use them effectively. It is very likely that faculty will need to develop at least some level of expertise with the tools they use. Institutions might, for example, require a Web-presence for all their courses. At minimum, all faculty could present their syllabi and instructor contact information online, preferably through an LMS. Institutions may also want to mandate the use of an LMS. Although institutions have begun to address these questions, few consistent standards or recommendations have yet to emerge. This is a critical need.

To overcome concerns about academic quality, institutions will need to demonstrate the ways that IT improves the quality of courses that integrate IT. This effort must parallel institutional attention to accreditation standards, the development of learning outcomes, assessments and benchmarks, and course design and redesign efforts. Non-users and institutional decision-makers must be educated about the pedagogically-sound ways that courses can implement and integrate IT (Seminoff & Wepner, 1997). One strategy is to set up centers focused on learning and teaching like the Learning, Teaching, and Innovative Technologies Center at Middle Tennessee State University or the Technology Assisted Curriculum Center at the University of Utah. These Centers provide faculty with resources, training, and expertise on the use of IT. They strive to move faculty toward thinking about sound pedagogical IT integration by helping “faculty members gain a better understanding of technology and incorporate it into their lesson plans . . . [to] meet their education objectives . . .” (Villano, 2006, p. 32).

Another strategy is to incorporate peer reviews of courses using IT, not only to help to improve the quality of those courses, but also to clarify the criteria that constitute best practices (Bombardieri, 2006). When they receive peer reviews, new IT users are provided with developmental guidance and feedback. By conducting such reviews,

experienced users improve their pedagogical expertise. Thus, developing a peer review process is an excellent way to improve academic quality for users with different levels of experience. All of these strategies (as well as the ones we have listed in previous sections) can foster an institution’s education about and exposure to IT. As this process increases in frequency, concerns over academic quality should be ameliorated.

As we mentioned earlier in this chapter, even if incentives and compensation are available to help faculty learn about and integrate IT, time and effort demands must still be addressed. Increasing the size of these “carrots” might encourage some faculty members to become new IT users (Seminoff & Wepner, 1997). However, efforts must also be directed to increasing the perceived value and necessity of incorporating IT into teaching. Not only must faculty members be convinced, but department chairs, deans, and chief academic officers must also be brought on board.

As long as faculty members get little or no “credit” for re-assessing their pedagogy through course design and redesign efforts that incorporate new instructional technologies, they will continue to be resistant to changing their tried-and-true teaching methods (Beggs, 2000). Thus, another way to increase the perceived value of IT is for institutions to increase the credit given to IT users by promotion and tenure committees (Bombardieri, 2006; Hagner & Schneebeck, 2001; Seminoff & Wepner, 1997; Young, 2002). Young (2002) points to the seldom heard phrase, “‘Teach well or perish’”! (§ 57). Unless more value is placed on these endeavors, some faculty may feel it is more advantageous to wait until they have been tenured to learn about and to incorporate the new instructional technologies. The efforts to ensure greater academic quality discussed earlier can help T/P committees to develop appropriate guidelines that reflect best practices. Hagner and Schneebeck (2001) recommend that clear articulation of the parameters for scholarship and activity in the area of IT, which can lead to T/P, be presented

to faculty in writing. Failure to articulate those parameters will keep non-users from transitioning to prospective IT users and prospective users from transitioning to new users.

Finally, to ease concerns over job security in regards to the impact of technology-related issues, open dialogues between faculty and administration offer a good beginning. Faculty need a forum, be it special sessions of a faculty senate or an even more open venue, where they can voice their concerns. They need to be made to feel their input matters, and administrators need the opportunity to address and ease those concerns. Open discussions about this and all other barriers is a key element to promote IT integration (Hagner & Schneebeck, 2001) and to improve the socialization process. Negotiating to a level of comfort for both groups would do much for the future of higher education and its move towards increasing IT integration to promote student learning—after all, improving student learning is common ground for both groups.

CONCLUSION

Increasing faculty integration of IT in higher education has proven to be a complicated and difficult process. Faculty members encounter numerous barriers that negatively affect their evaluation of IT and adversely affect their commitment to implementing new technologies. They frequently need to change roles within the teaching domain (often without clear direction, encouragement, or acknowledgement), adding to the difficulties for prospective or new users of IT. The pace of IT improvements and innovations means that even experienced IT users cannot rest. Barriers aside, there are many ways that higher education faculty members and institutions can increase their commitment to and integration of IT. Despite the challenges, clear progress has been and will continue to be made.

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KEY TERMS AND DEFINITIONS

Advanced Instructional Technologies: Cutting-edge technologies that have not been widely used in educational settings.

Basic Instructional Technologies: Technologies such as email and web pages that are considered standard tools of IT.

Instructional Technology: Applications of technology aimed at instructional objectives.

Learning Management System (LMS): Platform: Applications that collect the most frequently used IT tools into a combined application that can be integrated into a University's enterprise systems.

Net Generation: Persons born in the 1980's or later; members of the Net Generation have never known life without the Internet.

New Academy: "Acknowledges the changes manifested in the Net Generation; uses the power of technology to enable deeper learning; demonstrates the interplay of interaction of culture and technology; and changes the nature of interaction among members" (Barone, 2005, p. 14.1).

Student-Centered Instruction (Constructivism): Current approach to education based on active engagement with content.

Teacher-Centered Instruction: Traditional approach to education based on information dissemination, and passive learning.

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Chapter 5.8

Social Psychology and Instructional Technology

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ABSTRACT

This chapter examines how principles in social psychology can be applied to instructional technology. Two areas are discussed to explain why individuals would have a positive attitude towards instructional technology but not engage in consistent behaviors. Social psychological research demonstrates attitudes do not necessarily correlate with behaviors. Factors that moderate this relationship include attitude extremity, attitude importance, attitude accessibility, direct experience, attitude specificity, habits, and social norms. Additionally, if individuals cannot comprehend messages, they cannot develop their knowledge of instructional technology even if they wanted. To comprehend messages, individuals have to have the ability (i.e., both knowledge and time) to

thoroughly process them. Examples are provided illustrating each of these concepts. The author hopes by examining the field of social psychology, new ideas, new understanding, and new areas of research can emerge in the field of instructional technology.

INTRODUCTION

It is often useful for outsiders to examine another discipline and suggest ways their field can apply. Therefore, as a social psychologist, I would like to glance at instructional technology and attempt to illustrate how research from social psychology can help instructional and other educational technologists better understand their domain. I will give a brief definition of social psychology along with its contribution of the idea of situationism. Then I will give an example of how

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social psychology can be applied to a perplexing question in instructional technology, why people who like and support instructional technology do not maximize their knowledge of or efficient use of their instructional technology systems. I will demonstrate that social psychological research on attitude-behavior consistency and the theoretical idea that people are motivated tacticians help explain this counterintuitive behavior.

BACKGROUND

Social psychology is defined as “the scientific attempt to understand and explain how the thoughts, feelings, and behaviors of individuals are influenced by the actual, imagined, or implied presence of other human beings” (Fiske, 2004, p. 4). A typical social psychology textbook includes chapters on social cognition, person perception, self, attitudes, prejudice, social influence, relationships, helping, and aggression. Issues relating to gender and culture are examined in each chapter. Theories and research from social psychology have helped create and expand the areas of industrial/organizational psychology, health psychology, forensic psychology, and political psychology.

Given that a main theoretical perspective in social psychology is sociocultural (Taylor, 1998), the theoretical paradigm in instructional technology that social psychology would most closely relate to is situated learning theory (Reiser & Dempsey, 2002). In addition, along with the rest of psychology, social psychology underwent a cognitive revolution in the 1970s with social cognition emerging as a main theoretical perspective (Taylor, 1998). Therefore, social psychology may also have applications to instructional technology that have its roots in information processing.

As the definition and the main topics illustrate, social psychology examines how people interact with other people. However, information technology often examines how individuals will interact with objects, and there are differences in how

individuals relate to people versus objects (Fiske & Taylor, 1991). As an individual perceives and interacts with others, others perceive, judge, and respond in return. Although objects may interact with people and respond to their actions, objects do not richly interact, are less likely to change, and are not perceived as causal agents. Nevertheless, there are several areas of psychology, especially ones focusing on intra-individual processes such as social cognition and attitudes that would be most relevant to instructional technology.

A key component of social psychology that relates to many issues in instructional technology is the idea of situationism. Situationism (Ross & Nisbett, 1991) is the perspective that a major cause of social behavior is the situation. Although many types of psychology relate to the importance of the individual, Lewin (1951), often considered the father of modern social psychology, theorized behavior is a function of both personality and environment. Social psychologists recognize the importance of the person, but they also recognize the importance of the situation and are familiar with research that demonstrates how many people underestimate the strength the situation has on people’s behaviors (Jones, 1990).

This idea of situationism has allowed social psychologists to explain why people often behave counterintuitively such as being willing to give electric shocks in near lethal doses to individuals (Milgram, 1974), deliberately changing their answer just to go along with a group (Asch, 1956), and not helping a person who clearly needs assistance (Darley & Latané, 1968). In each case, the situation was powerful enough to override how the individual personality would be prone to behave.

To demonstrate how social psychology could relate to instructional technology, this chapter explores two examples of why people may not maximize their knowledge and efficient use of their instructional technology system. Specifically, the chapter examines why a college instructor would not have a Web site for their course, and why people do not use many of the available shortcuts

on their computer. For example, in Microsoft Office, CTRL-S can be used to save a document; however, many people exclusively use the mouse to save. Although this keystroke saves time, many people do not use it.

There are many reasons why somebody would not be interested in instructional technology. Not surprisingly, people who are not interested in new technology or people who are afraid of new technology would likely not be motivated to maximize their knowledge and efficiency of their system. Rather, they would avoid using the technology altogether. This behavior would be intuitive although perhaps not productive. Therefore, to examine how social psychology can explain *counterintuitive* behavior, these examples will assume the person is interested in instructional technology and wants to learn and develop their skills and be a more effective teacher. Therefore, the examples used in this chapter concern a college instructor who wants to develop a course Web site but does not and a person who wants to learn Microsoft Office shortcuts but does not. To illustrate how people who have positive attitudes about instructional technology may not behave in ways congruent with that attitude, the following sections discuss research on attitude-behavior consistency and the theoretical idea of people as motivated tacticians.

ATTITUDE-BEHAVIOR CONSISTENCY

Attitudes are the “overall evaluation of persons (including oneself), objects, and issues” (Petty & Wegener, 1998, p. 323), and behavior is the action related towards the person, object, or issue. Early social psychological research LaPiere (1934) indicated people’s attitudes do not always match their behavior. In fact, an early review of the literature demonstrated typically small correlations, usually less than .30, between attitudes and behavior (Wicker, 1969). Later research has

indicated when attitudes are more likely to predict behavior. Factors that have been shown, through this research, to moderate the relationship between attitudes and behaviors include attitude strength, attitude specificity, habits, and social norms.

Several properties relate to the strength of an attitude (Krosnick, Boninger, Chaung, Berent, & Carnot, 1993). One might believe strength in attitudes relates only to the extremity of the attitude (Prislin, 1996). That is, a strong positive attitude towards instructional technology means the person is extremely in favor of it. However, stronger attitudes can also be strong because they are more important, accessible, or based on direct experience. Importance is defined as how deeply the individual cares about the attitude object. Accessibility relates to whether the attitude is routinely salient (i.e., prominent) in a person’s mind. For example, in a national election, people’s political attitudes will likely be more accessible. Direct experience means people have had encounters with the object themselves as opposed to getting information about the object from a secondary source. For instance, a person may have a stronger attitude about a specific brand of car if they have driven the car themselves rather than listening to a friend about his or her driving experience.

Based on the ideas of attitude strength there are many situations in which a person has a positive attitude about instructional technology, but does not act like it. Obviously, if an instructor only has a slightly positive (i.e., very low on extremity) attitude towards creating a course Web site, then there will be little motivation to complete that task. As another example, although a person may believe they should use the Microsoft Word shortcut, they perceive the consequences as being minimal and not affecting their values. Therefore, the attitude has low importance. Also, if their attitude about educational technology is not accessible during an important planning period, possibly because other topics are competing for attention, then behavior may not be predicted from a positive

attitude. Finally, if the person who has a positive attitude about course Web sites does not have any direct experience with them, then their attitude may be weaker than if they have previously had a course Web site.

Based on this analysis, there are several methods to increase positive behaviors toward instructional technology. (1) Increase the extremity of the attitude. Probably the most permanent way of changing an attitude would be to create quality arguments in favor of the instructional technology and give them repeatedly to the audience (Cacioppo & Petty, 1985; Petty, Haugtvedt, & Smith, 1995). (2) Emphasize the importance of the attitude. For example, a person does not likely care about wasting 2 seconds using a mouse instead of a shortcut. However, pointing out how many shortcuts exist and how much time could be saved over an extended period may increase the attitude's importance. (3) Create an environment such that people will recall their attitude at a crucial time. For example, instructors could be presented with information about course Web sites and reminded of their attitude right before they begin planning the next semester. (4) Finally, provide direct experience. Providing resources to instructors to allow them to create a course Web site, could increase the likelihood they would, in the future, create another course Web site on their own. However, care needs to be taken to make sure creating a course Web site does not make the instructor begin to have a negative attitude about course Web sites.

Another reason why attitudes do not necessarily predict behaviors is that the measured attitude is too general to predict a specific behavior (Kim & Hunter, 1993). For example, a person may have a positive attitude about the United Way but not make any yearly donation. Measuring the person's attitude towards, not the United Way as a whole, but rather towards making donations to the United Way will give a better indication of whether the person will make a donation to the United Way. Likewise, many people have a positive attitude

about instructional technology; however that attitude may be too general to predict the person's behaviors related to instructional technology. For example, an instructor may have a positive attitude towards instructional technology, but that attitude would likely not predict whether the person would create a course Web site. Rather, measuring a matching attitude about creating course Web sites would better predict behavior. Although this insight does not provide recommendations for getting individuals to use instructional technology more effectively, it does provide insight into how to measure attitudes about instructional technology that better predict a desired behavior.

Attitudes may not relate to behaviors due to habits. For instance, a person may have a negative attitude about biting one's fingernails, but continues to bite them out of habit. Research indicates habits are automatically activated based on a goal (Aarts & Dijksterhuis, 2000). For example, a person may have a habit of using the computer mouse that is activated by the goal of saving the Microsoft Office document. Because there is no controlled processing, the attitude of using instructional technology efficiently is not accessed. This factor could be quite problematic in the realm of instructional technology because adapting to new instructional technologies likely means discarding old habits.

A final reason why attitudes may not predict behavior has to do with social norms. Social norms are cultural rules about how to behave and not behave. Social norms are often powerful enough to affect behavior. For example, a salesperson may have a negative attitude about a customer, but it is unlikely the salesperson will behave in a way that lets the customer know their dislike. A teenager may only smoke because it is the social norm of their peer group. Social norms can easily prevent a person from adopting positive behaviors relating to instructional technology even if they have a positive attitude. If people do not receive approval from important others, or in fact receive disapproval from these important others, then

even a positive attitude will unlikely produce a congruent behavior. These important others can be peers, upper administration, students, and so forth. For positive attitudes about course Web sites to relate to behavior, the administration would have to make sure the social norms approve of course Web sites.

PEOPLE AS MOTIVATED TACTICIANS

The social psychological idea that people are motivated tacticians also illustrates why individuals may have a positive attitude towards instructional technology but not have matching behaviors. However, instead of directly examining behavior, this idea focuses on whether a person can become more knowledgeable about a topic. With the cognitive revolution in psychology and social psychology, researchers initially theorized people were cognitive misers (Fiske & Taylor, 1984). That is, people would only process the minimal amount of information needed about a concept and would naturally conserve their cognitive resources. Being a cognitive miser is oftentimes beneficial. With all the stimuli and decisions people are presented with everyday, people must have processing shortcuts to be able to successfully relate to the world around them. However, if people were consistently cognitive misers, it would be very difficult for them to learn new instructional technologies. People would rely on tricks used with previous systems and would be less likely to adapt to new technology or even new versions of existing technology. Rather, cognitive resources would be saved for other uses.

Social psychological theorists realized people do not always act as cognitive misers. Rather, they pick and choose when to expend significant cognitive energy and when to be cognitive misers. In other words, researchers theorized individuals are what are called motivated tacticians (Fiske & Taylor, 1991). For example, a person would

likely not spend much cognitive energy choosing which groceries to purchase. Rather, various shortcuts would be used such as what has been bought in the past, what is on sale, what is very convenient to get, and so forth. However, when a person purchases a car, they often spend much more time and energy determining if it is a good purchase. Although they may still use shortcuts (e.g., whether their friend likes the car or not), it is difficult to imagine a person being more cavalier choosing a car than choosing cereal.

Evidence indicates people process information thoroughly when they have both motivation and ability to expend cognitive energy (Petty & Cacioppo, 1986). Motivation to improve one's knowledge about instructional technology would likely be present if one has a positive attitude about instructional technology. However, if a person does not have the ability, that person will be forced to process information heuristically (i.e., using shortcuts). Ability includes both knowledge and time. If a person does not understand instructional technology, they will likely not be able to make good decisions concerning its use. For example, if the person does not have enough experience with the technology to understand the help documentation, then when they encounter a problem, that person will not be able to think carefully or easily expand their knowledge. Similarly, if a person does not have enough experience with a type of technology, instruction could easily be "over their head" and not useful. Likewise, if a person does not have enough time to think carefully about a topic, they will likely not be able to learn more about it. All of these problems can occur even if they are interested in learning about the technology. An instructor who wants to create a course Web site without enough ability would likely not be able to develop the knowledge necessary to facilitate the creation of a quality Web site. Consequently, for an instructor to be able to create an effective course Web site, they must have the time and enough knowledge to proceed.

FUTURE TRENDS

Although it is important to become familiar with one's own discipline, oftentimes other disciplines can shed light on important topics. Clearly instructional technology applies to many different fields from the military to business and from higher education to health care (Reiser & Dempsey, 2002). Undoubtedly, as instructional technology becomes more and more relevant, the frequency of potential applications will only increase. Hopefully, at the same time instructional technology will continue to incorporate research into their discipline from other fields. In this chapter I have suggested social psychology be at the forefront of disciplines that can be useful for instructional technologists to explore so they may better understand their own discipline. I would like to mention another benefit of examining social psychology. Although the examples used in this chapter assumed individuals would be positively motivated to develop their knowledge concerning instructional technology, that assumption is often not realistic. Research and theories from social psychology can also show how to persuade people to believe they need to gain a greater appreciation of instructional technology. This deep body of knowledge has already been applied to other situations in which a person is often not motivated, such as helping health psychologists study how doctors can get patients to obey instructions (Sadava, 1997).

CONCLUSION

Research and theories from social psychology demonstrate how individuals may have a positive attitude about instructional technology but not have a corresponding behavior. The factors this chapter has examined can be broken down into person factors and situational (i.e., environmental) factors. Person factors include attitude extremity, attitude importance, attitude accessibility, direct experience, habits, and knowledge. Environmental

factors include social norms. Although there are a greater number of person than situation factors, personality is not necessarily more relevant than the situation in determining how individuals will behave. Rather, the environment of the group (e.g., organization, classroom) can greatly affect not only situational factors but also many of the person variables. An organization can provide time and encourage direct experience. Likewise, an organization through its culture can increase attitude accessibility and the importance of certain attitudes. As indicated by research in social psychology, the situation is more important than most people realize.

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KEY TERMS AND DEFINITIONS

Ability: Ability is having the resources (e.g., knowledge, time) to accomplish a task.

Attitude Strength: Attitude strength is the stability of an attitude and the impact the attitude has on information processing and behavior.

Attitude-Behavior Consistency:

Attitude/behavior consistency is whether an attitude (i.e., overall evaluation) does or does not correspond with behavior (i.e., action).

Cognitive Miser: Cognitive miser is the idea that people minimize the use of their cognitive resources.

Motivated Tactician: Motivated tactician is the idea that people choose when to minimize

the use of their cognitive resources and when to engage in effortful processing of information.

Situationism: Situationism is the theory that situations are a major determinant of individual behavior.

Social Psychology: Social psychology is the scientific study of how individuals relate with and are influenced by other people.

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Chapter 5.9

Addressing Emotions within E-Learning Systems

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ABSTRACT

Emotions are attracting growing attention within the instructional design research community. However, clarification is still required as to how exactly to address emotions within the field of e-learning. The aim of this chapter is twofold. Firstly, we will focus on the reasons for including emotions within the instructional technology domain, and in particular, on the relevance of emotions to computer-based learning. The need for specific theory in this regard is heightened by the current drive to design instructional de-

vices that interact with learners in a motivating, engaging, and helpful way. Secondly, within the of the framework affective computing paradigm, the different modalities for detecting emotions in instructional technology contexts will be systematically reviewed, and the strengths and limits of each will be discussed on the basis of the most up-to-date research outcomes. Finally, a tentative architecture for emotion recognition in computer-based learning will be proposed, focusing on the adoption of a multimodal approach to emotion recognition, in order to overcome the limitations and the difficulties associated with individual modalities.

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INTRODUCTION

The Role of Emotions in Learning

There is growing recognition that emotions and affect play an important role in learning. The learning process is influenced by factors connected to the person, the task, and the context as well as the learner's own on-going evaluation of the process itself. Situational characteristics and individual appraisals can trigger emotions (Efklides & Volet, 2005). In turn, as stated by Barrett and Salovey (2002), affect in learning facilitates the development of persistence and interest in a topic. Emotions can also influence learning through information processing activity and organization of recall (Pekrun, Goetz, Titz, & Perry, 2002). Furthermore, emotions can provide information about the learner's own evaluation of the learning process, since they are linked to control- and value-related appraisals within a learning environment (Gläser-Zikuda & Mayring, 2003). For instance, positive emotions generally indicate that successful task control and interest have been experienced. Our learning, therefore, is heavily dependent on the emotional state we are in (LeDoux, 1998), and on the dynamic pattern of positive and negative emotions occurring in a given time period within a learning context (Sansone & Thoman, 2005).

The role of emotions can be relatively easily recognized and managed within face-to-face learning, where they have been shown to be significantly related to student motivation, learning strategies, cognitive resources, and achievement (Pekrun et al., 2002). What is worth considering is the role of emotions when students are remote from their teacher—even when computer-based education can be supported by a human tutor, the latter is likely to have a lesser awareness of the emotional state of students, and may thus more easily fail to provide a responsible teaching presence and appropriate leadership and direction (Wosnitza & Volet, 2005). Despite general awareness of

the need to consider emotions in e-learning environments, it seems that, with the exception of computer anxiety, the emotions experienced during computer-based learning have not yet been analyzed in depth (Pekrun, 2005). Thus, there is a great need for e-learning projects to take the role of emotions in learning into account and to integrate this understanding into their pedagogical approach.

Affect and Emotions in E-Learning Design

Very often, e-learning implies the presentation of information and material on a very rational basis, overlooking the role of emotions. Yet, computer-based learning can be affected by a range of emotions, including some which do not occur within face-to-face learning, such as emotions directed at technology. Nowadays almost all Web-based training platforms allow computer-mediated communication, where e-learning can take place within either solo or social situations. In solo learning, self-directed, task-directed, and technology-directed emotions have been identified. In social online learning, further emotions have been observed, such as emotions directed at another learner, at the group the learner belongs to, or at another group of learners that his/her group is interacting with (Wosnitza & Volet, 2005).

Moreover, as O'Regan (2003) has pointed out, there has been little exploration to date of the extent, nature, and significance of affect and emotions in e-learning design. If emotions are essential to human thinking and learning processes, virtual platforms and learning environments need to cater to the emotional factor in order to be successful. In particular, the computer graphical interface should not treat humans like information processing machines, but should take their emotions into account. Therefore, it is critical that system designers consider the range of possible affective states that users may experience while interacting with the system.

The key problematic issue remains how to address emotions in human-computer interaction: This topic is currently the focus of a specific research field defined as affective computing (Picard, 1997). All studies with the aim of including emotions within information technology design can be ascribed to this domain, which deals specifically with three different levels of emotion integration: the detection of user emotions, the expression of emotions by computers, and ultimately, the possibility for a computer to “have” emotions. All three levels of emotion integration can greatly enhance the interaction of users with computer programs. Thus, software can nowadays be provided with a kind of emotional intelligence, conceived of as one of the most critical characteristics for successful human interaction (Salovey & Mayer, 1990). The current chapter will mainly focus on the issue of detection.

With specific reference to educational research, according to Picard et al. (2004), new technologies can play a double role: On the one hand, they can help provide new types of research data on the role of affect in learning, laying the bases for new approaches to education, and on the other, can provide enhanced computer-based learning environments to support the user more effectively through his/her learning process.

This chapter introduces the preliminary questions needing to be addressed in order to carry out emotion assessment within learning environments. Such questions highlight the need for wider use of recognition instruments. Subsequently, after reviewing a number of possible channels of emotion detection in e-learning applications, a multimodal approach is recommended in order to increase reliability of recognition outcomes. On the basis of this multimodal approach, a tentative architecture for automatic emotion recognition is outlined. Inclusion of a cognitive component is suggested, in order to integrate the outcomes from different channels, as well as the registration of meaningful events experienced by the user during the learning experience.

DETECTING EMOTIONS WITHIN INSTRUCTIONAL TECHNOLOGY DOMAIN

The first step towards the integration of emotional intelligence is the ability to detect users’ emotions. Two main emotion detection approaches can be identified within e-learning environments—that carried out by a human tutor, or teacher, participating in the learning environment, and that carried out by the e-learning system itself, termed *automatic*. The first is largely similar to the emotion recognition taking place in traditional learning environments and may also be used in computer supported learning, although the human tutor may have reduced access to emotional information. The second demands a more defined and specific basis and is more suitable for autonomous e-learning systems.

When addressing automatic emotion recognition, researchers must answer two main questions: First, when in the course of the learning interaction the system should be emotionally aware, and second, how it should recognize emotions, that is, based on which signals.

With regard to the timing issue, emotion recognition processes may be activated in three different periods vis-à-vis the learning path: (1) measurement immediately before and/or after the learning process, (2) measurement during the learning process, and (3) stimulated recall measurement of emotions after the learning process (Wosnitza & Volet, 2005).

Measuring emotions just before or after the learning process, on the one hand does not interrupt the learning experience but, on the other, requires specific pre-scripted moments to be integrated that may irritate the user and may lose efficacy due to the delay between the emotional experience and the emotional assessment. The delay factor also impairs the effectiveness of the “emotional coping” that the system should ideally carry out. Similar, but amplified, drawbacks apply to stimulated recall measurement.

Emotion recognition during the learning process may be a better solution. This involves real-time emotion assessment, with the potential to be time effective when an emotionally relevant modification occurs. On the other hand, real-time emotion automatic recognition faces greater technical challenges than the other possible timing options, and furthermore needs to be as truly automatic as possible so as not to disrupt the learning process. In consequence, a balanced recommendation is for real-time emotion recognition to take place in specific and critical learning moments.

In regards on *how* to detect emotions, a number of channels are described in the next paragraph. Before outlining individual modalities it is worth mentioning that considering emotion to be a componential process (Scherer, 1984, 2001) enables simultaneous inclusion of many different measures (Pantic & Rothkrantz, 2003). This approach enhances the likelihood of recognizing an emotional state, and partially reduces the risk of distortion due to factors such as social desirability and deliberate control of emotional expression (Pekrun, 2005). Each channel presents its own limitations, but these may be partially overcome by the adoption of a multimodal approach to emotion recognition, which integrates information from multiple sources and may be regulated depending on the context of use.

A Multimodal Approach to Emotion Recognition

Providing e-learning systems with the ability to *recognize* user emotions is a prerequisite for the enhancement of computer-based learning by integrating emotional experience. Recognition systems face two core challenges: (1) detection of the emotion-related signals provided by the users and (2) inference of the emotional state of the user according to the signals detected.

With regard to modes of detection, in addition to self-report measures, a number of channels are considered emotion sensitive. For instance,

studies have been carried out on the link between emotional states and modifications in each of the following channels: physiological correlates, facial expressions, gestures, verbal communication, vocal non-verbal communication.

Physiological correlates of emotions have been considered a reliable means of detection since the work of James (1884). Ekman, Levenson, and Friesen (1983) suggested that the identification of distinct emotions on the basis of autonomic nervous system (ANS) activity requires taking into account different indices simultaneously. Various instruments for the detection of physiological signals (e.g., blood volume pulse, respiration, skin conductance, electromyography, neurological response) are already in existence and are subject to constant enhancement, particularly in order to make them less intrusive by integrating them into more natural seeming devices, for example, incorporation of sensors in a mouse or wearable jackets. The main problem is recognized to be the extreme variability of these signals across people and situations and even within the same person. This is borne out by the fact that few studies have indicated the existence of specific patterns of autonomic activity for specific emotions (for a review see Cacioppo, Berntson, Larsen, Poehlmann, & Ito, 2000). The search for an invariant relationship between emotions and physiological responses should be abandoned in favor of the analysis of, under what conditions, and for which emotions, differential physiological activity is observed (Cacioppo et al., 2000).

A number of attempts at automatic emotion recognition from physiological measures have been made. Some researchers have tried to directly link a set of values to a set of emotions via various statistical algorithms (Nasoz, Alvarez, Lisetti, & Finkelstein, 2004). Others, using a dimensional model of emotion (where emotions are represented along some main axes, typically arousal and valence) have tried to use each physiological measure as an index of a single dimension (Picard, Vyzas, & Healey, 2001; Prendinger, Mori, & Ishizuka,

2005). What emerged from most of these studies is that physiological measures alone cannot provide enough information for emotion recognition: other information is needed (Scheirer, Fernandez, Klein, & Picard, 2002). In addition, awareness of the context can have critical significance for the interpretation of physiological data (Stemmler, 2003; Ward & Marsden, 2003).

Facial expressions of emotions have been investigated in depth. According to Ekman (1994), each emotion goes with a specific pattern of facial actions, as predicted by the Facial Action Coding System (FACS) (Ekman & Friesen, 1978). Although this bi-univocal link has been severely criticized, most of the research on automated emotion recognition is based on the FACS model. An early work carried out by Kaiser and Wehrle (1992) described a procedure for automatic detection of facial behavior independently of individual physiognomic differences, through the use of plastic dots affixed to predefined facial regions. A pattern-recognition algorithm identifies dot patterns that are classified according to the FACS by an artificial neural network. More recently, Cowie et al. (2001) outlined a system for the recognition of facial expressions by identifying Facial Animation Parameter Units defined in MPEG-4 standard, but the system is still not fully automatic and requires human assistance. Conversely, Kapoor, Qi, and Picard (2003) proposed a fully automatic framework that requires no manual intervention to analyze and recognize upper facial actions, corresponding to the regions of eyes and eyebrows. Tian, Kanade, and Cohn (2000) developed an automated system to analyze subtle changes in facial expressions, based on both permanent (brows, eyes, mouth) and transient (deepening of facial furrows) facial features in a nearly frontal image sequence. The system is based on multi-state templates that require manual set up in the first frame of the sequence; thus the system is not fully automatic.

In any case, the FACS model is not free of problems. Although prototypic expressions of some emotions, for example happiness, are natural, they occur infrequently in everyday life, since people tend to communicate more through subtle facial actions. In addition, emotions like confusion, boredom, and frustration do not have corresponding prototypic expressions. Furthermore, this method lacks temporal and detailed spatial information (Russell & Fernández-Dols, 1997).

Gestures are not generally linked to specific emotions. Although some studies have identified expression of emotional meaning through body movements (Wallbott, 1998), psychologists generally maintain that the meaning of gestures is mainly determined by the specific interaction context. Consequently, it is difficult to assume a direct link between gestures and specific emotional states.

The situation with regard to *posture* is even more complicated, since in the field of nonverbal behavior research there is no established and generalized criterion about how to classify postures or about the association between posture and emotional state. However, some attempts have been made to automatically detect emotion from postures and gestures. Mota and Picard (2003) presented a system for recognizing naturally occurring postures and associated affective states, relating to the interest level of children while performing a learning task on a computer. The system is capable of two kinds of recognition: (1) recognition of a static posture position and (2) recognition of a sequence of postural behaviors. The system is not fully automatic because it requires preliminary selection and coding of posture action units by human observers. Similarly, affective states linked to postures have to be selected and labeled manually by observers.

The *verbal communication* of emotions concerns terms and words produced in concurrence with an emotion, and it takes into account the cultural differences reflected in the terms adopted and in their meaning (the so-called emotional lexi-

con). The language-emotion relationship has been studied from various perspectives: lexicographic research on words that refer to emotions, highly related to the universality or culture-relativity of human emotions (Wierzbicka, 1995); syntactic research focusing on emotion verbs like *to fear*, and so forth; investigation of certain types of language use, such as hyperbole, repetition, the use of strong metaphors; conversational analysis, which studies the rules regulating the occurrence of emotionally expressive behavior in interaction.

Attempts at automatic emotion recognition based on verbal communication can be grouped into a number of categories: (1) *keyword spotting*, where text is classified into affect categories based on the presence of fairly unambiguous affect words like *distressed*, *enraged*, and *happy*, for example, *affective reasoner* (Elliott, 1993) and Ortony's affective lexicon (Ortony, Clore, & Collins, 1988); (2) *lexical affinity*, detecting more than just obvious affect words, the approach assigns arbitrary words a probabilistic "affinity" with a particular emotion; (3) *statistical natural language processing*, that is, by feeding a machine a learning algorithm with a large training corpus of affectively annotated texts, it is possible for the system to learn the affective valence of affective keywords as well as that of other arbitrary keywords (as in the lexical affinity approach), punctuation, and word co-occurrence frequencies.

The *vocal-nonverbal communication* of emotions deals with the differences that can be identified in some phonatory variables (e.g., intensity, tone, rhythm) when an individual is, for example, expressing happiness or sadness: Some patterns of vocal supra-segmental traits have been described (for a review see Juslin & Laukka, 2003; Scherer, 2003). Several studies have shown that each emotion is associated with a distinctive vocal profile in a systematic way.

A growing research corpus about automatic recognition of emotions from voice can be found in scientific literature. It should be pointed out that the motivations behind these studies range from

theoretical and scientific to application based. The first category focuses on acted speech and on a broader range of emotions, while the second includes, for instance, work on speech from automatic call centers (Batliner et al., 2000) and research on detection of stress during driving (Fernandez & Picard, 2003). As pointed out by Oudeyer (2003), research on automated vocal production and recognition of emotion has only been carried out for a short number of years. As well as systems aimed at automatically detecting some basic emotions independently of context, systems have been developed to focus on one/two target emotions, of particular relevance to specific application fields. For example, Batliner et al. (2000) proposed a system for the recognition of anger to enhance the effectiveness and usability of automatic dialog processing.

Self-report measures have also been proposed to detect emotions. Some researchers have developed questionnaires to be administered to participants in order to obtain information about their emotional experience (Russell & Mehrabian, 1977; Scherer, 1988). Besides questionnaires, other self-report measures based on nonverbal and pictorial methods (e.g., Self Assessment Manikin Scale; Bradley & Lang, 1984) were put forward; here users choose the images that best represent their emotional states, partially overcoming the limits inherent to linguistic and verbal expression.

This means of detection, on the one hand is non-intrusive, fast and cheap, but, on the other, can be affected by distortion due to social desirability factors and to the potential inability of the user to correctly express his/her own emotional experience.

What emerges from this review is that each channel has its own strengths and weaknesses that should be taken into account when trying to implement an automatic recognition model. Table 1 provides a brief critical assessment of the different channels reviewed, both from psychological and implementational viewpoints.

Table 1. Assessment of different detection channels

	CHANNEL EVALUATION	INTRUSIVENESS	TECHNICAL COMPLEXITY	PRICE / COSTS
<i>Physiological measures</i>	Advantages: Rapid and synchronous modifications. Biological foundations. Uncontrollable by the participant. Limits: Easily influenced by non-emotional events and environment. Wide variations across people, situations, and even within the same individual.	Very high. Future development of wearable devices may reduce it.	Hardware difficulties: Integration of specific devices. Software difficulties: (1) real-time data processing; (2) recognition algorithms.	Medium-high for physiological detection device.
<i>Facial expressions, gestures, and posture</i>	Advantages: Relatively spontaneous; easy to observe; objective. Limits: influenced by non emotional factors and by environmental events (context). May be culturally influenced. Gestures are linked to conversation.	Medium. People can be annoyed by cameras. Some systems require cameras positioned on participants' head.	Hardware difficulties: Integration of cameras. Software difficulties: (1) AU extraction; (2) posture tracking and extraction; 3) real-time processing.	High for cameras and AU recognition software.
<i>Speech (verbal)</i>	Advantages: Non intrusive; easy to collect. Limits: For emotion lexicon, difficult to know whether the reported emotion is a conceptualisation or the effective state; whereas linguistic indexes require long conversational sequences to be detected.	Low	Software difficulties: Integration of word recognition software and emotional semantic map.	Low for microphone. Medium for word recognition software
<i>Vocal non-verbal measures</i>	Advantages: Link to physiological changes; wide research tradition on emotional vocal patterns; low intrusivity. Limits: Technical difficulties; problems in noisy environments; possible problems with phonetic variability; few results for naturally collected data; recognition rate varies according to the database (number of emotions, mode of data collection, number of speakers); systematic confusion for some emotions.	Low	Hardware difficulties: Integration of a spectrograph. Software difficulties: (1) real-time data processing.; (2) recognition algorithms.	Low for the microphone and for spectrograph.
<i>Self-report measures</i>	Advantages: Simple to administer to the user. Limits: distortions due to social desirability, errors in the self-monitoring process, cultural differences, potential disruption of learning path.	Medium/low. Requires definition of timing, may disrupt the learning process.	None	Low

Guidelines for Designing an Inferential System of Emotion Recognition

Once emotion-related signals have been detected, the recognition system needs an inferential system in order to attribute an emotional state to the users.

The inferential system can be defined as a cognitive architecture that is able to integrate the

various input signals with other elements, so as to infer the user's emotional state.

Specifically, we propose that a cognitive architecture of emotions should be designed in order to output a possible emotional state, by working from four main inputs: (1) individual characteristics, (2) initial signal profile, (3) real-time signals, and (4) context modeling.

Firstly, the system should profile the user in terms of different psychological variables in

order to establish his/her individual personality characteristics. In other words, the user should be emotionally and motivationally profiled (e.g., Matsubara & Nagamachi, 1996), and these characteristics, subsequently, should be taken into account to weight the possible outcomes of the context modeling.

Secondly, an initial stage of interaction should be provided for, in order to detect the baseline values of physiological and vocal nonverbal signals for each user (physiological and vocal profiles). Due to the interpersonal variation for these signals, the inferential system needs a period to register the signal levels of the user at rest: these values will be considered the baseline for modifications detected during the interaction (Berntson, Uchino, & Cacioppo, 1994).

Thirdly, the inferential system should work on the outputs of different modality-specific modules (speech: vocal analysis module; visual analysis module; physiological signal module; self-report measures module; speech: verbal module). Each of these has its own limitations, and none can be fully relied upon to detect emotions in isolation from the others, whereas multimodal analysis may at least partially reduce problems (Pantic & Rothkrantz, 2003). All the modules provide information about behavior and physiological variations displayed by the user at a certain stage of the interaction: Variations should be processed by the inferential system in order to assess emotional state using an advanced statistical approach, including different learning and classification algorithms. To this end, it is critically necessary to define a training database, as a fundamental prerequisite for developing reliable classification algorithms (Anolli et al., 2005).

Fourthly, context modeling is one of the main features to be included, and it may be one of the more promising ways to enhance inferential reliability. If only physiological and communication measures are considered, distortions and mistaken emotional attributions may occur, since a key component of emotional experience is still

lacking. Emotions result from both an arousal component and from a cognitive component, the latter encompassing the appraisal of *arousal* and its attribution to an emotion eliciting event. Appraisal theories suggest that emotions are elicited and shaped by an individual's subjective evaluation of situations or events that affect the individual's needs or goals (Frijda, 1986; Scherer, 1984; Weiner, 1986). Environmental or proprioceptive stimuli are evaluated by the individual vis-à-vis a number of criteria and dimensions linked to individual meaning. As a result, the same stimulus can provoke very different emotional reactions among people (Lazarus, 1966), depending on the outcome of the subjective appraisal.

Appraisal theorists suggest that individuals use a fixed number of dimensions or criteria for evaluating the significance of the events. These criteria can be categorized into four major classes: (1) intrinsic characteristics, such as novelty; (2) significance for individual's needs or goals; (3) ability to influence or cope with the consequences of an event; and (4) compatibility with social or personal standards, norms, or values (Scherer, 1984).

The model of emotions proposed by Ortony et al. (1988) is one of the most used within affective computing, since it can be implemented in computer software. The authors do not represent affect as a set of basic emotions nor as emotions defined within a dimensional space, but group emotions according to the eliciting cognitive conditions.

The inclusion of context modeling to address the cognitive component of emotion may require the definition of an additional module (registry module). This module would take into account relevant information about events happening to the user, pertinent both to the learning context and the learning process, for example, a failure while using a certain software or the loss of some data due to a system error.

While it is not possible to register what is happening outside of the concrete interaction, it may be useful to consider the events of the learning

interaction itself, for example, failure in a test phase could be presumed to be negative valenced and to influence emotional state according to corresponding appraisal criteria. In other words, the system could be provided with some appraisal criteria that would partially define the emotional significance of events occurring to users.

The cognitive architecture should be able to process variations within each modality, integrate them, and attribute a potential meaning to them depending on the initial state and profile of the specific user and output of the registry module.

CONCLUSION

A topic of key interest to educational researchers is the search for strategies capable of inspiring the interest and active participation of learners (Bransford, Brown, & Cocking, 1999). In traditional face-to-face learning this hinges on the ability of the teacher. Teasing out and replicating all the components of this ability remains a huge challenge for e-learning designers. One possible way forward, according to Picard et al. (2004), is to approach these learning goals by incorporating affective information into the e-learning path. This line of enquiry appears all the more feasible, as a growing number of relevant technologies

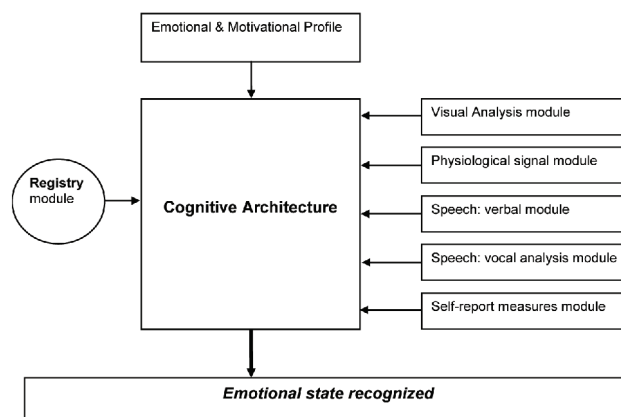
are coming on stream, especially in the field of emotional detection.

Recently, a number of projects have addressed the inclusion of affect in learning and education environments (see Kapoor, Mota, & Picard, 2001; Zhou & Conati, 2002). For instance, as cited previously, a preliminary system for the automatic detection of children's interest levels during learning situations, based on a combination of posture and facial expressions, was designed at the Massachusetts Institute of Technology Media Lab (Picard et al., 2004).

In this paper we have described a possible way to enhance an automatic emotion recognition system. The key defining characteristics of our proposal are multimodality, that is, the inclusion of multiple detection channels and contextual awareness of events occurring within the learning path. Both of these characteristics can contribute to creating a more effective system.

Nonetheless, some key limitations of the proposal should be discussed. Currently, it is not possible to identify the optimum combination of real-time measures and other sources of information required for emotion recognition. A "golden truth" is still lacking, both for the individual channels reviewed and how best to combine them. As already stressed, each channel presents specific reliability problems, and some have additional

Figure 1. Ideal representation of a possible emotion recognition system



drawbacks that partially hinder implementation (e.g., intrusiveness in detecting physiological signals). In order to minimize technical obstacles, more suitable and comfortable devices are needed, which may be wearable or integrated in normally used instruments (mouse, keyboards, etc.).

In addition to technical and scientific limitations, researchers should be aware of ethical issues raised by the implementation of devices connected with emotions. Ethical considerations should be continuously taken into account at all stages of research and development, from the preliminary phase of emotional data collection (in particular if data is acquired through induction procedures) to the final concrete implementation of recognition platforms within everyday applications, because of their potential to detect learners' emotions beyond their conscious wish to disclose them.

In conclusion, it should be pointed out that a recognition system is not an end in itself, but a means to design instructional technology environments to be more effective in supporting user learning experience. Once a system has detected and recognized an emotional state, it can take this information into account in selecting those subsequent actions held most appropriate to improve learner performance, according to the pedagogical strategy in use. Although some scattered attempts have been made to incorporate emotions into models of learning (e.g., Kort, Reilly, & Picard, 2001; Mandler, 1984), no widely shared theoretical model can be identified. The main issue to be investigated along with the definition of emotion recognition systems remains the development of a generally accepted theoretical model of how to use affective information in learning.

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KEY TERMS AND DEFINITIONS

Affective Computing: Affective computing is a research field that aims at including emotions within information technology design. It deals specifically with three different levels of emotion integration: (1) the detection of user emotions, (2) the expression of emotions by computers, and ultimately, (3) the possibility for a computer to "have" emotions.

Appraisal: Appraisal refers to the cognitive evaluation antecedent to an emotional episode. Appraisal theoretical models are characterized and differentiated by the appraisal dimensions included.

Autonomic Nervous System (ANS): ANS is the part of the nervous system that regulates individual organ function and homeostasis, and for the most part, is not subject to voluntary control. It is usually divided into sympathetic and parasympathetic.

Computer Anxiety: Computer anxiety is the individual fear or apprehension of using a computer directly or the anticipation of having to use it.

Emotional Intelligence: Emotional intelligence is the underlying general competence that comprises a variety of emotional skills. Such skills vary according to the different models of emotional intelligence proposed.

Facial Action Coding System (FACS): FACS is a system originally developed by Paul Ekman

and Wallace Friesen in 1978 to taxonomize human facial expression. It is the most used method to measure and describe facial behaviors, coded through action units (AU).

Modality (of Emotional Detection): Modality is each of the different channels that are considered to be emotion-sensitive (i.e., physiological

measures, vocal non-verbal measures, self-report measures, facial expressions, posture and gestures, and verbal content).

Multimodal Emotion Recognition: Multimodal emotion recognition is where one is inferring an emotional state and integrating inputs coming from multiple emotion-sensitive sources.

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Chapter 5.10

Behaviorism and Developments in Instructional Design and Technology

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INTRODUCTION: THE BASICS OF BEHAVIORISM

The *theory of behaviorism* concentrates on the study of overt behaviors that can be observed and measured (Good & Brophy, 1990). In general, the behavior theorists view the mind as a “black box” in the sense that response to *stimulus* can be observed quantitatively, ignoring the possibility of thought processes occurring in the mind. Behaviorists believe that learning takes place as the result of a response that follows on a specific stimulus. By repeating the *S-R* (stimulus-response) cycle, the organism (may it be an animal or human) is *conditioned* into repeating the response whenever the same stimulus is present. The behavioral emphasis on breaking down complex tasks, such as learning to read, into subskills that

are taught separately, has a powerful influence on instructional design. Behaviors can be modified, and learning is measured by observable change in behavior. The behavior theorists emphasize the need of objectivity, which leads to great accentuation of statistical and mathematical analysis. The design principles introduced by the behavior theorists continue to guide the development of today’s computer-based learning. In distance-education courseware and instructional software, key behavior-modification principles are used. For example, a typical course Web site usually states the objectives of the software; uses text, visual, or audio to apply appropriate *reinforcers*; provides repetition and immediate feedback; uses principles to shape, chain, model, punish, and award the learners; incorporates a scoring system as a part of the system; and provides status of the progress of the learner. Major learning theorists associated with behaviorism are the following:

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- Pavlov
- Thorndike
- Skinner
- Watson
- Gagné

The major educational technology developments in America that can be attributed to behaviorism are the following:

- The behavioral objectives movement
- The teaching machine phase
- The programmed instruction movement
- The individualized instructional approaches
- The computer-assisted learning
- The systems approach to instruction

Major instructional design theorists associated with behaviorism are as follows:

- Glaser
- Gagné and Briggs
- Dick and Carey
- Mager

BACKGROUND: BEHAVIORISM AND LEARNING THEORIES

The advent of behavioral theories can be traced back to the elder Sophists of ancient Greece, Cicero, Herbart, and Spencer (Saettler, 1990). Behaviorism, as a learning theory, can be traced back to Aristotle, whose essay “Memory” focused on associations being made between events such as lightning and thunder. Other philosophers that followed Aristotle’s thoughts are Hobbes (1650), Hume (1740), Brown (1820), Bain (1855), and Ebbinghaus (1885). Franklin Bobbitt developed the modern concept of behavioral objectives in the early 1900s. More recently, the names associated with the development of the behaviorist theory include Pavlov, Thorndike, Watson, and B. F. Skinner.

Pavlov (1849-1936)

The Russian physiologist Ivan Petrovich Pavlov is the precursor to behavioral science. He is best known for his work in classical conditioning or stimulus substitution. Pavlov’s experiment involved food, a dog, and a bell. His work inaugurated the era of S-R psychology.

Pavlov placed meat powder (an unconditioned stimulus) on a dog’s tongue, which caused the dog to automatically salivate (the unconditioned response). The unconditioned responses are natural and not learned. On a series of subsequent trials, Pavlov sounded a bell at the same time he gave the meat powder to the dog. When the food was accompanied by the bell many times, Pavlov found that he could withhold the food, and the bell’s sound itself would cause the dog to salivate. The bell became the *conditioned stimulus* that caused the conditioned response of salivating (Thomas, 1992). In 1904, he was awarded the Nobel Prize for his research on digestive processes.

The stimulus and response items of Pavlov’s experiment can be summarized as follows:

- **Food:** Unconditioned Stimulus
- **Salivation:** Unconditioned Response
- **Bell:** Conditioned Stimulus
- **Salivation:** Conditioned Response

Pavlov also made the following observations (Mergel, 1998):

- *Stimulus generalization:* Once the dog has learned to salivate at the sound of the bell, it will salivate at other similar sounds.
- *Extinction:* If you stop pairing the bell with the food, salivation will eventually cease in response to the bell.
- *Spontaneous recovery:* Extinguished responses can be “recovered” after an elapsed time, but will soon extinguish again if the dog is not presented with food.

- *Discrimination*: The dog could learn to discriminate between similar bells (stimuli), and discern which bell would result in the presentation of food and which would not.
- *Higher order conditioning*: Once the dog has been conditioned to associate the bell with food, another unconditioned stimulus, such as a light, may be flashed at the same time that the bell is rung. Eventually the dog will salivate at the flash of the light without the sound of the bell.

Thorndike (1874-1949)

Another influential contributor to establishing education as a science was Edward L. Thorndike. Thorndike's laws were built upon the stimulus-response hypothesis of Pavlov. He was also a strong advocate of educational measurement.

Around the turn of the century, Thorndike conducted researches in animal behavior before becoming interested in human development. He was interested in discovering whether animals, such as cats and dogs, could learn their tasks through imitation or observation.

Thorndike's *laws of learning* for humans, based on *connectionism*, stated that learning was the formation of a connection between stimulus and response. His behavioral learning theory studied increasing a behavior with the use of rewards, punishment, and practice. Three major laws in Thorndike's laws of learning are the *law of effects*, which suggested that the strength of connection is dependent on what follows, the *law of exercise*, which suggested that practice strengthens the connection while disuse weakens it, and the *law of readiness*, which suggested that if physically ready, the connection is satisfying for the organism.

Close temporal sequence is not the only means of insuring the connection of the satisfaction with the response producing it. The other equally important factors are the frequency, energy, and duration of the connection, and the closeness with which the satisfaction is associated with the response.

The result is most clearly seen in the effect of increasing the interval between the response and the satisfaction or discomfort. Such an increase diminishes the rate of learning. Minimum delay in reinforcement has a crucial impact on the learning process. What is called attention to the response or *knowledge of the results* counts also. A slightly satisfying or indifferent response made often may win a closer connection than a more satisfying response made only rarely.

Thorndike believed that when the response was positive, a neural bond would be established between the stimulus and response, and learning takes place when the bonds are formed into patterns of behavior (Saettler, 1990). This is the origin of the linear style using trial and error in laboratory research for inquiry-based learning.

Watson (1878-1958)

John B. Watson is credited with coining the term behaviorism. Like Thorndike, he was originally involved in animal research, but later became involved in the study of human development. Watson believed that humans are born with a few reflexes and emotional reactions of love and rage, and all other behaviors are established through stimulus-response associations through conditioning.

Watson demonstrated classical conditioning in an experiment involving a young child named Albert and a white rat. Originally, Albert was not afraid of the rat. Watson made a sudden loud noise whenever Albert touched the rat. Frightened by the loud noise, Albert became conditioned to fear and to avoid the rat. The fear was generalized to other small animals. Watson then extinguished the fear by presenting the rat without loud noises. Research of the study suggests that the conditioned fear was more powerful and permanent than it really was (Good & Brophy, 1990; Harris, 1979; Samelson, 1980).

Watson's work demonstrated the role of conditioning in the development of emotional responses

to certain stimuli. This helps to explain certain fears, phobias, and prejudices that people develop.

Skinner (1904-1990)

Like Pavlov, Thorndike, and Watson, Burrhus Friederich Skinner believed in the stimulus-response pattern of conditioned behaviors. His theory ignored the possibility of any processes occurring in the mind and directly dealt with changes in observable behaviors. In other words, actual behaviors are the focus of concern in his theory, rather than emotions, thoughts, or other hypothetical constructs (Maddux, Johnson, & Willis, 1992).

Most of Skinner's research was centered around the *Skinner box*. A Skinner box is an experimental space that contains one or more operands, such as a lever, that may be pressed by a rat. The box also contained various sources of stimuli. Skinner contributed much to the study of operant conditioning, which is a change in the probability of a response due to an event that followed the initial response (Skinner, 1968). The theory of Skinner is based on the idea that learning is a function of change in behavior. When a particular S-R pattern is reinforced (rewarded), the individual is conditioned to respond. Changes in behavior are the result of an individual's response to events (stimuli) that occur in the environment. In his early career, Skinner started with experimenting with animals such as pigeons and rats. He later turned his research interests from animals to humans, especially his own daughters.

Principles and Mechanisms of Skinner's Operant Conditioning

- **Positive reinforcement or reward:** Behavior that is positively reinforced will reoccur; intermittent reinforcement is particularly effective. A reinforcer is anything that strengthens the desired response. A

reinforcer could be verbal praise, a good grade, or a feeling of satisfaction.

- **Negative reinforcement:** Responses that allow escape from painful or undesirable situations are likely to be repeated. A negative reinforcer is any stimulus that results in the increased frequency of a response when it is withdrawn. It is different from aversive stimuli, or punishment, which results in reduced responses (Good & Brophy, 1990).
- **Punishment:** Responses that bring painful or undesirable consequences will be suppressed, but may reappear if reinforcement contingencies change.
- **Extinction or nonreinforcement:** Responses that are not reinforced are not likely to be repeated.
- **The schedules of reinforcement:** The schedules of reinforcement can govern the contingency between responses and reinforcement and their effects on establishing and maintaining behavior. Schedules that depend on the number of responses made are called ratio schedules. The ratio of the schedule is the number of responses required per reinforcement. If the contingency between responses and reinforcement depends on time, the schedule is called an interval schedule.

For an animal to learn a behavior, such as pressing a lever to produce food, successive approximations of the behavior are rewarded until the animal learns the association between the lever and the food reward. To begin the shaping process, the animal may be rewarded for simply turning in the direction of the lever, then be rewarded for moving toward the lever, be rewarded for brushing against the lever, and finally be rewarded for pawing the lever. If placed in a cage, an animal may take an extended period of time to figure out that pressing a lever will produce food. Behavioral

chaining occurs when a succession of steps needs to be learned. Information should be presented in small amounts so that responses can be reinforced or shaped. The animal would master each step in sequence until the entire sequence is learned.

Due to stimulus generalization, reinforcements will generalize across similar stimuli producing secondary conditioning. Once the desired behavioral response is accomplished, reinforcement does not have to be present every single time. In fact, it can be maintained more successfully through partial reinforcement schedules. Skinner explained partial reinforcement schedules including interval schedules, ratio schedules, fixed-interval schedules, variable-interval schedules, fixed-ratio schedules, and variable-ratio schedules. He found that variable-interval and variable-ratio schedules produce more persistent rates of response because the learners cannot predict when the reinforcement will occur (Milhollan & Forisha, 1972).

Difference between Classical and Operant Conditioning

Skinner's work differs from that of his predecessors (classical conditioning) in that he studied the operant behaviors that are voluntary behaviors used in operating on the environment. The organism can emit responses instead of only eliciting a response due to an external stimulus. (Table 1)

He also emphasized the use of positive reinforcement in a repetitive manner. Another distinctive aspect of Skinner's theory is that it attempt-

ed to provide behavioral explanations for a broad range of cognitive phenomena. For example, Skinner explained motivation in terms of deprivation and reinforcement schedules.

Implications for Educational Technology

Skinner's operant conditioning has been widely applied in behavior modifications as well as teaching and instructional development, particularly in areas such as classroom management and programmed instruction. His influential book, *The Technology of Learning* (1968), explained how classroom instruction should reflect the behaviorist principles of operant conditioning.

Many of Skinner's instructional techniques are still widely used today (Roblyer, 2006). Consider the implications of Skinner's theory as applied to the development of programmed instruction (Markle, 1969; Skinner, 1968):

1. Practice should take the form of question-answer (stimulus-response) frames that expose the student to the subject in steps.
2. Require that the learner make a response for every frame and receive immediate feedback.
3. Try to arrange the difficulty of the questions so the response is always correct, resulting in a positive reinforcement.
4. Ensure that good performance in the lesson is paired with secondary reinforcers such as verbal praise, prizes, and good grades.

Table 1. Difference between classical and operant conditioning

Classical Conditioning	Operant Conditioning
Uses the term response	Uses the term behavior
Main components: stimulus and its response	Main components: behavior and its consequence
Cannot be used to shape behavior	Can be used to shape behavior
The stimulus causes the response	The consequence influences the behavior
Association between stimuli and responses	Reinforcement
Based on involuntary reflexive behavior	Based on voluntary behavior

The general criticism about Skinner is that he denies the existence of *free will* or human freedom. Skinner defines these values as self-control, which he believes humans do not possess. Many critics labeled him one-sided because he fails to consider any options other than what is “easily observed and manipulated” (Schellenberg, 1978).

Robert Gagné (1916-2002)

Like Skinner, Robert Gagné emphasized the use of positive reinforcement in a repetitive manner. Between 1949 and 1958, when Gagné was the director of the perceptual and motor skills laboratory of the U.S. Air Force, he began to develop some of his ideas that comprise his learning theory called the *conditions of learning* or *cumulative learning theory*. Although Gagné’s earlier work is grounded in the behaviorist tradition, his current work seems to be influenced by the information-processing view of learning and memory. He has published with David Merrill, Leslie Briggs, Walter Wager, and several other authors.

Gagné is best known for three of his contributions: the events of instruction, the types of learning, and learning hierarchies (Roblyer, 2003).

The Events of Instruction

Gagné identified the following nine events of instruction as elements of a good lesson (Gagné, Briggs, & Wager, 1992):

1. Gaining attention
2. Informing the learner of the objective
3. Stimulating recall of prerequisite learning
4. Presenting new materials
5. Providing learning guidelines
6. Eliciting performance
7. Providing feedback about corrections
8. Assessing performance
9. Enhancing retention and recall

The Types of Learning

The early writings by Gagné, Briggs, and Wager (1974) identified three categories of human factors that affect the learning event (see Table 2).

According to Gagné, each new skill learned should build on previously acquired skills. When designing instruction, the prerequisite lower-level skills and knowledge required have to be explained for an instructional objective.

In the 1990s, Gagné et al. (1992) identified several types of learning behaviors that students demonstrate after acquiring knowledge:

- Verbal information
- Intellectual skill
- Cognitive strategy
- Attitude
- Motor skill

Table 2. Human factors that affect the learning event

Major Categories	Human Factors
External Stimulus Factors	• Contiguity: time relationship between stimulus and response • Repetition: frequency of exposure to a stimulus • Reinforcement: follow-up to the stimulus
Internal Cognitive Factors	• Factual information: from memory • Intellectual skills: ability to manipulate information • Cognitive strategies: ability to process meaningful information
Internal Affective Factors	• Inhibition: reluctance to react to a stimulus • Anxiety: tension

Learning Hierarchies

Robert Gagné developed his taxonomy of learning to explore the practice-observable behaviors in 1972. Gagné distinguished the following eight different classes of intellectual skills in which human beings learn. These intellectual skills can be categorized on a dimension of complexity, ranging from simple recognition to abstract processes (Gagné et al., 1974):

1. **Signal learning:** The individual learns to make a general, diffuse response to a signal. Such was the classical-conditioned response of Pavlov.
2. **Stimulus-response learning:** The learner acquires a precise response to a discriminated stimulus.
3. **Chaining:** A chain of two or more stimulus-response connections is acquired.
4. **Verbal association:** The learning of chains that are verbal.
5. **Discrimination learning:** The individual learns to make different identifying responses to many different stimuli that may resemble each other in physical appearance.
6. **Concept learning:** The learner acquires a capability of making a common response to a class of stimuli.
7. **Rule learning:** A rule is a chain of two or more concepts.
8. **Problem solving:** This kind of learning requires the internal events usually called thinking.

The more complex kinds of intellectual processing are based upon these simpler varieties. To teach a skill, a teacher has to identify its prerequisite skills and ensure that the student possesses them. Gagné et al. (1992) called this building process “a learning hierarchy.”

Today, Gagné is considered an experimental psychologist who is concerned with learning and instruction. The model he proposed is a widely

accepted model used to inform the design process. He has impacted instructional design for K-12 schools as well as for business, industry, and the military.

MAIN FOCUS: BEHAVIORISM AND THE DEVELOPMENTS IN INSTRUCTIONAL DESIGN AND TECHNOLOGY

The following major educational technology developments in America can be attributed to behaviorism (Saettler, 1990):

- The behavioral objectives movement
- The teaching machine phase
- The programmed instruction movement
- The individualized instructional approaches
- The computer-assisted learning
- The systems approach to instruction

Behavioral Objectives Movement

The behaviorist theory is sometimes referred to as *objectivist* because the behaviorists emphasize the need for objectivity, which leads to great accentuation of statistical and mathematical analysis. They believe behaviors can be modified, and learning is measured by observable changes in behavior. As of today, learning objectives written by teachers are still widely recognized and very useful. Here is an example of a learning objective:

After having completed the unit, the student will be able to answer correctly 85% of the questions.

The behavioral objectives movement can be traced back to Benjamin Bloom in the 1950s and 1960s. At a time when the primary learning theory was behaviorism, an approach that viewed students as passive recipients of learning provided by their teachers and parents, Bloom presented

his taxonomy organization in *Taxonomy of Educational Objectives: Book I, Cognitive Domain* (Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). The view was that learning involved pupils' accumulation and remembering of varied pieces of information. Bloom and his colleagues began development of a taxonomy in the *cognitive*, *affective*, and *psychomotor* domains. Cognitive is for mental skills, affective is for growth in feelings or emotional areas, while psychomotor is for manual or physical skills.

Bloom's cognitive taxonomy is organized into six levels:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation

Bloom's "learning for mastery" defines mastery in terms of specific educational objectives, and mastery of each unit is essential for students before they advance to the next one.

Each teacher begins a new term or course with the expectation that about a third of his students will adequately learn what he has to teach. He expects about a third to fail or just "get by." Finally, he expects another third to learn a good deal of what he has to teach, but not enough to regard them as a "good student." (Bloom, Hastings, & Madaus, 1971, p. 43)

The affective domain includes the manner in which we deal with things emotionally, such as attitudes, motivations, feelings, values, and appreciation. The major categories listed in order are as follows (Bloom, Mesia, & Krathwohl, 1964):

- **Receiving phenomena:** Awareness, willingness to hear, selected attention

- **Responding to phenomena:** Active participation on the part of the learners
- **Valuing:** The worth or value a person attaches to a particular object, phenomenon, or behavior.
- **Organization:** Organizes values into priorities.
- **Internalizing values (characterization):** Has a value system that controls his or her behavior.

The psychomotor domain includes physical movement, the use of the motor-skill areas, and coordination. Most of the time, the development of these skills requires practice, and is measured in terms of speed, precision, distance, procedures, or techniques in execution. The major categories listed in order are as follows (Bloom et al., 1964):

- **Perception:** The ability to use sensory cues to guide motor activity.
- **Set:** Readiness to act. It includes mental, physical, and emotional sets.
- **Guided response:** The early stages in learning a complex skill that includes imitation and trial and error.
- **Mechanism:** This is the intermediate stage in learning a complex skill.
- **Complex overt response:** The skillful performance of motor acts that involve complex movement patterns.
- **Adaptation:** Skills are well developed and the individual can modify movement patterns to fit special requirements.
- **Origination:** Creating new movement patterns to fit a particular situation or specific problem.

According to Bloom et al. (1971), nearly all students can achieve mastery of material in a course when given the time and quality of instruction that they need. Therefore, to reach mastery, the student needs to get 80% to 90% of the answers right. The basic instructional task was to define

the course into educational units and find methods and material to help the students to reach the set level. The student would be tested with a formative test that would either indicate mastery or emphasize on what still needed to be learned in order to reach the next level.

By the late 1960s, most teachers were writing behavioral objectives (Mergel, 1998). Other names for objectives are “learning targets,” “educational objectives,” and “pupil outcomes.” Virtually all the tests pupils take in school are intended to measure one or more of the cognitive processes, and instruction is expected to focus on assisting students attain mastery of some subject area. The learning success may be measured by tests developed to measure each objective. To develop objectives, a learning task must be broken down through analysis into specific measurable tasks. Teachers began to write behavioral objectives for their lessons that were descriptions of specific, terminal behaviors manifested in terms of observable, measurable behavior. Cognitive objectives focus on memorizing, interpreting, and other intellectual activities.

A good objective states learning objectives in specified, quantifiable, terminal behaviors. As of today, Bloom’s taxonomy is still widely recognized and very useful. In a popular textbook used by teacher-training programs in the United States, Peter W. Airasian wrote, “Although teachers’ objectives may be explicit or implicit or clear or fuzzy, it is best that objectives be explicit, clear, and measurable. Regardless of how they are stated and what they are called, objectives are present in all teaching” (Airasian, 2001, p. 74).

Similarly, Robert Mager wrote *Preparing Instructional Objectives* in 1962, which prompted the interest and use of behavioral objectives among educators. In the book, Mager described an objective as “a description of a performance you want learners to be able to exhibit before you consider them competent. An objective describes an intended result of instruction rather than the process of instruction itself” (1984, p.

21). Objectives are important because teachers need an objective to find out if learning has been accomplished, and students need an objective as the means to organize their own efforts toward accomplishment. There is no sound basis for the selection of instructional materials when clearly defined objectives are lacking.

According to Mager, an objective must include the three major components:

1. **Performance:** What the learner should be able to do
2. **Conditions:** Under what circumstances
3. **Criterion:** How well it must be done

Later, Gagné and Briggs developed a set of instructions for writing objectives that is based on Mager’s work.

Teaching Machines and Programmed Instruction Movement

Although the elder Sophists, Comenius, Herbart, and Montessori used the concept of programmed instruction in their repertoire, B. F. Skinner is the most current and probably the best known advocate of teaching machines and programmed learning. Other contributors to this movement include Pressey and Crowder.

Edward Thorndike described the premise of computer-based instruction half a century before the feasibility of such a system became possible. Thorndike (1912, p. 165) wrote, “If, by a miracle of mechanical ingenuity, a book could be so arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print.”

In his machine, Sidney Pressey sought to incorporate Thorndike’s vision. Noticing that objective tests were becoming common in schools, in the 1920s, Pressey began experimenting with a machine for testing and scoring in his introductory psychology courses. Soon he recognized its

potential for teaching and learning. Pressey (1926, p. 374) stated, “the procedure in mastery of drill and informational material were in many instances simple and definite enough to permit handling of much routine teaching by mechanical means.” Pressey maintained that the teacher is “burdened by such routine of drill and information-fixing.”

Pressey’s teaching machine resembled a typewriter carriage with a window that revealed a question with four answers. The user pressed one of the four keys that corresponded to different answers. When the user pressed a key, the machine recorded the answer on a counter and then displayed the next question. Once finished, the person scoring the test slipped the test sheet back into the device and noted the score on the counter. Pressey demonstrated his multiple-choice machine at the 1925 American Psychological Association meeting (Travers, 1967).

Despite his confidence that the machine he developed would lead to an “industrial revolution in education” (Pressey, 1932, p. 672), this type of machine was never widely used. In the same year that Pressey predicted the revolution, the unemployment rate was over 20% high due to the Great Depression, and new developments in educational technology were delayed until after World War II.

More than 30 years later, among the group of farsighted researchers, Skinner had a vision of machines that could teach. He envisioned the following (1954, 1958):

- Machines are able to arrange appropriate contingencies of reinforcement by which specific forms of behavior could be set up by the use of specific stimuli.
- The learner should be able to put together his or her own response rather than select from alternatives.
- The learner must pass through a carefully designed sequence of steps. Each step must be small enough that it can always be

taken, yet in taking it, the student moves closer to fully competent behavior.

- The student must not be able to proceed to the following step until the first has been accomplished.
- The machine stimulates constant interaction between the program and the user.

This teaching machine has good record-keeping facilities of students’ progress. According to Maddux et al. (1992, p. 105), “Skinner’s machine presented the questions in 30 radial frames on a 12-inch disk.” They continued, “He called the material in the frames the program. Programs that led each user through the same materials in the same sequence were referred to as linear programs.” Skinner thought the success of such a machine depends on the material used in it. The learner’s concentration is improved by the use of these packages addressing the environmental factors that should be inductive to learning. Its other features also free the educator of rote work.

Skinner’s teaching machine required the learner to compose an answer rather than simply choose from a list of options. Also, the machine required the learner to proceed through a series of steps in a prescribed sequence, or through *linear programs*. Each step had to be small so that everyone would be successful, yet each step had to lead closer to the target behavior (referred to as *task analysis*; Maddox et al., 1992). Skinner’s machine was demonstrated in 1954. If used effectively, these machines would take the role of a private tutor, bringing one programmer (educator) into contact with a large number of students.

Skinner’s work on teaching machines has stimulated a large body of research. Today, his criteria for the teaching machines are still important components in developing modern computer-based learning programs (Maddox et al., 1992). Even though Skinner’s teaching machine stimulated a large body of interest, the device was not widely adopted by educators. However, his

idea of a teaching machine has led to programmed instruction.

Later on, Norman Crowder (1959) did not agree with Skinner that every learner should progress in the same sequence. His programs varied the sequence to some learners or omitted certain frames for others, depending on learner responses (referred to as *branching programs*). These modern programs come in various forms in the current educational software market: computerized drill and practice, simulations, and tutorials.

Today, the Education Thesaurus of UNESCO's International Bureau of Education (2002) defines teaching machines as, "Devices that mechanically, electrically and/or electronically present instructional programs at a rate controlled by the learners' responses."

Early Use of Programmed Instruction

Sometimes called *programmed learning*, programmed instruction is a book or workbook that employs the principles proposed by Skinner in his design of the teaching machine, with a special emphasis on task analysis and reinforcement for correct responses (Maddox et al., 1992). Skinner was also a proponent of programmed instruction, and much of the system is based on his theory of the nature of learning. It is an innovation that was more widely accepted in education than a teaching machine.

Believing that by tightly structuring the environment, students' behaviors can be shaped to achieve learning, Skinner envisioned lessons that use carefully planned steps of stimulus-response pairing and reinforcement to reach a goal. The lessons are to be administered in small, incremental steps.

Skinner and J. G. Holland experimentally used programmed instruction in the 1920s and 1930s. Early use of programmed instruction tended to concentrate on the development of hardware rather than course content. In the late 1950s, they first used programmed instruction in behavioral

psychology courses at Harvard. The first practical implementation of programmed instruction was achieved in 1960 by Basic Systems Inc. (Mechner, 1977). In the early 1960s, the proponents led by Skinner defined programmed instruction as using (a) an active response by the learner, (b) immediate reinforcement of correct responses, and (c) successive approximations toward the knowledge to be learned, in a sequence of steps so small that the learner can take each one without difficulty (1977).

The use of programmed instruction appeared in American elementary and secondary schools at around the same time (Saettler, 1990). Programs have been devised for the teaching of arithmetic, foreign languages, physics, spelling, reading, psychology, and several other subjects (*The Columbia Encyclopedia*, 2001-04). Industry and the military used programmed instruction to train personnel. Osguthrope and Zhou (1989) discussed the popularity of this approach in the 1950s and 1960s.

Although many educators agree that programmed instruction can contribute to more efficient classroom procedure and supplement conventional teaching methods, there has been considerable controversy regarding the merits of programmed instruction as the sole method of teaching (*The Columbia Encyclopedia*, 2001-2004). Programmed learning died out in the later part of the 1960s (Reiser, 1987). Researchers agreed that programmed instruction did not appear to live up to its original claims (Criswell, 1989; Reiser; Tillman, & Glynn, 1987). Concerned developers moved away from hardware development to programs based on analysis of learning.

By the early 1960s, there was a strong backlash against the use of both teaching machines and programmed instruction. Fitzgerald (1970) listed the rigidity of these devices in skimming as one of the overriding disadvantages. He also suggested that both teaching machines and programmed instruction would lead to dehumanization due to over reliance on machines.

Decades later, Skinner (1986) explained why programmed instruction and teaching machines were never popular:

The machines were crude, the programs were untested, and there were no ready standards of comparison. Teaching machines would have cost money that was not budgeted. Teachers misunderstood the role of the machines and were fearful of losing their jobs. (p. 105)

Today, the Education Thesaurus of UNESCO's International Bureau of Education (2002) defines programmed instruction as, "Learning in which the students progress at their own rate using workbooks, textbooks or electromagnetic resources that provide information in discrete steps, test learning at each step and provide immediate feedback about achievement."

Individualized Approaches to Instruction

Similar to teaching machines and programmed instruction, individualized instruction began in the early 1900s and was revived in the 1960s. The *Keller Plan* (sometimes called *Keller Method*, *personalized system of instruction* or PSI), *individually prescribed instruction* (IPI), *program for learning in accordance with needs* (PLAN), and *individually guided education* are all examples of individualized instruction in the United States (Saettler, 1990). Also similar to the previously mentioned behavioral objectives movement, teaching machine phase, and programmed instruction movement, the movement of individualized approaches to instruction represents the achievements for the neo-behaviorist systems approach to instruction. All had their foundation in the behavioral theories and psychological principles to the technology of education and have shown to generate a significant educational result.

The Keller Plan

The Keller Plan was developed by F. S. Keller, his colleague J. Gilmore Sherman, and two psychologists at the University of Brazilia. The Keller Plan is derived from the behaviorists reinforcement psychology with influence from teaching machines and programmed instructions. The group had in mind that students would perform better if they found satisfaction in their work (Buskist, Cush, & DeGrandpre, 1991). They argued that positive consequences (praise, good grades, feeling of achievement) were more important than the negative ones (boredom, failure, or punishment). Briefly, "those features which seem to distinguish (PSI) from conventional teaching procedures" include the following (Reboy & Semb, 1991, p. 213):

1. Mastery criteria
2. Self-pace
3. Stress upon the written word
4. The use of proctors
5. Lectures used for motivation rather than sources of information

The Keller Plan was developed for higher education, whereas Bloom's mastery was to accomplish mastery learning in K-12. A PSI course is divided into units and students have to show a mastery of the unit to be able to go ahead. Students are allowed to individually pace their own learning. The mastery level is usually set at 85% to 100% results (Buskist et al., 1991). The course is based upon a standard textbook, a study guide, journal articles, and other readings. Other common characteristics of PSI are the use of proctors. Proctors are undergraduate students who have successfully finished the course and are aware of the problems of new students. The proctors assist the students, score their quizzes, and react as feedback to the instructor of the course in general. The instructor's lectures and demonstrations in the PSI plan are not for instructional purpose but for enrichment and to provide motivation.

Individually Prescribed Instruction (1964)

In 1962, Robert Glaser synthesized the work of previous researchers and introduced the concept of IPI in 1962. IPI is an approach where the results of a learner's placement test are used to plan learner-specific instruction. The main features of IPI include prepared units, behavioral objectives, planned instructional sequences for various subjects, as well as a pretest and posttest for each unit, and materials to be used to continually evaluate the learner to meet behavioral objectives (Saettler, 1990). The use of IPI dwindled in the 1970s when it lost funding.

Program for Learning in Accordance with Needs (1967)

Headed by John C. Flanagan, PLAN was developed under sponsorship of American Institutes for Research (AIR), Westinghouse Learning Corporation, and several U.S. School districts. The main features of PLAN include selected items from about 6,000 behavioral objectives; instructional modules that took about two weeks of instruction each and was made up of approximately five objectives, mastery learning, and remedial learning plus retesting (Saettler, 1990). PLAN was abandoned in the late 1970s because of upgrading costs.

Computer-Assisted Instruction (CAI)

During the 1950s, CAI was first used in education, and training with early work was done by IBM. The mediation of instruction entered the computer age in the 1960s when Patrick Suppes and Richard Atkinson conducted their initial investigations into CAI in mathematics and reading. Developed through a systematic analysis of curriculum, Suppes' (1979) CAI provided learner feedback, branching, and response tracking.

CAI grew rapidly in the 1960s when federal funding for research and development in education and industrial laboratories was implemented. To determine the possible effectiveness of CAI, the U.S. government developed two competing companies, Control Data Corporation and Mitre Corporation, who came up with the PLATO (Programmed Logic for Automatic Teaching Operations) and TICCIT (Time-Shared, Interactive, Computer-Controlled Information Television) projects. Another significant development in the instructional applications of computers during the 1960s and 1970s was the development of the IBM 1500 computer. Kinzer, Sherwood, and Bransford (1986, p. 25) stated that the IBM 1500 was "the only computer ever developed specifically for computer-assisted instruction, rather than as a general-purpose computer for widespread applications."

PLATO is the first large-scale project for the use of computers in education. It is a project developed through the partnership between Control Data Corporation, the University of Illinois' Computer Education Research Laboratory (CERL), and the National Science Foundation. Designed to use a mainframe-based system, PLATO allowed a sizeable library of programs available for students, a sophisticated record-management system to keep track of individual students' progress, and a large number of simultaneous users (Pagliaro, 1983).

The PLATO IV system, introduced during the early 1970s, enabled up to 600 students to simultaneously access educational software (Alessi & Trollip, 1985). Each terminal serviced one terminal display and keyboard. The several thousand terminal systems served undergraduate education as well as elementary school reading, a community college in Urbana, and several campuses in Chicago (Office of Technology Assessment, 1982). During the early 1970s, PLATO IV was introduced, a large time-shared, instructional system. All data and programs were stored on a central computer.

The original PLATO system continued to grow throughout the 1970s and early 1980s to over 1,000 terminals throughout the country (Alessi & Trollip, 1985). Control Data Corporation started setting up PLATO systems around 1975. They already had over 100 PLATO systems operating by 1985.

The design principles introduced by Suppes continue to guide the development of today's instructional software. In CAI packages, key behavior-modification principles are used. A typical CAI software usually states the objectives of the software; uses text, visual, or audio to apply appropriate reinforcers; provides repetition and immediate feedback; uses principles to shape, chain, model, punish, and award the learners; incorporates a scoring system as a part of the system; and provides status of the progress of the learner (Mergel, 1998).

By using the CAI packages, individual learners can master the subject matter on their own time and at their own pace. As the student continually is kept on track of his or her performance, motivation is also enhanced. In contrast to being a mere receiver of information, the learner now more actively participates.

Despite money and research, by the mid-1970s, it was apparent that CAI was not going to be the success that people had expected due to the following reasons (Mergel, 1998):

- CAI had been oversold and could not deliver.
- Lack of support from certain sectors
- Technical problems in implementation
- Lack of quality software
- High cost

Some researchers also argue that CAI was very much drill and practice, which is controlled by the program developer rather than the learner. Little branching of instruction was implemented in the programs (Saettler, 1990).

Systems Approach to Instruction or Instructional Systems Design (ISD)

The systems approach involves setting goals and objectives, analyzing resources, devising a plan of action, and continuous evaluation and modification of the program (Saettler, 1990). This approach is rooted in the military and business world, was developed in the 1950s and 1960s, and has dominated educational technology and educational development since the 1970s. The systems approach to curriculum design is an attempt to use a process of logical development and ongoing monitoring and evaluation to allow continuous evaluation of the curriculum.

The onset of World War II introduced the huge instructional problem of training thousands of military personnel quickly and effectively. The answer at the time was an enormous influx of mediated learning material: films, slides, photographs, audiotapes, and print materials. In the 1960s, the military was rapidly infusing instructional systems development into their standard training procedures. This period was distinguished by the articulation of components of instructional systems and the recognition of their system properties.

The systems approach to instructional design was often accredited to James Finn. Seels (1989) described Finn as the father of the instructional design movement because he linked the theory of systems design to educational technology and thus, encouraged the integrated growth of these related fields of study. Finn has also made educational technologists aware that technology was as much a process as a piece of hardware (1989).

The systems approach views a system as a set of interrelated parts, all working toward a defined goal. Examples of systems include the human body and a community. Parts of a system will depend on each other for input and output. The entire system uses feedback to determine if the goal is achieved. In 1962 Robert Glaser employed the

term instructional system and named, elaborated, and diagramed its components.

Robert Gagné's *The Conditions of Learning* (1965) is a milestone that elaborated the analysis of learning objectives and related different classes of learning objectives to appropriate instructional designs. Gagné introduces behaviorist literature into the systems approach. His work has contributed greatly to the field of instructional technology in the aspect of instructional design. A systems-approach model of designing instruction is utilized to help learners understand the process of instructional design. Gagné also introduced the idea of task analysis to instructional design. Through task analysis, an instructional task could be broken down into sequential steps: a hierarchical relationship of tasks and subtasks. Gagné built on the principles of the systems approach that Skinner explored in programmed instruction.

The current version of the systems approach is a process comprised of a series of phases. Sometimes referred to as the ADDIE model, the systems approach of instructional design contains the following major phases: analysis, design, development, implementation, and evaluation.

- **Analysis**
 - Determine the instructional goal.
 - Analyze the instructional goal.
 - Analyze the learners and context of learning.
- **Design**
 - Write performance objectives.
- **Development**
 - Develop instructional strategies.
 - Develop and select instruction.
 - Develop assessment instruments.
- **Implementation**
 - Implement the system.
 - Revise the instruction if necessary.
- **Evaluation**
 - Design and conduct the formative evaluation of instruction.
 - Conduct summative evaluation

Each step receives input from the previous step and provides output for the next step. A system is modified if the goal is not achieved. Each component is carefully linked.

In the field of education, the systems-approach model first focused on language laboratories. The instruction can be viewed as a systematic process in which every component is crucial to achieve the goal of successful learning. These components include the learner, instructor, instructional materials, and the learning environment. The many components of the system interact to achieve learning. The focus is on what the learner will be able to know when the instruction is concluded. The systems approach does not prescribe or promote any particular teaching methodology. No one method will be appropriate for all objectives or for all students. Rather, it is a vehicle that helps teachers to think more systematically and logically about the objectives relevant to their students, and the means of achieving and assessing these. These early efforts of ISD in education led to several ISD models that were developed in the late 1960s at Florida State University.

Design models can be defined as the visualized representations of an instructional design process, displaying the main phases and their relationships. Each phase has an outcome that feeds the subsequent phase.

Currently, there are more than 100 different ISD models, but almost all are based on the generic ADDIE. The more commonly known models are the *Dick and Carey Model*, the Kemp Model, the ICARE Model, and the ASSURE Model. While a number of versions of the ISD model exist, the Dick and Carey model is very popular in current instructional design programs. The ADDIE model has been in use for training development for several decades. Today, Walter Dick and Lou Carey are widely viewed as the torchbearers of the approach with their authoritative book *The Systematic Design of Instruction* (1978).

Dick and Carey's model, the systems-approach model for designing instruction, is based on the

assumption that there is a predictable link between a stimulus and the response that it produces in a learner. It describes the phases of an iterative process that starts by identifying instructional goals and ends with evaluation. This model includes analysis, design, development, formative evaluation, plus needs assessment in a nonlinear relationship (Dick & Carey, 1978).

In a classroom setting, the instructional material is linked to the response that it produces in a learner through the learning of the materials. Instruction is specifically targeted on the skills and knowledge to be taught, and supplies the appropriate conditions for the learning of these outcomes.

The Dick and Carey model prescribes a methodology for designing instruction based on breaking instruction down into smaller components. The designer needs to identify the subskills the student must master that, in aggregate, permit the intended behavior to be learned, and then select the stimulus and strategy for its presentation that builds each subskill.

The instructional implication of the model is that learning is based on mastering a set of behaviors are predictable and therefore reliable. This model assumes that the correct instructional analysis and instruction will lead to demonstrable skills.

The following is a list of the elements of Dick and Carey's model explained in *The Systematic Design of Instruction*:

1. Determine the instructional goal.
2. Analyze the instructional goal.
3. Analyze the learners and contexts.
4. Write performance objectives.
5. Develop assessment instruments.
6. Develop instructional strategy.
7. Develop and select instruction.
8. Design and conduct formative evaluation.
9. Revise instruction.
10. Use summative evaluation.

Establishing an instructional goal or goals is typically preceded by needs assessment. The needs assessment is a formal process of identifying discrepancies between current outcomes and desired outcomes for an organization. Dick and Carey described the performance objectives as a statement of what the learners would be expected to do when they have completed a specified course of instruction, stated in terms of observable performances. Subordinate objectives are objectives that must be attained in order to accomplish a terminal objective; terminal objectives are objectives the learner will be expected to accomplish when they have completed a course of instruction. Through the learner and context analysis, key learner characteristics and the context in which the learning will occur are identified. The information provides the basis for developing accurately targeted instruction.

The designer conducts instructional analysis for an instructional goal in order to identify the relevant skills, their subordinate skills, and information required for a student to achieve the goal. The technique of hierarchical analysis is applied for goals in the intellectual skills domain to identify the critical subordinate skills needed to achieve the goal and their interrelationships. Formative evaluation is used to collect data and information that is used to improve a program, conducted while the program is still being developed. And finally, summative evaluation is conducted after an instructional program has been implemented and formative evaluation completed to present conclusions (<http://www.ic.arizona.edu/~teachorg/nlii03/isd.htm>).

FUTURE TRENDS AND CONCLUSION: BEHAVIORAL TEACHING AND LEARNING

Behavioral approaches to teaching generally involve the following:

1. The skills and information to be learned are broken down into small units.
2. Students' work is checked regularly and feedback is provided as well as encouragement (reinforcement).
3. Teaching is "out of context." Behaviorists generally believe that students can be taught best when the focus is directly on the content to be taught. Behavioral instruction often takes the material out of the context in which it will be used.
4. Instruction is direct or "teacher centered." Teachers must direct the learning process.
5. Learning is passive.
6. Students must learn the correct response.
7. Learning requires an external reward.
8. Knowledge is a matter of remembering information.
9. Understanding is a matter of seeing existing patterns.
10. Applications require "transfer of training," which requires "common elements" among problems.

Educational Implications

The behavioral emphasis on breaking down complex tasks into subskills that are taught separately is very common in American schools today.

The behavioral approaches to instruction, such as programmed instruction, are outcome based and emphasize small step size, overt responses, and frequent reinforcement of responses. From the behavioral viewpoint, the learner responds to a stimulus during instruction. Through reinforcement, successive approximations of the response are transformed into desired behaviors. Only the overt response is accepted, while the learner's thought is virtually ignored. Learning is understood to be the result of a casual link between instructional stimuli and student responses, which are strengthened or weakened through reinforcement.

Behavioral teaching and learning tend to focus on skills that will be used later. You learn facts about American history, for example, because it is assumed that knowing those facts will make you a better citizen when you are an adult. You learn basic mathematics and computational skills because you may need them when you get a job. Behavioral learning does not, however, generally ask you to actually put the skills or knowledge you learn into use in a "real" or "authentic" situation. That will come later when you graduate and get a job.

These effects are critical to the effectiveness of a computer program because they influence the learning events of a lesson. The behavior theorists give a great deal of attention to individual responses during interactions with computers. Behaviorists favor software designed for drill and practice and tutorial instruction. Drill-and-practice and tutorial applications have their roots in the early works on teaching machines and programmed instruction.

During computer-assisted learning, the effectiveness of a program depends on the internal responses to a stimulus, the senses used, and the ease of use of the computer so as to minimize distractions. Table 3 compares the basic behavioral roots, the general implications of the roots to general instructional design, and the implications of the behavioral roots to instructional technology.

What are the strengths and weaknesses of using the behavior approach to instructional design? Mergel (1998) pointed out the weakness that the learners may find themselves in a situation where the stimulus for the correct response does not occur, therefore, he or she cannot respond. For example, a worker who has been conditioned to respond to a certain cue at work stops production when an anomaly occurs because of lack of understanding of the system. The strength of using the behavior approach to instructional design, pointed out by Mergel, is that the learner is focused on a clear goal and can respond automatically to the cues of that goal. For example, World War II pilots were con-

Table 3. A comparison of basic behavioral roots, the general implications of the roots to general instructional design, and the implications of the behavioral roots to instructional technology

Behavioral Roots	Implications to General Instructional Design	Implications to Instructional Technology
1) Skills and information to be learned are broken down into small units.	There must be definite goals to accomplish.	The computer program can provide these attributes. • Practice should take the form of question-answer (stimulus-response) frames that expose the student to the subject in gradual steps. • Information should be presented in small amounts so that responses can be reinforced (“shaping”). • The first level of a program must be mastered before the learner can continue on to the next level. • The difficulty of the questions is arranged so the response is always correct and hence results in a positive reinforcement. • The content is divided into small modules or units. • Prerequisites are textually displayed. • Prerequisites are graphically displayed.
2) Students’ work is checked regularly and feedback is provided as well as encouragement (reinforcement).	Correct responses must be followed with immediate feedback or reinforcement. Stimuli can be positive or negative. The sensory perception in learning is very important.	The computer program can provide these attributes. • Depending on the function of the program, there can be positive or negative feedback. • The stimuli can be changed in a program if the response is not satisfactory. • It ensures that good performance in the lesson is paired with secondary reinforcers such as praise, prizes, and good scores. • The sound, animation, audio, and color in a program are important to give immediate feedback and have to do with the sensory perception of the learner. • Positive feedback can be given regularly. The learner can stop the program immediately if he or she does not like it.
3) Teaching is “out of context.” Behavioral instruction often takes the material out of the context in which it will be used.	Students can be taught best when the focus is directly on the content to be taught.	The computer program can provide these attributes. • It divides content into small modules or units. • The computer program plays the role of a teacher in posting the problems to be solved. • The content is textually displayed and reviewed. • The content is graphically displayed and reviewed.
4) Instruction is direct or “teacher centered.” Teachers must direct the learning process.	The learning environment must be controlled.	The computer program can provide these attributes. • Lectures, tutorials, drills, demonstrations, and other forms of controlled teaching guide the design of the software. • The teacher or program controls the presentation sequence and display rate. • The content is textually displayed. • The content is graphically displayed. • Attention-focusing devices such as animation, sound, pointers, and so forth are used. • The computer program plays the role of a teacher in posting the problems to be solved.
5) Learning is passive.	Learning is a change in behavior in which a stimulus in the environment has an influence on the learning and behavior of the learner.	The computer program can provide these attributes. • The purpose of the software is stated clearly. • A computer program can be very linear. • The teacher or program controls the presentation sequence and display rate. • Attention-focusing devices, such as animation, sound, pointers, and so forth, are used.

continues on following page

ditioned to react to silhouettes of enemy planes, a response that, one would hope, became automatic (1998). There were also researchers who questioned the breaking down of subject material into small parts, believing that it would lead away from an understanding of the “whole” (Saettler, 1990).

There are two journals that contain current behaviorist research: the *Journal for the Experimental Analysis of Behavior* (JEAB; <http://seab.envmed.rochester.edu/jeab/index.html>) and the *Journal of Applied Behavior Analysis* (<http://seab.envmed.rochester.edu/jaba/index.html>).

Table 3. continued

Behavioral Roots	Implications to General Instructional Design	Implications to Instructional Technology
6) Students must learn the correct response.	The exercise can be checked once it is completed.	The computer program can provide these attributes. • The exercise can be checked by the computer once it is completed. • Problems can be randomized, and the same problem can be repeated until the learner answers correctly. • It repeats content not mastered. • It displays the score or correct answers. • It helps screen for incorrect answers. • It provides outcome guides coordinated with performance tasks (e.g., activity check sheets). • It provides answer keys. • It requires that the learner make a response for every frame and receive immediate feedback.
7) Learning requires an external reward.	Extrinsic motivation plays a critical role in behaviorism.	The computer program can provide these attributes. • Extrinsically motivated, the learner wishes to get a better score.
8) Knowledge is a matter of remembering information.	Learning is taking place through memorizing.	The computer program can provide these attributes. • A drill program with repetition of problems is emphasized. • It reviews prerequisite content and vocabulary.
9) Understanding is a matter of seeing existing patterns.	The learner has learned something when you can observe his or her behavior.	The computer program can provide these attributes. • The scoring and evaluation functions of a program are two ways to decide if the learner has learned. • The progress of the learner can be monitored by the computer program. • It conducts performance tests. • It provides questions on new content. • It allows a limited response time for memory-level questions. • It uses computers for context-rich testing.
10) Applications require “transfer of training,” which requires “common elements” among problems.	A transfer of knowledge is taking place.	The computer program can provide these attributes. • It cross-references content to similar examples. • The computer program can provide additional information or examples.

Neo-Behavioral Theories

Classic behaviorism suggests that human nature is neither inherently positive nor negative but, rather, is shaped by influences from the person’s environment (Ormrod, 1999). In this view, learning emphasizes the attainment of measurable objectives that are achieved through a systematic instructional design process. Penland (1981) suggested a variation on the theme of behaviorism that is called a neo-behaviorist perspective. Neo-behaviorism departs from classic behaviorism in that, while the latter is concerned exclusively with observable behaviors, the former acknowledges the importance of self-direction that is internal to the individual. Thus, whereas classical behavior-

ism is only concerned with the environment as a determinant of behavior, neo-behaviorism stresses the interaction of the individual and environment.

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KEY TERMS AND DEFINITIONS

Classical Conditioning: The Russian physiologist Ivan Petrovich Pavlov is the precursor to behavioral science. He is best known for his work in classical conditioning or stimulus substitution. Pavlov's experiment involved food, a dog, and a bell. His work inaugurated the era of S-R psychology. Pavlov placed meat powder (an unconditioned stimulus) on a dog's tongue, which caused the dog to automatically salivate (the unconditioned response). The unconditioned responses are natural and not learned. On a series of subsequent trials, Pavlov sounded a bell at the same time he gave the meat powder to the dog. When the food was accompanied by the bell many times, Pavlov found that he could withhold the food, and the bell's sound itself would cause the dog to salivate.

Computer-Assisted Instruction (CAI): During the 1950s, CAI was first used in education, and training, with early work, was done by IBM. The mediation of instruction entered the computer age in

the 1960s when Patrick Suppes and Richard Atkinson conducted their initial investigations into CAI in mathematics and reading. Developed through a systematic analysis of curriculum, Suppes' (1979) CAI provided learner feedback, branching, and response tracking. CAI grew rapidly in the 1960s, when federal funding for research and development in education and industrial laboratories was implemented.

Instructional Objectives: A description of a performance you want learners to be able to exhibit before you consider them competent. An objective describes an intended result of instruction rather than the process of instruction itself.

Keller Plan: The Keller Plan (sometimes called Keller Method, personalized system of instruction or PSI), individually prescribed instruction (IPI), program for learning in accordance with needs (PLAN), and individually guided education are all examples of individualized instruction. The Keller Plan was developed by F. S. Keller, his colleague J. Gilmore Sherman, and two psychologists at the University of Brazilia. The Keller Plan is derived from the behaviorists reinforcement psychology with influence from teaching machines and programmed instructions.

Operant Conditioning: Skinner contributed much to the study of operant conditioning, which is a change in the probability of a response due to an event that followed the initial response. The theory of Skinner is based on the idea that learning is a function of change in behavior. When a particular S-R pattern is reinforced (rewarded), the individual is conditioned to respond. Changes in behavior are the result of an individual's response to events (stimuli) that occur in the environment. Principles and Mechanisms of Skinner's Operant Conditioning include: Positive Reinforcement or Reward, Negative Reinforcement, Punishment, and Extinction or Nonreinforcement.

Programmed Instruction: Sometimes called *programmed learning*, programmed instruction is

a book or workbook that employs the principles proposed by Skinner in his design of the teaching machine, with a special emphasis on task analysis and reinforcement for correct responses.

Schedules Of Reinforcement: The schedules of reinforcement can govern the contingency between responses and reinforcement and their effects on establishing and maintaining behavior. Schedules that depend on the number of responses made are called ratio schedules. The ratio of the schedule is the number of responses required per reinforcement. If the contingency between responses and reinforcement depends on time, the schedule is called an interval schedule.

Skinner Box: Most of Skinner's research was centered around the Skinner box. A Skinner box is an experimental space that contains one or more operands such as a lever that may be pressed by a rat. The box also contained various sources of stimuli. Skinner contributed much to the study of operant conditioning, which is a change in the probability of a response due to an event that followed the initial response. Changes in behavior are the result of an individual's response to events (stimuli) that occur in the environment. In his early career, Skinner started with experimenting with animals such as pigeons and rats. He later turned his research interests from animals to humans, especially his own daughters.

Teaching Machines: B. F. Skinner is the most current and probably the best-known advocate of teaching machines. Other contributors to this movement include Pressey and Crowder. Noticing that objective tests were becoming common in schools, in the 1920s, Pressey began experimenting with a machine for testing and scoring in his introductory psychology courses. Soon he recognized its potential for teaching and learning. Despite his confidence that the machine he developed would lead to an "industrial revolution in education," this type of machine was never widely used.

Chapter 5.11

Harnessing the Emotional Potential of Video Games

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ABSTRACT

This chapter explains the importance of acknowledging users' personalities, learning styles, and emotions in the design of educational games. It argues that the application of educational theories combined with knowledge of subjects' personality traits and an increased emotional depth offer a substantive approach to understand and improve the nature of learning in educational games. The authors hope that understanding the underlying motivation and behaviors of learners through the use of personality profiles will not only inform researchers of a better design of educational games, but also assist in understanding the intricate relationship between game design, instructional design, and users' personality at both cognitive and emotional levels.

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INTRODUCTION

Background and Motivation for the Study

Since the 1970s, a new generation of students has emerged: the digital natives (Prensky, 2001). They are technology-savvy, use digital devices, process information in parallel, and play games frequently. For this generation, video games have become a medium for entertainment, for socializing, performing collaborative activities, and also for learning (Gallarneau, 2005). On the other hand, traditional teaching does not always acknowledge the needs of this new generation and, as a result, learning in traditional settings is often perceived as boring or unappealing. Furthermore, digital natives develop skills that are not always acknowledged or measured by traditional instruction. For example, the Flynn effect suggests that

young children's IQs are constantly increasing but their academic results in mathematics are still poor.

The development of educational games has served the purpose of creating content that is both appealing and educational for this new generation. Using these games, players learn by doing and by experimenting in a constructivist manner. Indeed, video games represent ideal learning environments in which users can improve their skills and learn in a safe and controlled manner. They often implement well-known instructional strategies such as social learning, discovery learning, or zone of proximal development (Vygotsky, 1978). According to Gee (2004), a variety of learning principles are built into good video games. Such skills include critical learning, design principles, semiotic principles, and semiotic domain principles.

Despite an unsuccessful start with edutainment technology (education + entertainment), serious games are now much more appealing and can compete with commercial off-the-shelf (COTS) games thanks to more affordable and manageable technology (of e.g., game engines). They are increasingly accepted as a truly potential educational medium (Van Eck, 2006). However, despite promising features, there is a lack of experimental studies on their effectiveness at both motivational and educational levels. The findings on their effectiveness are often contradictory and the evaluations anecdotal, descriptive, or judgmental (Leemkuil, De Jong, & Ootes, 2000), and there is no consensus on a common standard for the design of educational games (Squire, 2002).

The authors suggest that one of the reasons for the discrepancy in the design techniques used and the results collected is that users differ in their personalities and learning styles. They believe that, because users' personalities dictate the way they interact in the game and ultimately the way they learn, there is a need to tailor the content in a way that appeals to each user and that promotes learning activities. Because video games represent a highly emotional experience as well as a structured problem-solving system, their potential

can be employed in a "user-centred" approach, to provide educational content that individually stimulates users' emotions and cognitive skills. The expectation is that by "reaching" students and adapting to their needs, the learning activity will be seamless and more effective.

User-Centred Approaches to Improve Educational Games Design

For a long time, traditional teaching methodologies focused on the content and educational objectives rather than the user. Because students have different expectations, preferences, and learning styles, a given educational content might not be effective across a wide range of students. User-centred learning offers a shift from traditional methodologies; it allows tailoring of teaching methods and content to users. In such environments, users' preferences, abilities, and reactions are evaluated and accounted for to maximise the learning outcomes (Levine, 1999).

Students Have Different Needs and Abilities

Students often differ in their predisposition for particular topics. These different approaches to learning can be illustrated by the theory of multiple intelligences, introduced by Gardner (1993), who proposed the existence of eight (initially seven) autonomous intelligences: linguistic (e.g., reading and writing), logical (e.g., problem-solving and mathematics), musical, visual/spatial (e.g., arts and map reading), bodily/kinaesthetic (e.g., sports), interpersonal (interpersonal skills), intrapersonal (knowing about one's strengths and weaknesses), and more recently naturalistic (e.g., enjoy learning about plants and animals). This theory has been gradually accepted in the educational system as a means to provide different approaches to teaching. The eight intelligences allow educators to "reach" students more easily, to adapt to their learning styles, to allow them to "grow", and is

particularly relevant for students with disabilities or special needs. The introduction of ICT and multimedia technology in schools has provided a means to accommodate different learning styles and to apply this theory. For instance, the use of video accommodates students with visual/spatial intelligence, whereas storytelling accommodates students whose primary intelligence is linguistic.

Throughout their childhood, children can possess and develop special abilities for topics such as sciences or languages. Research has found that infants have a clear understanding of basic biological and physical concepts or early numbers. For instance, they understand that objects need support not to fall, or that animated objects have the potential to move but inanimate ones don't (Bransford, Brown, & Cocking, 2000). They can also see a difference in the number of items represented. Children develop an early attention to language and gradually distinguish language differences. They actively attempt to understand the language spoken around them by making sense of what they are told in a particular environment. However, they need to practice actively to improve their language skills.

Yet, if children's abilities for "preferred subjects" can improve and speed up the way they learn, these abilities can prove to be problematic for topics that they do not prefer because their perception needs to adapt to new concepts (e.g., whole numbers and fractions).

ICT Should Accommodate Different Learning Styles

Children regularly use digital technologies that allow for a high degree of personalisation, and they ought to avail of learning environments that also meet their personal needs and expectations (Green, Facer, & Rudd, 2006). Focusing on users' needs can help improve educational outcomes because effective teaching strategies are those that focus on the learner. Therefore, the focus of modern education should be on meeting and

respecting each student's diversity and unique talents (Lambert & McCombs, 2002). Learner-centred teaching methodologies can prevent common problems encountered by traditional teaching such as boredom, fear of failure, lack of relevance, or lack of interest in the topic taught. Such methods are effective because they address users' needs at both cognitive and meta-cognitive levels, but they also account for their motivation, emotions, and individual differences (Lambert & McCombs, 2002).

User-centred learning can promote students' motivation and achievements. More importantly, it can help in the design of better educational games by addressing some inherent design difficulties such as the use of intrinsic/extrinsic motivation, linear/open/ended content, and so forth.

For example, on the one hand, it is felt that serious games should be developed so that players enjoy learning with no need for extra motivation (intrinsic learning). It is believed that rewards do not always guarantee motivation and they won't make-up for an uninteresting game (Alessi & Trollip, 2001; Becta, 2001). Mitchel & Savill-Smith (2004) support this view and believe that the structure of a video game is likely to have more impact on players' motivation than the game content itself. On the other hand, Rouse (2001) believes that users' accomplishments should be rewarded (extrinsic motivation) to keep them both confident and motivated.

However, the motivation to play an educational game, be it learning, fun, socialisation, and so forth, varies across users, and the correct use of extrinsic or intrinsic motivation should be based on the player. As suggested by Rouse (2001), the ideas associated with winning the game should appeal to each user and fulfill their motivation for playing: competition, learning, associating oneself with a character, working in teams, or being part of an imaginary group. This suggests that knowing a user's motivation and personality can help to create a learning environment in which they are willing to stay. The following section ex-

plains how psychology can be used to understand players' motivations and allow the game content to be adapted accordingly. It also explains how emotions improve the cognitive process.

ADAPTING CONTENT TO USERS' PERSONALITIES CAN IMPROVE EDUCATIONAL OUTCOMES

Players' Personalities Affect Their Behaviour in Video Games

New Understanding of the Relation between Games and Personalities

When video games first appeared as a mass-entertainment medium, they suffered from many stereotypes and it was believed that they had a negative influence on players' behaviours and health (eyestrain, neck pains) and to cause isolation (players reluctant to engage in social activities), violence (game as a motivation and vector of violent behaviours), sexist and homophobic behaviours, and the inability of the players to dissociate themselves from the content of the game. Some of these assumptions were unfounded. Studies showed that children are able to distance themselves from the game they are playing and that they can also decipher the games' goal and main components (Howard, 1998). Additionally, it was revealed that games, like any other activity, could be damaging if they were used beyond a reasonable period of time. Health issues might arise but mostly because of inappropriate use (Mitchel & Savill-Smith, 2004).

As noted by Jenkins (1993), it was felt that educators and parents needed to understand the potential of games at a less superficial level and to situate games in a social and educational context. There has been a shift from the initial preconceptions, and some researchers have been focusing on harnessing the emotional and psychological effects of video games for therapeutic or edu-

cational purposes. For the latter, the idea is that students' personalities dictate their preferences for games and also determine their objectives within the game. Knowing how players might react to stimuli at a cognitive or emotional level might help to customize their experience and hence make the educational game more effective.

It is now agreed that playing video games is a very personal experience, and that motivations for playing, as well as goals and source of enjoyment in video games, can vary across users (Griebel, 2006). Users play video games to prove themselves, for social interaction, for acceptance, to exercise, to improve their skills (Crawford, 2003; Salen & Zimmerman, 2003) but also to fulfill emotional needs (Lazzaro, 2004). However, as suggested by Freeman (2003), games often lack the emotional depth found in movies. He has therefore designed a set of techniques, borrowed from the film industry, aimed at improving the emotional experience in games so that users feel more engaged and emotionally fulfilled. Techniques to improve emotional depth include: dialogues, characters, relationships, game moments, and plots. Even if this approach has the potential to increase users' experience, it was suggested that it should be applied more systematically in order to offer an efficient yet easy-to-follow framework for deeply emotional video games (Kane, 2004). Creating emotions in games also raises the issue of determining the state of users' emotions to adapt emotions accordingly (Perron, 2005).

Profiling Players

Some recent studies have tried to categorise users' profiles (Rosewater, 2006) to understand their motivation and predict their actions. Bartle (1996) identifies four types of players in MUDs (multi-user dungeons):

- **Achievers** strive to gather points and progress to higher levels.

- **Socializers** are interested in people and inter-player relationships. They often sympathise and empathize with other players.
- **Explorers** are willing to understand the game mechanics and to discover new ideas or locations.
- **Killers** enjoy imposing themselves on others and particularly causing distress or pain to other players.

It was suggested that this categorisation lacked accuracy because the four types may overlap and also because the factors associated with each of the traits might not be describing the full spectrum of motivations behind MUD players' actions (Yee, 2002). In a study based on the work of Bartle, Yee (2002) identified five factors that could explain players' motivation in MMORPG (massively multi-player online role playing game): relationship, immersion, grief, achievement, and leadership. This categorisation was further refined (Yee, 2007) as "achievement" (advancement, game mechanics and competition), "social" (socializing, relationship, and teamwork), and "immersion" (discovery, role-playing, customization, and escapism). It proved that, contrary to the ideas of Bartle, players could belong to more than one category; the study also showed that the tendency for socialization is gender independent but that the goals behind socialization differ between genders.

Video game players' profiling is at an early stage and evidence suggests that traditional psychological personality models such as MBTI (Myer-Briggs Type Indicator) and 5-Factor can be used for user profiling. They can be applied to explain and predict some of the user's behaviours in games and in particular in educational games. According to Hopson (2001), psychology can offer a framework to help understand players' reactions in video games. Conati and Zhou (2003) show that pupils' personalities, as measured in the light of the Big-5 model, influence their behaviour, goals, and actions within educational games (e.g., some want to have fun and to learn

whereas others strive to avoid losing). Griebel (2006) shows that some players project part of their personality in their player character (PC) and that their playing style is directly affected by their dominant personality trait.

About Personality Traits

The field of personality addresses human individual differences and uniqueness. It accounts for consistent patterns of thinking, feeling, and behaving (Pervin, Cervone, & John, 2004). It helps to explain individuals' characteristics, their origins, and consequences for their behaviour. In psychology, individuals can be analysed and categorised through personality types or personality traits. For the former, people can be classified under a number of personality types, while for the latter, individuals are assigned to a position in a 5-Dimensional space.

Introduction to the 5-Factor and MBTI Models

The MBTI and 5-factor models are two of the most well-known personality models. They provide a way to measure personality and also provide a framework to predict associated behaviours. Studies have focused in particular on how users learn and seek information based on their personality traits. Such findings could be directly applicable to educational games should they account for player's personalities.

In the 5-factor model, researchers try to find basic units of personality by analysing the words that people generally use to describe themselves. It includes five personality traits: openness (eager to learn and open to new experiences), conscientiousness (hard worker), extraversion (enjoys social interaction), agreeableness, and neuroticism (prone to stress). The 5-factor model is also referred to as the Big-Five, because each of the five factors or traits includes a number of more specific traits. Goldberg et al. (2006) initiated this model

and McCrae and Costa (1992) then developed a personality test called the NEO-PR-I to evaluate the Big-Five personality factors. The NEO-PR-I can easily be transferred to an online personality test in the form of the IPIP (International Personality Item Pool). The IPIP (2006) provides a means to obtain personality profiles based on 50 or even 20 questions (Donnellan, Oswald, Baird, & Lucas, 2006). The former format provides relatively accurate results, while the latter is less precise but easier to include within an educational game (e.g., questions asked by a non-player character).

The MBTI (Myers Briggs Type Indicator) categorises personalities as: extraversion-introversion (E-I), sensing-intuition (S-N), thinking-feeling (T-F), and judgment-perception (J-P). It has been the subject of a wide range of studies, especially those establishing links between personality traits and learning styles. It is less practical to use for online questionnaires, but there is a correlation between the two models (McCrae & Costa, 1989): E-A and S-N are strongly related to extraversion and openness (respectively -0.74 and 0.72) whereas T-F and J-P are more weakly related to agreeableness and conscientiousness (respectively 0.44 and -0.49). The emotional stability dimension of the Big-5 is largely absent from the MBTI. Also, this model does not account for the emotional state of the user, which is represented by the neuroticism trait in the 5-factor model.

Learning Styles

A significant amount of literature has been dedicated to predicting behaviours, learning styles, and preferences linked to specific personality traits (Briggs-Myers & McCaulley, 1985; Heinström, 2003; Keirse, 1998). The following summarizes the state of the research so far and draws some conclusions for the design of successful user-centred educational games:

- **Neuroticism:** Users with a high level of neuroticism often consider lack of time as

a barrier. They need to increase their control and it is better to show them documents that confirm previous knowledge or ideas.

- **Extraversion:** Users with a high level of extraversion tend to privilege social activities but find solitary activities difficult and seek information through peers. They learn better by explaining to other students, they have a preference for thought-provoking documents and discussions and visible results. However, extraverted students do not tend to be systematic and often don't perform deep analysis of the material given.
- **Introversion:** Introverted students seek to interconnect knowledge relevant to the subject in hand. They like chunking, grouping, and interconnecting data. They learn best through quiet mental reflection and prefer reading, lectures and written work to oral work. Also, they prefer independent work and need sufficient time to process information.
- **Openness:** Users with a high level of openness are naturally curious and have a critical mindset. They are eager to find information (ideally from different sources), enjoy discovery learning, and as a result are open to accidental discovery. They focus on general concepts (they see the "big picture") and tend to forget about the details unless they relate to a pattern. Users with a high level of openness enjoy new material, and find repetition boring once they have understood the pattern. Ideal environments for this type of student should allow for creativity and provide them with different ways to solve problems.
- **Conservatism (Low levels of Openness):** Conservative students prefer clearly and recently written documents recommended by teachers and they like linear, structured and organized information. They learn through their senses, and because they are

very practical, they like to learn material related to real-life situations.

- **Agreeableness:** Users with a high level of agreeableness enjoy working in harmonious groups, they feel rewarded when they can help others but they can have difficulty when the material does not relate to people, human values, or relations.
- **Competitiveness:** Users with a high level of competitiveness like clear course and topic objectives. They are usually good at problem solving and enjoy feedback on their objective and achievement. They show a base for sceptical and critical thinking but can easily become impatient during learning activities.
- **Conscientiousness:** Users with a high level of conscientiousness are often willing to work hard to achieve their goal. They are ready to seek, analyze, and reconsider information.
- **Easy Going Students (Low Level of Conscientiousness):** Easy going students tend to be impulsive, easily distracted, careless, and hasty. They have a predilection for information that confirms their previous knowledge and their choice is often guided by a need for a quick answer. Because they reach conclusions too quickly, it is advisable to challenge their knowledge, to encourage them to consider pros and cons of the answer and to consider alternative solutions.

Users' Emotions Can Affect Learning

Before the appearance of formal education, learning was often passed through generations thanks to storytelling; This format was more engaging for learners as it often triggered an emotional response and hence more involvement from the audience (Decastel, 1999; Kort, 2005). However, for many years, learning in formal education has been perceived as a purely cognitive activity

where emotions were interfering with rather than helping the learning process. It is only in recent literature that the impact of emotions on learning has been acknowledged and built into learning models and strategies. Emotions can increase our receptivity to information; they keep us focused, interested, and durably linked to the information we are processing. They affect our memory and our cognitive process and can also be used for self-motivation. The next section describes how emotions can affect the cognitive process and memory.

Emotions and Memory

Research suggests that stimuli that create emotional responses tend to be more easily remembered than those that don't (Rapaport, 1950). Emotions can have a positive or negative impact on memory depending on the learners' emotional state and on the emotional content of the learning material. According to Parrott and Spackman (2000), there are three factors that govern the link between emotions and memory:

- The quality of the material to be remembered (content);
- The emotional state of the user when encoding information (encoding); and
- The state of the user when recalling information (recall).

There is an interaction between these three characteristics. Users' existing emotions and emotions elicited by the content can interact to impact positively or negatively at encoding or recall. This gives rise to three types of interaction:

- **Mood-congruent encoding:** Learning is increased when emotions conveyed by the content match user's emotions and moods. At the time of encoding, intense emotions can improve memory for central details.

- **Mood congruent recall:** Learning is increased when the user's emotions match the emotions conveyed by the content to be recalled. Recall is usually better for positive moods than for negative moods (Singer & Salovey, 1988).
- **Mood-independent recall:** Memory is increased when the mood of the user at the time of recall matches their mood at the time of encoding. This is particularly efficient for users with relatively stable moods.

It is also interesting to note that individuals tend to prefer stories that match their present mood (Green, 1997).

Positive and Negative Emotions

Emotions can facilitate thinking, and it was shown (Salovey, Bedell, Detweiler, & Mayer, 2000) that: (1) addressing a problem while in different moods might enable individuals to consider this problem from different perspectives, and (2) emotions create different information processing styles. Positive moods promote creativity and an open-minded approach whereas negative feelings are usually characterised by a slow problem-solving process associated with more focused and deliberate strategies.

The influence of emotions on cognitive tasks depends on the task in hand (Isen, 2000). For example, positive emotions tend to promote exploration and openness especially in safe situations whereas in dangerous situations, individuals tend to act more cautiously. It has been accepted for a long time that positive emotions had a positive bias on perception and memory whereas negative moods resulted in negative distortions.

Being in a good mood does not necessarily lead to better cognitive performance, and it was shown that tests or activity requiring executive functions (forward planning and sequencing of events) was disrupted by a positive mood (Carlson, Buskist, & Martin, 2000). Furthermore, according to Stege,

Tergwogt, and Koops (1994), positive moods have a more important impact on cognitive processes than negative moods. This asymmetry in the effect of emotions tends to level off as people grow up because they learn strategies to cope with negative feelings (mood repair).

Using Emotional Intelligence to Increase Cognitive Efficiency

Whereas emotions are often a reaction to our environment, some persons have the ability to use these emotions for motivation purposes. For example, while some students might strive to remain positive about an exam and reassure themselves about the outcome, other students who often work better under pressure use the idea or prospect of failure as a motivation to meet deadlines (Salovey et al., 2000). Such persons can be described as emotionally intelligent because they use their emotions strategically.

Emotional intelligence (EI) refers to the ability to perceive, appraise, and express emotions, the emotional facilitation of thinking, understanding, and analysing emotional information and regulating emotions. Individuals create strategies that affect their emotions and learning abilities, and their motivation as a result. Individuals' abilities to control their emotions increase as they mature. EI is considered to be an important factor for academic success as it helps with self-motivation and mood management (Goleman, 1994).

A Review of Educational Models Based on Emotions

As emotions have become more accepted for educational applications, several instructional design methods that include emotions have been developed such as: FEASP, ARCS, or CEO. They acknowledge the effect of emotions on learning and propose theoretical frameworks for sound emotional educational environments.

- The ARCS model is an instructional model based on motivation. Its core component covers: attention, relevance (intrinsic motivation), confidence, and satisfaction. It aims at encompassing the necessary conditions to motivate learners. It is more relevant in a corporate setting and, as opposed to the flow theory, the motivation is extrinsic rather than intrinsic.
- The CEO model is developed for Web-based education and emphasizes safety, challenge, and new thinking (MacFadden, 2000). It develops support for safety (support, acceptance), challenge (confusion, anxiety, frustration, disequilibrium), and new thinking (“ahah” moments).
- The FEASP model (fear, envy, anger, sympathy, pleasure) (Astleitner & Hermann, 2000), promotes the creation of instructional experiences based on positive feelings. It aims at reducing negative feelings (FEA) and at increasing the positive ones (SP).
- Regardless of the learner’s initial emotional state, a learning experience is often emotionally dynamic because the learner feels various emotions: curiosity, fascination, surprise, anxiety, confusion, bewilderment, frustration, anguish, chagrin, hope, perplexity, elation, satisfaction, and confidence. Experiencing a mix of feelings is necessary to progress, to make sense of our experience and to accelerate the learning process (Kort, 2005). The idea of experiencing a mix of positive and negative feelings and the ones developed in the FEASP model are, however, not contradictory. The FEASP model focuses on the learning environment (not on the content), providing safety, collaboration opportunities, a reduction in users’ frustrations and a feeling of fairness. It allows learners to experience a mix of feelings but in a safe and controlled environment.

More recently, attempts have been made to create educational games models that combine instructional design, game design, and also account for user’s emotions. Kiili (2005, 2006) offers a model for educational games that combines both instructional design and the flow theory. It provides players with both meaningful challenges and educational tasks. Amory and Seagram (2003) and Amory (2007) believe that educational games should be based on sound educational theories and have developed an object-oriented model that combines game development and instructional design. The GOM (game objective model), POM (personal outlining model), and the GAM (game achievement model) address students’ motivation and educational goals. They help to develop non-linear games and to meet educational objectives. However, this approach seldom accounts for a user’s preferences and learning style.

Video Games as Sound Emotional Experiences

Video games can be described or analysed through the instructional models mentioned in the previous section, and as such provide an emotional dimension that can help learning. As described by Crawford (2003) they can be compared to an emotional rollercoaster where users experience a wide range of emotions but always in a safe environment. They are in-line with the FEASP model because they reduce the negative feelings linked to the environment (ease of use, interface, computer crashing, etc.) and increase positive feelings such as sympathy and pleasure. They also provide attention, relevance, and confidence by means of easy learning curves.

Consequences for Game Design: Guidelines for User-Centred Educational Games

The following section interprets the findings reviewed previously and discusses the conse-

quences for educational game design. It contrasts user-centred approaches with traditional game design techniques.

Using Emotions to Improve the Cognitive Process

In the previous section, the authors have explained how emotions can impact on the cognitive process and how some strategies can be applied to accommodate students. However, detecting user's emotions can be very difficult. Despite the existence of techniques to detect facial expressions, very few studies have successfully managed to detect emotions based on standard devices (mouse, keyboard, colour-selection, icon selection, keystroke intensity, etc.). Inducing an emotional state in a user can prove to be difficult. However, evidence has shown that when presented with visual and audio information, the latter was predominant (Anderson & Casey, 1997), suggesting that audio information could be used effectively to induce an emotional state in a user. Freeman (2003) also suggests that the use of symbols or dialogues within the game can be used to elicit particular emotions.

Emotions in educational games could be used as follows:

- Increase memory retention: Mood-independent encoding and recall might be efficient for users with a low level of Neuroticism (stable mood). Inducing in them a particular mood at the time of encoding and recall should improve memory (recall).
- Using NPC dialogues, users can be either reassured about their results (users with a high level of Neuroticism) or challenged to do better (users with a high level of Competitiveness).
- Use positive emotions to support creative activities (open-ended strategies).
- Spend a considerable amount of time play-testing so that frustrating issues are avoid-

ed (e.g., game crashing often, game not adapted to the platform).

- Demonstrate the game in the classroom and provide helpers that can explain the game if needed.
- Design the game with the target population in mind (age group, gender, skills, etc.).

Customizing Information Content and Structure to Players

Information in video games can be managed in many different ways:

- Information “flow” and feedback: By managing the flow of information in a game it is possible to inform users and increase their motivation. Four types of information can be provided to users: accurate, misleading, partial and false (Alessi & Trollip, 2001; Teem, 2001). If designers want to increase challenge and motivation for users with a high level of openness or competitiveness, they can provide misleading, partial or even false information. Students with a high level of openness will find an opportunity to use their critical thinking abilities and curiosity. This is particularly effective in games where the player is investigating as a detective. However, in this case, players should be made aware of the possibility of the computer using false information. For students with a high level of neuroticism, accurate information that conforms to their previous knowledge will be more effective. Feedback should be given to users in obvious forms to enable them to reflect, reconsider, discuss options, and develop successful strategies (Becta, 2001). Players should be made aware of their progress, and information such as ranking should be used, especially for users with a high level of competitiveness.

- Learning about the game using booklets and built-in demo levels: Game designers often proscribe the use of booklets, as they believe that users ought to learn solely by playing (Rouse, 2001). On the other hand, Alessi and Trollip (2001) advise that booklets be available to players. In the light of educational theories, students with a high level of neuroticism, conservatism, or introversion would benefit from booklets that refer to information previously learnt during classes and provides them with a sense of control. However, students with a high level of extraversion might prefer to ask their peers instead. In this case, referring students to booklets might prove inefficient. Moreover, students with a high level of openness will enjoy a demo level where they learn the game mechanics. The same applies to students with a low level of openness because they are very practical.

Customizing the Game Play Using Linear and Open-ended Content

The game structure plays a significant part in players' involvement and motivation. According to Alessi and Trollip (2001), the game structure is one of the keys to a good educational game. Aldrich (2001) identifies three types of content: linear, cyclical (drill and practice), and open-ended. Non-linearity provides more interaction and allows players to reach their objectives in different ways, giving them more choice and hence making the game more fun (Rouse, 2001). One of the best ways to achieve an entertaining game is to implement interactive storytelling mixing linear and open-ended content so that the players enjoy both an interactive/immersive experience but also the dramatic qualities of the story.

Linear content might be especially suitable for users with a low level of openness because they like clear objectives and structured material. On the other hand, open-ended content might ap-

peal more to users with a high level of openness who show a high degree of creativity and enjoy exploration. Techniques to implement non-linear game-play can apply to both game structure and content. They include:

- Storytelling, multiple solutions (different ways to achieve a goal).
- Dialogs with NPCs: This option might be especially suitable for users with a high level of Agreeableness if the NPC relates to people and if the player is asked for help.
- NPC behaviours
- Books: Finding a book (or any written material) within the virtual world might be best appreciated by users with a high level of introversion because they enjoy written work.
- Computer terminals

Although repetition drills can be useful, especially for users with a high level of neuroticism (it increases their confidence), users with a high level of openness might rapidly find them boring. Alternative learning opportunities based on exploration and discovery should be put in place for these users.

A Case Study on the Effects of Users' Personalities in Educational Games

In March 2006, the authors conducted a study in two Cork secondary schools in order to evaluate the impact of student's personalities on the design of educational games. It was aimed at assessing two hypotheses formulated by the authors:

1. Displaying time in educational games impacts negatively on users with a high level of neuroticism; and
2. Displaying ranking information impacts positively on users with a high level of competitiveness.

The authors developed an educational game called MathQuest using Java3D. This game was designed to teach mathematics. It featured a 3-D-maze in which players had to navigate and find the exit to the next level in less than 12 minutes. Each level included a set of doors that players had to open to progress further in the game. To open a door, players had to solve a linear equation. Solving an equation consisted of 5-6 steps.

While progressing through each step to solve equation, information was recorded such as time to solve the equation, success rate, and so forth. The game included a tutoring system that followed student's progress throughout the game and that provided them with feedback. In the first level, the system assessed students' skills in solving a linear equation and determined what skills needed improvement. Data recorded in the game were saved on a remote server for further analysis.

The game was designed to change its content (time displayed, feedback, and ranking information) according to players' personality and to record their progress.

Points were awarded to players based on:

- Their proficiency at solving equations (each successful step in solving an equation was rewarded); and
- The number of levels achieved (bonuses were given at the end of each level based on how fast they completed the level; the faster the more points were awarded). The score for each user was updated regularly on the remote server and the ranking was updated accordingly.

Eighty 1st and 2nd year secondary school students took part in the study. They were identified with a unique ID composed of the initials of their teacher, a number corresponding to their class, and another random number (e.g. RF_01_02). This ensured that the results of the study would be totally anonymous.

The pupils initially took an online personality test developed by the authors and based on the IPIP. It consisted of 50 questions. The students were identified only with their ID and the results were stored in a remote database. Results for the test were assessed for their validity and reliability and proved to fulfil both criteria. Reliability of each personality test (Lumsden, 1976) was evaluated using the split halves method ($P(23) > 0.648$; $p < 0.05$). Validity measurement (overuse of the same answer and social desirability) showed that only two students overused the same answer, and two students answered in a socially desirable manner.

Following the personality test, pupils were divided into four groups according to their personality profile: one experimental group (A) and one control group (B) for each of the hypotheses.

- Students with a high level of neuroticism were used to assess the first hypothesis [Displaying time in educational games impacts negatively on users with a high level of neuroticism] and were assigned to either group A1 or B1.
- Students with a high level of competitiveness were used to assess the second hypothesis [Displaying ranking impacts positively on users with a high level of competitiveness] and were assigned to either group A2 or B2.

Conducting the Study

The study was conducted as follows:

- Users did a 10-minute written test on equations
- Users played the game for 25 minutes
- Users did a 10-minute written post-test on equations

Both pre- and post-tests were created in accordance with the Irish curriculum. The game was

initially demonstrated to the pupils so that they could gain a basic understanding of what was expected from them and how to use the different controls in the game. Helpers were available during the game. They were composed of the teacher, the authors and 3-4 5th year students who had been previously acquainted with the game. Users were equipped with headphones and played the game individually (one computer per student). They were asked to raise their hand should they have a question.

As mentioned in the previous section, the game adapted the content according to the user's personality:

- At the start of the game, users were asked to enter their ID.
- The game would then connect to a remote database, retrieve the users' personality traits and group (A1, B1, etc.).
- For the students belonging to the group A1 (experimental group for the first hypothesis), there was no time limit and as a result no time was displayed on the screen during the game.
- For the students belonging to the group B1 (control group for the first hypothesis) a countdown was displayed at the top left corner of the screen.
- For the students belonging to the group A2 (experimental group for the second hypothesis), no information on their current rank was displayed on the screen.
- For the students belonging to the group B2 (control group for the second hypothesis), player's rank was displayed on the screen in real time (e.g. 2/80).

Results of the Study

The data recorded and used to assess the two hypotheses were as follows:

- Pre-test
- Post-test
- Average time to solve an equation in the game
- Number of equations solved in the game

In the light of the data collected, the results were as follows:

- The first hypothesis (displaying time in educational games impacts negatively on users with a high level of neuroticism) was not supported. Instead the results showed that, on average, students for whom time was displayed in the game had improved their academic results more significantly than students for whom time was not displayed (respectively 81% and 43%). Moreover, a statistical analysis of the results using the Mann-Whitney test showed that displaying time in MathQuest had increased players' proficiency at solving equations ($U(14,12)=39$; $p<0.05$) as well as their confidence ($U(8,5)=1$; $p<0.05$)).
- The second hypothesis (displaying ranking in educational games for subjects with a high level of competitiveness increases their proficiency in solving mathematical equations) was partially supported. Raw data showed that on average, subjects for whom ranking information was displayed had improved their test results more significantly than students for whom ranking was not displayed (respectively 15% and 11.3% improvement). Also, the former seemed to have become more proficient at solving equations than the latter as the average time to solve an equation in the game was lower for the former than for the latter (respectively 41.92 seconds and 82.37 seconds). These results, however, were not supported by a statistical analysis probably

due to the small number of subjects available to assess this hypothesis.

Discussion

Whereas the first hypothesis was not validated, the authors noticed that more than 65% of the subjects (17 out of 26) who belonged to both group A1 and group B1 and who had played the game also possessed a high level of competitiveness. It suggests that when subjects possessed high levels of both competitiveness and neuroticism traits, displaying the time for these students acted as a motivating factor rather than a constraint. This study has shown that user profiling can be difficult due to the fact that users have several prominent personality traits rather than one. It has also illustrated that traditional personality models and educational theories offer a good starting point to understand how users learn and behave in educational games, but further research is needed to refine these models when applied to educational games.

CONCLUSIONS AND IMPLICATIONS

General Implications

Students have different learning styles and needs due to their different personalities. ICT should accommodate these learning styles with tailored educational content. By doing so, students' motivation can be increased as well as the educational outcomes. Despite pre-conceptions about the negative effect of games, it is now clear that games can have a positive impact on users' behaviours and emotions. They help users to feel better about themselves and also to engage in creative, educational and social activities.

Developers need to harness this potential to create software that is both entertaining and educational. However, since the field of educational games is still at an early stage there is a lack of

models to increase both educational effectiveness and emotional depth. User profiling allows the creation of a more personalized and engaging experience by predicting users' behaviour and adapting the content to their emotional needs. Models created by Yee offer a promising start; however, educational game development could benefit significantly from the use of existing psychological models such as the MBTI or the Big 5. Serious game developers can also benefit from existing research dedicated to user-centred teaching and learning. By combining these two approaches, we can obtain educational games that are firmly grounded in both educational and psychological theories and that offer reliable and reproducible results.

Furthermore, since games represent rich interactive and emotional experiences, emotions should be used to increase not only enjoyment but also the cognitive process through NPCs, sound, and dialogues. More emphasis should be put on developing frameworks to increase emotions in games, and use them as a cognitive support tailored to individuals needs. Games are systems that provide information, emotions, a high level of interaction and a story line that can be delivered in many different ways. All of these should be tailored to users' personality and needs at both emotional and cognitive levels.

Studies should be designed not only to evaluate user's motivation and learning outcomes but also to draw correlations between users' personalities, game design features and educational outcomes. However, as suggested by Rittel and Webber (1973), learning is a "wicked" problem; many factors can contribute to or interfere with the learning process and cause inconsistent results across experiments. Such inconsistencies can be caused by experimental design flaws, as suggested by Brown, Fisher, and Brailsford (2007):

- Questionnaires on learning styles lack reliability and validity and can invalidate results collected during the experiments.

- Control groups are not always used but doing so would limit placebo effects.
- Studies do not always employ “*real users*” and, as a result, the findings cannot reliably be generalized.
- Observation time is too small (longitudinal studies are preferable for long time effects).
- Subjects are not always naïves and they should be selected at random.
- Models usually adapt to user’s previous knowledge but should focus on their learning style.

Consequences for Researchers

Researchers need to focus on longitudinal studies using well-known reliable and valid tools to assess users’ personalities and learning styles so that results are consistent and easily reproducible on a larger scale. Further studies need to be carried-out to categorise more accurately game players and learners. However, traditional psychological personality tests such as the MBTI or the Five-star model and the work of Yee (2007) offer a good starting point.

Consequences for Policy Makers

Policy makers need to consider video games as an effective tool for education. Time should be set aside for teachers to become familiar with this technology so that they can play, explain the game, and animate de-briefing sessions which offer an opportunity for pupils to relate their experience and share their understanding of the concepts explained in the game.

Multi-disciplinary teams that include teachers, developers, and psychologists should be formed to provide an approach that provides a better understanding of the learning process at motivational, cognitive and emotional levels.

Consequences for Developers

Developers should offer games with a wide range of educational opportunities and diversity to motivate players and accommodate different learning styles (Becta, 2001; Mitchel & Savill-Smith, 2004). They should offer a combination of both linear and open-ended content, a choice of interfaces (e.g., various combinations of video, audio and text, use of colour, etc.), and a choice of character (both female and male). Serious games should account for ethnicity differences, offer a range of themed activities relevant to a wide range of interests and skills, and include alternative input/output for people with special needs.

Serious games should also include built-in processes to detect and accommodate user’s preferences. At a cognitive level, this can be implemented using intelligent tutoring systems; however, at an emotional level, traditional gaming techniques such as dialogues, sound, and video, should be used to provide a more convenient approach than questionnaires.

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KEY TERMS AND DEFINITIONS

Big-5: The Big-5 is an instrument used in psychology to measure subjects' personality traits in a 5-D space.

Emotional Intelligence (EI): Refers to the ability to perceive, appraise, and express emotions, the emotional facilitation of thinking, understanding, and analysing emotional information and regulating emotions.

Information and Communication Technology (ICT): In the context of education, it includes any communication devices and applications such as: radio, video, mobile phones, computers, and network hardware and software used to enhance the learning experience.

Intelligent Tutoring System (ITS): Used in educational software to replace a human tutor.

Myer-Briggs Type Indicator (MBTI): The MBTI is an instrument used in psychology to measure subjects' dominant personality type.

Non-Player Character (NPC): Character in a computer whose actions are not controlled by a human player.

User-Centred Learning: Learning environment that accounts for users' preferences, abilities, and reactions to maximise the learning outcomes.

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Chapter 5.12

Students' Attitudes toward Process and Product Oriented Online Collaborative Learning

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ABSTRACT

Although the pedagogical advantages of online interactive learning are well known, much needs to be done in instructional design of applicable collaborative learning tasks that motivate sustained student participation and interaction. In a previous study based on a Web-based course offered in 2004, Wang (2007) investigated the factors that promote sustained online collaboration for knowledge building. By providing new data from the same Web-based course offered in 2006 and 2007, this study investigates students' attitudes toward process- and product-oriented online collaborative learning. The analysis of 93 post course survey questionnaire data show that the overwhelming majority of students have positive experience with online collaborative

learning. Data also suggest that students are more enthusiastic about process-oriented tasks and their attitudes toward product-oriented collaborative learning tasks are mixed.

INTRODUCTION

The pedagogical advantages of student interaction in collaborative construction of knowledge are grounded in the social constructivist perspective of learning. From the social constructivist perspective, all learning is inherently social in nature. Knowledge is discovered and constructed through negotiation, or collective sense making (Duin & Hansen, 1994; Kern, 1995; Wang & Teles, 1998; Wu, 2003). Pedagogically sound tasks in an online learning environment should, therefore, reflect social learning and facilitate interactive learning and collaborative construction of knowledge.

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Interactive Learning and Factors Influence Online Collaboration

From a student's perspective, online interaction in learning takes place at two different levels: interaction with the contents, including interactive computer software and multimedia system, and interaction with instructors and between peers (Evans & Gibbons, 2007; Gao & Lehman, 2003). There is evidence that pedagogically well-designed interactive learning tasks actually increase rather than decrease student access to instructors; increase interactions between instructors and among students; and increase students involvement of course content as well (Lavooy & Newlin, 2003; Mouza, Kaplan, & Espinet, 2000; Wu, 2003). Interactive learning tasks also promote greater equality of participation (Mouza, Kaplan, & Espinet, 2000), more extensive opinion giving and exchanges (Summer & Hostetler, 2002), empower shy students to participate, and promote more student-centered learning (Kern, 1995; Wang & Teles, 1998)

At the level of interaction with content, students benefit more from producing explanations than receiving explanations. Such proactive learning engages students in a higher level of thinking than the reactive type of learning (Gao & Lehman, 2003; Wu, 2003). Additionally, students who reported high levels of collaborative learning in an online course tend to be highly satisfied with their learning and they also tend to perceive high levels of social presence in the course (So & Brush, 2007).

Despite these advantages, research also indicates that online interactive learning and collaboration are not always sustainable and students' participation in Computer Mediated Communication (CMC) tasks may wane after the assessed tasks that require the postings are completed (Macdonald, 2003). In a survey on college student's attitudes toward participation in electronic discussions, Williams & Pury (2002, p.1) found that "contrary to much literature on electronic collaboration suggesting students

enjoy online collaboration, our students did not enjoy online discussion regardless of whether the discussion was optional or mandatory." Like any other form of learning, learning collaboratively in an online course is also characterized by individual differences. Collaboration as a process of participating to the knowledge communities is not an equal process to all the members of the community (Leinonen, Järvelä, & Lipponen, 2003). Much needs to be done to explore factors that promote sustained student interest in online interactive learning and collaboration.

One challenge for developing sustainable online collaborative learning tasks lies in the nature of the CMC system itself. Although CMC supports interaction and collaborative learning, it also has inherent shortcomings. Disadvantages include the time it takes to exchange messages and the increased difficulties in expressing ideas clearly in a context reduced learning environment and the difficulty in coordinating and clarifying ideas (Sumner & Hostetler, 2002). The increased time it takes to reach consensus and decisions (Kuhl, 2002; Sumner & Hostetler, 2002) and to produce a final product (Macdonald, 2003). Given all these difficulties students need to overcome in order to collaborate effectively in interactive learning environment, online instructors need to address these obstacles with careful instructional design and provide support for collaborative learning with appropriate interactive learning tasks.

Research has also shown that computer mediated communicative tasks require more active role of students than traditional instruction in the face-to-face environment does (Wang & Teles, 1998). Students need to be willing to send a formal written question rather than have a casual conversation with peers or with the instructor in order to have their questions answered (Kuhl, 2002). To communicate effectively with peers and the instructor, students need to create the context through written messages, which requires the writing skills to identify their problems and express them precisely in order to have the ques-

tions answered. Team work and negotiation for meaning are necessary skills in CMC that cannot be assumed. Students need to learn to be familiar with the discourse of the discipline and academic genre for an online synchronous and asynchronous forum (Kuhl, 2002; Macdonald, 2003).

In addition to negotiation skills online, previous research has identified a number of other factors that influence student participation and interaction in a web-based learning environment. Among others, the assessment of collaborative learning tasks plays a crucial role in ensuring student participation (Kear, 2004; Kear & Heap, 1999; Macdonald, 2003) and it directly influences the level of participation (Wang, 2007). In general, assessed collaborative learning tasks attract student participation at the cost of unassessed tasks. Furthermore, grade for discussion was also positively related to students' perceived learning (Jiang & Ting 2000).

The structure of discussion in CMC is found to be another important factor in ensuring the amount of participation and level of interaction and collaboration among the peers. Such structure includes the size of the discussion groups, the nature and types of discussion topics (Williams & Pury, 2002), and whether the collaboration emphasizes on the process of learning or the end product of such collaboration, or both (Kear, 2004; Kear & Heap, 1999; Macdonald, 2003; Wang, 2007). Research also indicates that student facilitators play an important role in attracting their peers' participation in online group discussions and the success of such roles are closely related to the depth of the discussion threads that often lead to more than six or more rounds of student postings (Hew & Cheung, 2007). The interaction level between the students and the teacher and among the students was found to be a significant factor in determining the effectiveness of the teaching method (Offir, Lev & Bezalel, 2007).

In addition, class size and level of participation in terms of note writing and reading is also found to be related. Data show that large classes

are related with an increase in the number of notes written, a decrease in average note size, and an increase in note scanning rather than reading (Hewitt & Brett, 2007).

To summarize, although the pedagogical advantages of online collaborative learning are commonly recognized, such learning is sometimes difficult to sustain due to a number of factors. Among others, online negotiation skills, the direct link between collaborative tasks and assessment, the structure of online discussions such as the nature and types of discussion topics, the size of the group, and the differences between process and product oriented collaborative tasks are some of the factors that influence student participation, interaction, and collaboration.

Process and Product Oriented Online Collaborative Learning

Online collaboration can be either process or product oriented. Forum discussions regarding course contents or related issues are commonly process oriented as the sharing of ideas help learners understand the issues without necessarily leading to a final product. Students are assessed individually based on their participation and quality of their contributions. Alternatively, online interaction and collaboration may lead to a final product such as an essay, a project, or a webpage, etc. There can be two assessment elements to such tasks, a common grade for the group for the overall quality of the collaborative product and individual grades for the contribution of each individual to the collaborative endeavor (Kear, 2004; Kear & Heap, 1999; Macdonald, 2003). The similarities and differences of process and product oriented online collaborative learning tasks are summarized in Table 1.

For a product oriented collaboration, simply assigning learners to work on a group project does not necessarily mean that they will work collaboratively. Learners tend to use a task specialization approach where tasks are divided among group

Table 1. Similarities and differences between process and product oriented online collaborative learning tasks

Process oriented tasks	Product oriented tasks
Exchange of views to share ideas that may or may not lead to agreements	Exchange of views that are consensus building to reach agreements
No end product	End product: a project, report, etc.
Relatively easy to interact and share views	Difficult to reach agreement by a time line
Individual grade	Common and/or Individual grade

members. Therefore, learners may not look for opportunities to develop mutual engagement, knowledge and skill exchange, and interpersonal communication skills (So & Brush, 2007). Therefore, the instructional design of product oriented online collaborative learning tasks need to take measures to ensure real collaboration among peers.

The Study

In a previous study based on a web-based course offered in 2004, Wang (2007) investigated the factors that promote sustained online collaboration. The current study extends the previous study by providing new data from the same web-based course offered in 2006 and 2007. In addition to investigating the factors that promote sustained collaborative learning in a web-based course using asynchronous conferencing system as its main learning tasks (Wang 2007), this study further investigates the students' attitudes toward collaborative learning. In particular, it investigates the learners' perspectives of process and product oriented online collaborative learning tasks. Both types of interactive learning activities were implemented as the main learning tasks of the web-based course under study.

The research questions are:

1. What are students' overall attitudes toward collaborative learning as the main learning tasks in a web-based course?
2. Are there any differences in student attitudes toward process and product oriented online

collaborative learning tasks? If so, what are the factors that influence students' different perspectives toward such tasks?

3. What pedagogical implications do the findings have?

COURSE INFORMATION AND DATA COLLECTION

Course Information

The course under study is an upper division general education course on Bilingualism and Bilingual Education delivered entirely on Blackboard at a state university in California. In a previous study, (Wang 2007), data were collected from a post course questionnaire in Spring and Fall 2004 semesters when this web-based course was first offered. A total of 60 students, 22 in the Spring Semester class, and 20 and 18 students in the two Fall Semester classes completed the course. A total of 53 of the students completed the post course survey questionnaire and the results were reported in the previous study (Wang, 2007). The current study further investigates students' attitudes toward online collaborative learning with additional 93 survey questionnaires completed by the students who took the same course during the Fall 2006 and 2007 semesters. Course structure remained unchanged for the most part.

Forum discussions on course readings and related issues formed the core interactive learning activities that were 45% of the course grade. These were process oriented interactive learning

tasks for which individual grades were assigned for each student based on their quantity and the quality of postings in the forums. Small groups of 4-6 people were formed at the beginning of the semester for the weekly asynchronous group forums. During the 16 week semester, a total of 18 discussion forums were completed in each online group. For each forum, the instructor assigned a reading chapter along with comprehension questions and discussion topics to help the students to grasp the contents. Students divided the reading questions among themselves in their groups and posted the answers to each question for the first round of postings. They were also required to make comments on at least one peer's answers in the second round of postings to carry on the discussions.

To ensure participation, strict deadlines for each round of postings were enforced and each student's answers to the questions and comment messages were assessed by the instructor who assigned up to 3% of the course grade for participation of each discussion forum.

The other major collaborative task was a product oriented group project that constituted 12% of course grade for which all the students in the same group received a common grade based on the level of collaboration and the quality of the final written report. There was no individual assessment component for the group project. The interdependent grading (a common grade for all members of a group only) was aimed at promoting more collaboration among the peers to produce a true collaborative product with individual contributions. The group project was closely related to one of the course themes on types of bilingual education programs. Each student was required to visit a local school to interview a bilingual teacher to gain first hand information about bilingual education programs implemented in California. Students then shared and synthesized the interview data to produce a group report. They were not required to meet face-to-face for the group project but they exchanged information in an online forum

that was mostly procedural to plan, negotiate, to reach agreement and to produce the final product. The process of planning and producing the project required negotiation, cooperation, and collaboration among peers to actually arrive at consensus to produce a report. Though not graded, the progress of each group in the online forums was closely monitored by the instructor. The only deadline for submitting the group project was imposed to ensure the completion of the work for the first two semesters when the course was offered in 2004 (Wang, 2007).

During Fall 2006 and 2007 semesters when the course was offered (two classes for each semester), strict intermittent deadlines for each step (such as the completion of the interview, the posting of interviews in the Group Forums, and the completion of the first draft of the group project) were enforced in addition to the final deadline for the submission of the Group Project. These measures were taken to ensure that the "slow" students must stay on the course and complete their tasks according to the schedule at every step.

Other course activities included two individual written assignments (8%) and three online exams (35%) that assessed the learning outcomes of the course readings and group discussions. Table 2 summarizes the course activities and grading.

Data Collection: Post Course Survey Data

At the end of the semester, an online survey was administered in each class to collect information about students' learning experience and their attitudes toward the course, in particular, their experience with online collaboration in both the weekly conference discussions and the group project. The survey questionnaire, which consisted of 17 multiple choice questions and 4 open-ended questions (see Appendix) was uploaded to the survey area of the course on Blackboard. Students were able to access and complete the survey questionnaire anonymously during the week after the final exam.

Table 2. Course activities and grading

Activities	Grading	Description
Weekly group forums	45%	Structured discussions on course readings
Weekly class forums	0%	Required postings of moderator's summaries from each weekly group forum (Spring Semester class only)
Group project	12%	Final product graded interdependently (same grade for each member of the group)
Individual assignments	8%	No interaction among students required
Three exams	35%	Online exams on course contents to assess outcome of learning

Blackboard automatically calculated the results of the multiple choice questions in percentage. The transcripts of the survey responses for all three classes were printed out for analysis. Ninety – three students completed the survey questionnaire. Therefore, the analysis of the survey data is based on the 93 completed questionnaires. These new data were also analyzed along with the 53 survey questionnaire data reported in Wang (2007) study that were based on the same course offered in the Spring and Fall 2004.

RESULTS

Students' Attitudes toward Collaborative Learning

Table 3 presents students' responses to the question "what are your thoughts about the structure of the course?" Students took this web-based course overwhelmingly preferred the interactive learning structure of the course to the weekly quizzes if they were given the choices. Although the percentage of students who preferred weekly quizzes based

on the readings increased from 8% in 2004 to 24% in 2006 and 2007, the overall majority of them still preferred the current course structure.

An additional question about the learners' overall experience with this web-based course was included in the survey for the 2006 and 2007 classes and the results are summarized in Table 4. Ninety-eight percent of the students reported that their experience with this web-based course was "very positive" and "positive". Therefore, even though about a quarter of the students preferred 'weekly quizzes' type of less interactive learning if there were given the choices, they still reported that their overall experience with the course was "positive" and "very positive".

What factors encouraged students to participate in this form of active and interactive learning throughout the semester? Did the students really think that they learned from building on each other's insights? What were the effects of such learning as reflected by students' responses in the survey data? The survey questionnaire addressed these issues in a number of questions. Table 5 summarizes students' responses to the effectiveness of group discussions.

Table 3. Students' responses to "what are your thoughts about the structure of the course?"

Choices	2004, N= 53	2006-2007, N= 93
I like the way the course is structured in terms of forum discussions because we learn from each other.	92.5%	76%
I prefer weekly quizzes based on the readings rather than answering questions and joining the group discussions.	7.5%	24%

Table 4. Students' responses to the question "my experience with this web-based course:" (N=93)

Choices	2006-2007, N=93
Is very positive	53%
Is positive	44%
Is negative	1%
Is very negative	1%

Chi Square analyses of students' responses to the questions in Table 5 along the scale of strongly agree to strongly disagree were all significant beyond 0.0001 level. About 90% of the students agreed or strongly agreed that answering questions and participating in discussions helped them understand the readings better and that online discussion was helpful because they collaborated more and learned more from each other. Additionally, 72% of the students responded that they learned more from online discussions than they would have learned from the lectures. Furthermore, 89% of the students responded that group cohesion and mutual trust was an important factor in their group.

Level of Participation

Students' participation in group discussions was not only required but was also directly linked to the assessment of their postings in the forums. The

required postings and their assessment appeared to play an important role in motivating the students to participate the discussions. Table 6 summarizes students' responses to the level of participation in their group discussions if the postings were *not* required and graded. The new data from the 2006 and 2007 classes were more or less the same as the previous data when the course was offered for the first time in 2004. Overall, 45% -50% of the students responded they would post some but not as many messages, 21% said they would post very few and 6%-8% responded they would not post any messages at all! Only 21% -28% (an increase of 7% in the new data) responded they would post the same number of messages. One might argue that the survey data may not reflect the real level of participation in discussions if the postings were not required or assessed because all the postings in this course were actually required and assessed. Therefore, a firm claim of the effect of assessment on forum contributions must be tested with a treatment group whose postings in forums were assessed and compared with a control group whose postings in forums were optional and unassessed. Nevertheless, students' responses to this survey question still reflect the "if not" situation because they had just completed the weekly postings for the entire semester and such learning experience would certainly affect their responses. Therefore, the "if not assessed"

Table 5. Students' views about group discussions (N=53)

Survey Questions	% Responses				Chi ²
	Strongly agree	Agree	Disagree	Strongly disagree	
My answers to the questions and comments on peers' messages help me to understand the readings better.	30%	62%	8%	0%	49.717
My peers' answers/comments helped me understand the readings better.	32%	57%	11%	0%	39.453
I learned more from online discussions than I would have learned from lectures.	25%	47%	25%	2%	21.792
The online discussion is helpful because we collaborate more and learn from each other more.	38%	55%	6%	2%	41.415
The group cohesion and mutual trust is an important factor in our group.	53%	36%	11%	0%	36.132

Table 6. Students' responses to "would you post the same number of messages as you actually did over the semester if these postings were optional, not required or graded?"

Choices	2004, (N= 54)	2006-2007, (N=93)
Yes, I will post the same number of messages	21%	28%
I will post some messages but not as many	51%	45%
I will post very few messages	21%	21%
I will not post any messages	8%	6%

situation was contrasted against the real situation of "assessed" postings.

In addition to the number of postings, the amount of time spent on reading peers' messages in an asynchronous forum also reflects the level of participation of collaborative learning. When the course was offered in 2006 and 2007, the survey questionnaire asked an additional question about the reading of peers' messages in the forums, also an important indication of interactive learning. The results are summarized in Table 7.

Thirty-seven percent of the students responded that they read all the messages posted by the peers while 47% of the students read most but not all the messages. Adding the answers to these two items up, the overall majority of the students, 84%, read most if not all the postings in their groups. Still, 10% of the students read only some messages while 6% of them responded that they did not read these messages often. Unlike the required postings by the deadlines in an asynchronous forum, it is relatively more difficult to enforce the reading of each posting in such learning en-

vironment. Therefore, the request to make comments on peers' messages for a required second round of posting is the only direct measure to enforce the reading. Still, 16% of the students read only some of the messages. It is very likely that these students chose to read one or two peers' postings on which they made comments. Previous studies have examined the relationship between group size and the amount of reading of postings of online asynchronous forums. It is important to point out that group size and number of postings in a forum may have a direct impact on the number of messages the students actually chose to read. The students' self-reported amount of reading of messages will be further discussed in the next session.

Group Formation

Table 8 summarizes students' responses to the question on group formation. The 2004 data were based on the 37 questionnaires from the Fall semester students as the Spring 2004 semester course did not have this question in the survey. Not much noticeable differences were observed from the new data when the course was offered in 2006 and 2007. There is a slight increase of percentage of students, from 8% to 15%, who wanted to work with different people in a group every few weeks. Almost the same percentage of students, 30% vs. 31% for the two sets of data, responded that it made no difference for them to work with the same or different people in a group throughout the semester. More than half other students

Table 7. Students' responses to "In our group discussions," (N=93)

Choices	2006-2007, N=93
I read all the messages posted by my peers	37%
I read most but not all the messages by my peers	47%
I read some but not all the messages	10%
I do not read these messages often	6%

Table 8. Students' responses to "what is your view about group formation?"

Choices	Fall 2004 N=37	2006-2007, N=93
I want to work with the same group members the way it is now because we know each other better.	62%	53%
I want to work with different people in a group every few weeks because we will learn from other students we never meet.	8%	15%
It will not make a difference to me working with the same people or different people in a group.	30%	31%

responded that they preferred to work with the same people for their group discussions because they knew each other better and the number was even higher (62%) for the Fall 2004 class data.

It appears that the group as a community for online learning established deep roots in this course. Except for some course related general forums in which questions regarding course activities were exchanged, students generally did not have access to the majority of the fellow students in their class. It would not have been surprising if students had expressed their desires to learn the discussions in other groups through some form of exchanges on a class level, or, through reshuffling groups. Yet, the survey responses suggest that at least two thirds of the students did not express the need to work outside their fixed small groups.

It is important to note that the survey data reflected the students' views towards their working groups that were fixed for the entire semester. If they actually had the chance to work in different groups in this online course, they might have different views. To explore the advantages and disadvantages of fixed or dynamic small groups in a web-based course that uses weekly forum discussions, both group types need to be included in the data in future studies.

Process vs. Product Oriented Collaboration

Table 9 presents students' responses to a question that allowed for multiple choices about the group

project. In this "choose all that apply" multiple choice question, the first two choices were aimed at assessing whether the assignment itself was important for the course in the students' eyes because the importance of the group project may affect their overall performance, or, vice versa. As seen in Table 9, 70% of the students from the 2004 classes felt that the group project was a good assignment and agreed they learned a lot through doing it. Sixty-eight percent of the students also responded that the project made the course readings more meaningful and relevant. About half of the student population, 48% -52%, in the 2006 and 2007 classes viewed the group project as an important task, a noticeable decline for the previous semesters in 2004.

The Fall 2004 semester post course survey asked an additional question about their experience with the group project and the responses are summarized in Table 10. (This question was not included in the Spring 2004 post course survey.) New data from the 2006 and 2007 classes were also included in Table 10.

As seen from Table 10, the new data of 2006 and 2007 were almost identical to the Fall 2004 class, despite the fact that the number of students who perceived the importance of this group project actually went down for the students in the 2006 and 2007 classes.

While 24% of the students preferred to work with peers because they had no problems to collaborate, exactly another 24% of them did not like to depend on other peoples' schedules because some just did not get the work done

Table 9. The group project about bilingual programs in our local schools

Multiple choices (choose all that apply)	2004, N=53	2006-2007, N=93
Is a good assignment and I learned a lot through doing the project.	70%	48%
Makes the course readings more meaningful and more relevant to me.	68%	52%
Is a good assignment but takes too much time to complete.	17%	20%
Could be an individual assignment focusing on one school rather than a group project that involves more collaboration.	30%	24%
Is not very important for this course.	4%	2%

Table 10. Students' response to the group project

Choices	Fall 2004, N=37	2006-2007, N=93
I prefer individual work leading to a project of my own even though I only have information about one school.	32%	27%
I prefer to collaborate with peers the way it is now because it is not a problem with me to collaborate.	24%	24%
I prefer to collaborate with others for a group project but I do not like to depend on other people's schedule because some just do not get their work done on time.	24%	24%
Even though it is hard to collaborative for the group project, it is still worth doing it because we learn more about our bilingual programs in different schools through doing it together.	22%	25%

on time. It is surprising that the percentage of responses to these two choices were identical for the two sets of data, even though more intermittent deadlines were imposed at different stages for the group project in 2006 and 2007 classes as new measures to facilitate the collaboration among peers. Twenty-five percent of the students in the 2006 and 2007 classes felt it worthwhile to collaborate for the group project despite the fact that it was difficult, only a slight increase of 3% from the Fall 2004 class. Similarly, 27% of the students preferred individual work leading to a project of their own even though they would not accomplish as much, a slight decrease of a 5% from the previous data. Compared to the overall positive responses toward collaboration in forum discussions (see Table 3 and Table 4), students' attitudes toward online collaboration in producing the group project were mixed.

Such differences were also reflected in some student comments on the group project in the open-end questions. One student wrote "I think

it's too inconvenient to try and get a group project together online. I also don't like having someone's performance affect my grade. I would rather do the project on my own." It appears that the end product type of collaborative tasks demands more consensus-building collaboration. When students were timed for such intensive interaction and collaboration, they became less enthusiastic about it.

DISCUSSION

Students' Overall Attitudes toward Collaborative Learning and Their Level of Participation

The new data based on the 2006 and 2007 classes support the earlier findings about students' attitudes toward online collaborative learning. Ninety-eight percent of the students reported that they were "positive" and "very positive" with this web-based course. The overall majority of them

also stated that they preferred the forum discussions to weekly quizzes as the main learning tasks, if they were given the choices.

As summarized in Wang (2007) findings, a number of factors contributed to the sustained small group discussions in this course. One of the factors may be the structure of the forums that required two rounds of postings. Students not only always had "something to say" in each forum but knew exactly what specific questions they were expected to answer in advance. These written exercises required in the first round of postings kept each individual student accountable for knowing the contents through reading. Therefore, students' interaction with the course readings, the first level of interaction with the material, was enhanced by producing written answers to be commented by peers in the group forums. The enthusiasm in group discussions never waned forum after forum because each forum focused on a new reading chapter.

Furthermore, the comment messages required students to exchange information by building on each other's ideas to negotiate for meaning and to collaboratively construction knowledge. Such interaction between peers and between students and instructors provided another level of interaction for learning. Students' positive experience with the semester long forum discussions was related to the benefits of proactive learning and learning from each other for knowledge construction. While the advantages of online interactive learning have long been proved in previous studies (Kern, 1995; Lavooy & Newlin, 2003; Mouza, Kaplan, & Espinet, 2000; Summer & Hostetler, 2002; Wang & Teles, 1998; Wu, 2003), this study provided new data for the use of small group discussion as the core interactive learning tasks through the application of carefully prepared discussion questions that elicits proactive learning and through peer interaction and collaboration. When online collaborative learning tasks become main course pedagogy, such interactive learning is likely to be more sustainable and effective.

With regard to levels of participation in collaborative learning, previous research indicates that the size of online learning community affects the level of comforts which influences the level of participation (Hewitt & Brett, 2007; Williams & Pury, 2002). Hewitt & Brett (2007) reported that large classes were related with an increase in the number of notes (messages) written, a decrease in average note size, and an increase in note scanning rather than reading. The current findings suggest that students were comfortable with their peers in a group of 4-6 members and group cohesion and mutual trust was an important element for their collaborative learning. However, data also show that such trust and comfort with a smaller group size is no guarantee of semester-long sustainable interactive learning in the asynchronous forums. Overall, only 28% of the students responded that they would post the same number of messages in their forums if the postings were not required and graded. Forty-five percent of the students responded they would post some but not as many messages and 21% percent of the students said they would post very few messages. What is more, 8% of the students responded they would not post *any* messages at all. These numbers from the new data were almost identical to the previous data. Taken together, these data support the previous research findings that the assessment of collaborative learning tasks plays a crucial role in ensuring student participation. Macdonald (2003) reported that students actively contributed to the discussions when the tasks were assessed but participation of discussions waned when the postings became optional. Grade for discussion was also positively related to students' perceived learning (Jiang & Ting 2000). Apparently, any optional interactive learning tasks would not have sustained for the entire semester.

Another indication of the level of participation is the amount of reading of messages posted by the peers in their group forums. Thirty-seven percent of the students reported that they read all the messages posted by the peers while 47% of

them read most but not all the messages. However, 16% of the students responded that they read only some messages or did not often read the messages posted by the peers. Unlike the required postings by the deadlines in an asynchronous forum, it is relatively more difficult to enforce the reading of each posting in such learning environment. It is important to note that the size of the group (4-6 students) is relatively small for asynchronous forums and it was assumed that such a size would generate sufficient responses from each other. On the other hand, the number of messages produced by each member was manageable and easy to keep track of. Future studies need to investigate the level of participation of collaborative learning with different group sizes and with different learning tasks.

With regard to group formation, the majority of students reported that they preferred working with the same members of the group for the entire semester rather than rotating the peers. Obviously, it takes time to establish such mutual trust, even in a small group of 4-6 members. Therefore, it is very likely that the group cohesion and mutual trust comes from the semester long of interaction, cooperation and collaboration online. The new data showed a slight increase of the percentage of students who expressed the desire to work with different peers during the semester. Future studies need to investigate the benefits and disadvantages of dynamic group formations in which students are given the chance to work with different online peers during the semester.

Students' Attitudes toward Process and Product Oriented Interactive Learning

Very few studies have dealt with the differences between process and product oriented interactive learning tasks and how these differences influence peer interaction and collaboration (Kear, 2004; Kear & Heap, 1999; Macdonald, 2003; Wang, 2007). This web-based course applied both process

and product orientated interactive learning tasks that required different types and levels of interaction and collaboration. As discussed earlier, in the weekly group forums, the debate and exchange of ideas focused on the process of learning that did not lead to a final product. In contrast, the group project was a product driven collaborative task in that the interaction and collaboration among the peers through sharing and exchange of ideas and negotiation must help to reach certain consensus to produce a group report. Survey data suggest that students were more enthusiastic about process oriented group discussions than the group project.

In the previous study based on the same course offered in 2004, Wang (2007) found that among others, the main reasons for students' frustration about the group project were the difficulties in reaching agreement according to a time frame, especially in the online environment. The differences in working pace and conflicts of schedules, and, perhaps more importantly, differences in level of devotion to the collaborative task in online environment made it more difficult for the peers to reach consensus in the process of doing the group project. The early birds who preferred to start and complete their parts of the work in a timely fashion conflicted with those who procrastinated in getting the work done. As peers in the same group would receive a common grade only for their project, there was pressure for them to compromise to reach agreements in completing the project.

In order to reduce the frustration caused by the schedule conflicts between the peers, a few intermittent deadlines were imposed when the course was offered in 2006 and 2007 years. Students had to meet each deadline (individual interviews, sharing the interview summaries, and draft the project) at each step to avoid the last minute rush that usually delayed the progress of the group work. The new data about the group project from 2006-2007 classes were collected after these new measures were taken.

As seen from Table 9 and Table 10, these new measures did not appear to address these challenges the groups faced in completing the projects. In fact, only 24% of the students from the current data, (exactly the same 24% of the students in the previous study) responded that they preferred to collaborate with others for a group project but they did not like to depend on other peoples' schedule because some just did not get their work done on time. Similarly, 24% of students in the current data (exactly the same percentage as found in the previous study) responded that they preferred to collaborate with peers because it was not a problem for them to collaborate. Only a slight increase of the number of students, from the previous 22% to the current 25%, responded that even though it was hard to collaborative for the group project, it is still worth doing it because they learned more about the bilingual programs in different schools through doing it together. There was also a slight decrease of number of students, from the previous 32% to the current 27%, who stated that they preferred individual work leading to a project of their own even though they only have information about one school. These data suggest that, overall, students' attitude towards the group project was mixed. There was less enthusiasm for the group project than for the weekly forum discussions.

In addition to the differences in working schedules and level of devotion to the group project, the common grade assigned to students for their group project appeared to be another factor that caused the frustration for this collaborative task. Although the common grade can be used as a useful instructional strategy to implement end product driven collaborative tasks to encourage collaboration, the frustration and stress caused by the schedule conflicts and different levels of devotion toward such collaboration calls for more careful instructional design of such tasks. Perhaps some form of individual grading in addition to the interdependent grading are necessary to measure each individual student's efforts and contribution. In fact, Kear & Heap (1999) reported

that students expressed a preference for a higher individual grade component when both common and individual grades were assigned for their group project. It is important to balance the level of collaboration among the students and the individual flexibility of online learning. Future studies need to address the pedagogical design of end product driven collaborative tasks in web-based courses.

CONCLUSION

The new data in the current study further supported the earlier findings (Wang, 2007) about students' positive attitudes toward collaborative learning as main learning tasks in a web-based course. The overall majority of them also stated that they preferred the forum discussions to weekly quizzes as the main learning tasks, if they were given the choices. Among others, the structure of the online discussion, group cohesion, direct link of the interactive learning tasks to the assessment, and strictly imposed deadlines are some of the important factors that influence students' learning experience and level of participation in collaborative learning. The differences in process and product driven interactive learning tasks also have a different impact on student online collaboration. In general, students were more enthusiastic about process oriented than product driven collaborative tasks. Despite the new measures taken in the form of imposing more intermittent deadlines for the preparation of the group project, a product oriented collaborative task, a substantial number of students still preferred to do an individual project on their own, if they were given the choices. Many of them expressed their concerns about their grades being affected by their peers' work. It appears that assigning a common grade to all the members of the group may not be the best way of assessing such a product oriented collaborative task. Some element of individual assessment component might be necessary to reflect the different level of devotion of the students.

Finally, as the current data are based on one web-based course that was mainly a reading course, the findings may not be generalized into a broad scope. Because of this limitation, the current findings may not be directly applicable to other courses that have a different online pedagogical approach. Yet, a few recommendations may be made for designing and implementing similar interactive learning activities to promote sustained and effective online collaboration.

- Although a very good tool for promoting interactive learning and collaboration, online discussion is not always sustainable if not well planned and structured. It is recommended that instructors carefully design each forum discussion with direct involvement of course contents with pre-determined specific questions to engage students in a high level of thinking through providing written answers to the topics for which peer critiques are required.
- To continue to motivate the students, link the assessment with all interactive learning tasks utilizing specific grading scales.
- Impose strict deadlines for each round of postings in each discussion forum.
- Form small groups of 4-6 as learning communities for discussions so the peers will have sufficient input from each other yet still find it easy to keep track of all the postings in each new thread.
- Use process oriented interactive learning tasks to facilitate continuous online interaction and collaboration and yet still give each student sufficient amount of freedom in completing the assessed learning tasks.
- When design product oriented interactive learning tasks, much care needs to be taken in order to prepare the students to reach consensus. Give sufficient time for completing such learning assignment. Incorporate both common and individual grades in grading an group project.

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APPENDIX: SURVEY QUESTIONNAIRE

1. Is this your first web-based (entirely online) course?
 - a. Yes.
 - b. No, I already took one entirely online course before this one.
 - c. No, I took two or more other entirely online courses before this one.
 - d I took one or more web-enhanced course (partially online) before this web-based (entirely online course).
 - e. No, I have never taken any web-based nor web-enhanced course.
2. This reading course is structured on group discussions with individual and group assignments. What are your thoughts about the structure of the course?
 - a. I like the way the course is structured in terms of forum discussions because we learn from each other.
 - b. I prefer weekly quizzes based on the readings rather than answering questions/joining group discussions.
3. Will you post the same number of messages as you actually did over the semester if these postings were optional, not required and graded?
 - a. Yes, I will pos the same number of messages.
 - b. I will post some messages but not as many.
 - c. I will post very few messages.
 - d. I will not post any messages.
4. Please circle one answer for each of the following:
 - a. In our group forums, my answers to the questions and comments on peers' messages help me to understand the contents/readings of the course better.
strongly agree
agree
disagree
strongly disagree
 - b. My peers' answers/comments helped me to understand the readings better.
strongly agree
agree
disagree
strongly disagree
 - c. I learned more through online discussions than I would have learned from the lectures.
strongly agree
agree
disagree
strongly disagree

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- d. The online discussion is helpful because we collaborate more with each other and support each other.
strongly agree
agree
disagree
strongly disagree
 - e. The group cohesion and mutual trust is an important factor in our group forums.
strongly agree
agree
disagree
strongly disagree
 - f. I prefer individual work to group work and would have done better if I did not have to collaborate with my peers in my group for **discussions**.
strongly agree
agree
disagree
strongly disagree
 - g. I prefer individual work to group work and would have done better if I did not have to collaborate with my peers in the group for the **final project**.
strongly agree
agree
disagree
strongly disagree
 - h. The deadlines for the readings and postings in each forum are very important because they help me to complete the readings and the course.
strongly agree
agree
disagree
strongly disagree
 - i. The overall course contents are interesting and I have learned a lot about bilingualism and bilingual education from taking this course.
strongly agree
agree
disagree
strongly disagree
5. Choose one of the following:
- a. I wanted other group members to read our group discussions and I also missed the discussions in other groups.

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- b. Every group should have summarized their forum discussions each week and post it to a general forum so that interested students could comment on the discussions in other groups.
 - c. Reading and responding to peers' messages in our own group discussions is sufficient for me to understand the course contents. It would take too much time to read and respond to summary messages from other groups.
6. What is your view about group formation?
- a. I want to work with the same group members the way it is now because we know each other better.
 - b. I want to work with different people in a group every few weeks because we will learn from other students we never meet.
 - c. It will not make a difference to me working with the same people or different people in a group.
7. The pace of the course, including readings and postings
- a. Is neither too fast nor too slow for me.
 - b. Is too fast for me because I always try to catch up with the readings.
 - c. Is too slow for me and we could have read more chapters.
 - d. Should be OK for a course like this but I found it too fast for me because I work many hours a week and have limited time for course work.
8. Course documents:
- a. I printed out all the lecture notes and review guides (or some of them) because they are helpful.
 - b. I read the lecture notes and the review guides online but did not print them all.
 - c. I never printed out nor read the lecture notes and the review guides because they are not essential for me.
9. The videos on reserve in the music library are used in all other face to face sessions of the same course. I found these videos
- a. worth seeing because they are informative and very relevant to the course content.
 - b. relevant to the course content, but it is hard for me to make special trips to the university to watch them all.
 - c. are not relevant to the course content and can be omitted.
10. You took all the three exams online in this semester. Do you think the online exam should be kept the way they are now, or do you prefer to take these exams in a classroom on a certain date?
- a. I prefer online exams the way they are now.
 - b. I prefer to come to a classroom to write the exams.
 - c. I have no preference.
11. Exam format:
- a. I prefer multiple choice exams.
 - b. I prefer essay question type of exams.
 - c. It does not make a difference for me.

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12. The group project about bilingual programs in our local schools (circle all the answers that apply to you)
 - a. Is a good assignment and I learned a lot through doing the project.
 - b. Makes the course readings more meaningful and more relevant to me.
 - c. Is a good assignment but takes too much time to complete.
 - d. Could be an individual assignment focusing on one school rather than a group project that involves more collaboration.
 - e. Is not very important for this course.
13. For the group project:
 - a. I prefer individual work leading to a project of my own even though I only have information about one school.
 - b. I prefer to collaborate with peers the way it is now because it is not a problem with me to collaborate.
 - c. I prefer to collaborate with others for a group project but I do not like to depend on other people's schedule because some just do not get their work done on time.
 - d. Even though it is hard to collaborate for the group project, it is still worth doing it because we learn more about our bilingual programs in different schools through doing it together.
14. Overall, my experience with this web-based course
 - a. Is very positive.
 - b. Is positive.
 - c. Is negative.
 - d. Is very negative.
15. Experience with the Blackboard and the online forums: circle all apply to you.
 - a. I found it challenging at the beginning but quickly picked up and like it now.
 - b. The interface is straightforward and easy to learn, although I was not very experienced with any online courses.
 - c. It was never a problem for me because I am good at technology.
 - d. It was a plus because I learned the technology as well as the course contents
16. If I have the choice in future,
 - a. I will take a similar web-based course.
 - b. I will not choose to take a similar web-based course.
 - c. It will not make a difference, web-based or face-to-face version.
17. Would you recommend a friend to take this web-based course?
 - a. Yes
 - b. No
 - c. Not sure

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18. Please take some time to answer the following questions:
- a. Please describe your experience with the forum discussion part of the course. (positive, negative, expectation, effect on learning, etc. anything you think is relevant)
 - b. What do you like the most, or dislike the most about this course?
 - c. In your opinion, what are the most important elements for a web-based course like this to be successful?
 - d. To improve the course for future students, what changes do you recommend?

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Chapter 5.13

Plagiarism and the Community College

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ABSTRACT

Although plagiarism is a problem in all educational institutions, the diversity of the community college student population and of the community college mission creates even more challenges. The purpose of this chapter is to discuss characteristics of community college students, define intentional and unintentional plagiarism, and provide methods that faculty can use to help students avoid both kinds of plagiarism.

INTRODUCTION

Most sources agree that plagiarism is a major problem for educational institutions (Breen & Maassen, 2005; Ercegovac & Richardson,

2004; Furedi, 2004; Martin, 1994; Ryan, 2004; Standler, 2000). In their literature review of academic dishonesty and plagiarism, Ercegovac and Richardson (2004) quote a Bronfenbrenner et al. report, *The State of Americans*, “Virtually every high school student in 1989 (97 percent) admits having let another student copy from his or her work” (p. 311). More recently, the Internet has helped make copy and paste plagiarism fast and easy; furthermore, Internet paper mills are relatively inexpensive and offer papers that are harder for teachers to detect (Bloomfield, 2004; Bombak, 2005; Edlund, 2000; Ercegovac & Richardson, 2004; Harris, 2004; Howard, 2001; Leland, 2002; McKenzie, 1998; Murray, 2002; Plagiarism.org, 2005; Rocklin, 1998; Ryan, 2004; Scanlon, 2003; Standler, 2000; Sterngold, 2004). Amazon.com has a “Search Inside the Book” feature that allows users to search for ideas and content within specific texts (Sterngold, 2004),

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certainly a valuable research tool but also a plagiarist's golden opportunity. The Council of Writing Program Administrators (WPA) states that the ease of Internet plagiarism "has begun to affect teachers at all levels, at times diverting them from the work of developing students' writing, reading, and critical thinking abilities."

If technology has amplified the problem of plagiarism for all educational institutions, the problem seems especially pronounced in the community college setting because of the diversity of the student population and because of the emphasis that community colleges put on meeting their students' changing needs. This chapter will define plagiarism, describe the growth of the community college and characteristics of community college students, and provide instructional approaches faculty can use to help students avoid both intentional and unintentional plagiarism.

PLAGIARISM CONFUSION

Students and faculty have difficulties with plagiarism on college campuses because the concept of plagiarism is misunderstood (Breen & Maassen, 2005; Ercegovic & Richardson, 2004; Scanlon, 2003). Even though almost every institution's Web site contains definitions of academic dishonesty and plagiarism, Breen and Maassen (2005) state that it is clear that "the existence of a policy was not sufficient in and of itself to eliminate plagiarism." Scanlon (2003) says that the "amount of misconception on this topic appears to have grown exponentially in the past few years, as access to the Internet becomes nearly universal." He cites several studies that suggest that students are not sure what plagiarism is and that they do not think it is as serious an issue as faculty does.

Faculty also may be unclear about plagiarism definitions, types, and consequences (Breen & Maassen, 2005; Ercegovic & Richardson, 2004; Scanlon, 2003). In their literature review of academic dishonesty, Ercegovic and Richardson

(2004) cite a study by Burke of faculty at a two-year college: "The fact that 86 percent of the studied faculty suspected academic dishonesty in their classroom but did not perceive it to be a major problem should be investigated further" (p. 310). They cite other studies that find that although faculty members complain about cheating and plagiarism, "many do little or nothing about it ... It seems there is a lack of alignment between offences and punishment and a lack of communication among administrators, faculty, parents, and students" (p. 311).

The WPA Council Web site, "Defining and Avoiding Plagiarism," states that students may be confused because "academicians and scholars may define plagiarism differently or more stringently than have instructors or administrators in students' earlier education or in other writing situations." For Murray (2002), these definitions vary widely even "across and within departments, allowing students wiggle room and making it tempting for faculty to ignore potential problems."

DEFINITIONS OF PLAGIARISM

McLemee (2004) cites the Oxford English Dictionary's definition of *plagiarism*: it is derived from the Latin *plagiarius*, meaning "one who abducts the child or slave of another," and "the word plagiarism was first used in its current sense by the Roman poet Martial, in the first century AD, as a sarcastic put-down of another writer who had cribbed some of Martial's verse" (p. A9). Today, most educational institutions consider plagiarism a threat to ethical standards; The Purdue Online Writing Lab (OWL) says that "There are few intellectual offenses more serious than plagiarism in academic and professional contexts," (Stolley, 2006), and Bolkan (2006) calls it "the unoriginal sin" (p. 13).

The Council of Writing Program Administrators (WPA) seems to take a moderate approach to the issue, defining plagiarism in the following

way: "In an instructional setting, plagiarism occurs when a writer deliberately uses someone else's language, ideas, or other original (not common knowledge) material without acknowledging its source." The key term here seems to be *deliberately*. The WPA Council distinguishes between plagiarism and misuse of sources:

students are not guilty of plagiarism when they try in good faith to acknowledge others' work but fail to do so accurately or fully. These failures are largely the result of failures in prior teaching and learning: students lack the knowledge of and ability to use the conventions of authorial attribution.

Like the word *deliberate*, the words *in good faith* take into account student *intentions*, not just the results. Several sources agree that many plagiarism cases are probably inadvertent (Breen & Maassen, 2005; Martin, 1994). Martin (1994) says, "Students are apprentices, and some of them learn the scholarly trade slowly" (p. 37).

On the other hand, other sources do not try to judge whether the use was deliberate or not and make no distinction between plagiarism and misuse of sources. In fact, for Standler (2000), "the intent of a plagiarist is *irrelevant*. The act of quoting material without including the indicia of a quotation is sufficient to convict someone of plagiarism. It is *no defense* for the plagiarist to say 'I forgot.' or 'It is only a rough draft.' or 'I did not know it was plagiarism.'"

Like Standler, several university Web sites do not take into account the writer's intention. Stolley, on the Purdue OWL Web site, "Avoiding Plagiarism," warns students that even "inadvertent mistakes can lead to charges of plagiarism ... A charge of plagiarism can have severe consequences, including expulsion from a university or loss of a job, not to mention a writer's loss of credibility and professional standing." These are very strong words, perhaps intending to scare students into taking the issue seriously. The Georgetown University "What Is Plagiarism?" Web site informs

students that "even using one of [a source's] small, characteristic phrases without quotation marks is considered plagiarism." Similarly, McLemee (2004) defines plagiarism in this way: "A writer who fails to give appropriate acknowledgment when repeating another's wording or particularly apt term, paraphrasing another's argument, or presenting another's line of thinking is guilty of plagiarism." These definitions make no distinction between deliberate plagiarism and inadvertent plagiarism or misuse of sources.

These examples seem to illustrate that there are major differences that hinge on whether institutions make allowance for intention or deliberateness. However, McCullen (2003) acknowledges that "it is not so easy to draw a hard and fast line between what is a deliberate case of plagiarism and an unintentional error in citation" (p. 40).

Because community colleges attract diverse students with diverse educational goals, faculty members need to acknowledge the problems their students face when given a writing or research project and help them avoid both intentional and unintentional plagiarism. Intentional plagiarism, which takes place when a student buys a paper from a paper mill, uses another student's paper as if it were his or her own, or fabricates sources or citations, can be addressed by restructuring assignments, helping students develop better time management skills, and using learner-centered teaching methods. Unintentional plagiarism, which occurs when the student uses a phrase from a source and cites it but does not put it in quotation marks, when the student copies and pastes to such an extent that he or she loses control of the paper, or when the student inaccurately records source material, can be addressed using student/teacher conferences, portfolios, and peer evaluations.

In order to understand why plagiarism is a problem in community colleges, a discussion of the characteristics of community college students is provided.

GROWTH OF COMMUNITY COLLEGES

Since the beginnings of the community college system in 1901 when Mt. Juliet Community College in Illinois was begun as an outgrowth of high school, community colleges have altered the American postsecondary educational system, making college more accessible and more affordable. Kasper (2002-2003), an economist for the Office of Occupational Statistics, states, “No other segment of postsecondary education has been more responsive to its community’s workforce needs. At community colleges, students can learn at any point in their lives while taking advantage of low tuition, convenient campus locations, open admissions, and comprehensive course offerings” (p. 14). Enrollments in community colleges have grown faster than four-year institutions. According to Kasper, “enrollment at public four-year colleges and universities roughly doubled from 1965 to 1999, while enrollment at public community colleges increased about fivefold” (p. 14). Kasper states that although 26 percent of all students attending public degree-granting institutions in 1965 attended community colleges, that percentage had almost doubled in 1992 to 48 percent (p. 14). More than 11.5 million students attend nearly 1200 community colleges (Lamkin, 2004).

Community colleges might have begun as a low cost alternative for students seeking a four-year degree who were denied access to universities, but the mission of community colleges has expanded to include career certificate training, workplace training, continuing education opportunities, associate degrees, and associate of applied science degrees. Many students attend a community college to transfer to a four-year institution, but others want to fulfill short-term goals. This diversity of mission is one way that community colleges differ from four-year institutions. Carnevale (2001) highlights the advantages of a community college education:

Unlike company-training programs, which usually omit academic preparation, and four-year colleges, which provide academic challenges but rarely link them to occupational constructs, community colleges are able to provide students with the tools they need to sustain career in the modern economy by developing a curricula that incorporates both academic knowledge and occupational skill training.

This goal of bridging academia and the work place can be accomplished by focusing on student needs, but this task is made difficult because of the diverse student population in the community college.

THE COMMUNITY COLLEGE STUDENT

Besides the differences in their educational mission, community colleges and four-year institutions also differ in student diversity. According to Lamkin (2004), the image of a typical college student as “a recent high school graduate, a young, white, middle-or upper-income person pursuing a four-year degree on a residential campus” (p. 12) has changed. Perhaps this image may describe students at many four-year institutions, but not community colleges, which now account for about half of the U.S. postsecondary student population (Sampson, 2004). Lamkin (2004) states, “attracting particularly high proportions of underserved students, including low-income students, first-generation college-goers, and students of color, community colleges enroll 46 percent of all African American, 55 percent of all Hispanic, and 55 percent of all Native American students” (p. 12). Asians and Hispanics are the fastest growing minorities (American Association of Community Colleges, 2000). “As with other groups before them, upwardly mobile ethnic and racial groups will rely on community colleges as

their on-ramp to the higher education highway” (Carnevale, 2001).

Lamkin (2004) reports that community college students are often at-risk; more than half of them have at least two of the seven characteristics that have been shown to influence drop out rates: delayed enrollment after high school graduation, lack of a high school diploma, part-time enrollment, full-time work (at least 30 hours a week), financial independence from parents, dependants other than a spouse, or single parenthood. “Low income and students of color are especially likely to exhibit these characteristics” (p. 12).

Teaching students how to avoid plagiarism may make sense in the white majority American culture with its emphasis on the importance of the individual, copyright law, and the legality of ownership of individual ideas. However, other cultures may not value this kind of individual ownership, so plagiarism of words and ideas may not be something community college students from non-white cultures see any reason to avoid. English as a second language (ESL) students may have particular problems understanding plagiarism issues since they have a language as well as a culture difference from mainstream America (Breen & Maassen, 2005; Ercegovic & Richardson, 2004).

UNDERPREPARED STUDENTS

The open door policy of most community colleges allows students who would never have been able to attend a university to begin a college education, even with poor high school GPAs, low placement tests, and limited financial resources. Shemo (2006) describes hundreds of thousands of students arriving at community college doors, “eager but unready.” Many of these students are the first in their families or neighborhood to attend college, so they have no mentors in their families or peer group. Most underprepared students lack academic writing and research skills. They may not be able to comprehend a syllabus description

on how to avoid plagiarism or understand Web site examples of plagiarism.

On its Web site, The University of Alberta lists the following reasons why students plagiarize, all of which may be exacerbated by underprepared students’ lack of academic experience:

- Lack of research skills
- Problems evaluating Internet sources
- Confusion between plagiarism and paraphrasing
- Careless note taking
- Confusion about how to properly cite sources
- Misconception of plagiarism
- Misconception of intellectual property, copyright, and public domain
- Misconception of common knowledge
- Perception of online information as public knowledge
- Poor time management and organizational skills
- The commodification of knowledge and education

Although most campuses have some kind of tutoring centers that provide free support for students who are delving into writing or research projects, the irony is that underprepared students often are the very ones who do not take advantage of the opportunity. They know they have academic limitations, but they are afraid to take the very public step into an academic assistance center for fear of announcing their weaknesses to the world. Faculty can help students overcome their embarrassment by sharing information and statistics from the centers that show that many A and B students take advantage of tutors and academic support. Another suggestion is to have the staff from the center visit the classroom, or even better to take the entire class over to visit the center so that students will be familiar with the people and environment. Often a class visit

is all it takes to give underprepared students the confidence to ask for help.

Since their scholastic experience is limited, underprepared students are often confused by the idea of common knowledge. A definition is given by Stolley on the Purdue OWL Web site: “Generally speaking, you can regard something as common knowledge if you find the same information undocumented in at least five credible sources. Additionally, it might be common knowledge if you think the information you’re presenting is something your readers will already know, or something that a person could easily find in general reference sources.” However, underprepared students might have problems understanding the meaning of “undocumented,” “credible sources,” and “general reference sources.”

Paraphrasing is also difficult for underprepared students. Lacking formal academic language, they often cannot state in their own words what a source is saying. In order to avoid plagiarism, they instead quote whole sections of source material rather than summarizing or paraphrasing. Until underprepared students have the expanded vocabulary that comes with educational experience, paraphrasing will remain a difficult task for them. Faculty who receive an overly quoted paper should realize that the student is trying to follow the academic rules of citing sources and needs to be guided to gain control over those sources in small steps. Requiring students to print out and attach source material to their research paper rather than allowing students to rely on copying and pasting is one way teachers can help students begin the critical thinking process it takes to paraphrase and summarize.

A research paper or project is “one of the most challenging projects students undertake in college because it requires strong research, writing, and critical thinking skills to carry out successfully” (Sterngold, 2004), and the lessons learned from such a project are crucial to students’ educational experience. Unfortunately, because of the bad experiences community college faculty have had

when they get poorly documented papers, riddled with organizational and grammar errors, many stop requiring a research paper.

To help support underprepared students, many colleges offer developmental courses. Nordstrom (1997) states that according to the National Center for Education Statistics (NCES), 78 percent of all postsecondary institutions offered at least one developmental reading, writing, or mathematics course in 1995. Virtually all public two-year institutions and 81 percent of public four-year institutions offered developmental courses, while 63 percent of private two- and four-year institutions offered them. Developmental classes help older students review academic skills they may have forgotten and help recent high school graduates develop college-level skills they may have never been taught. Students who graduate from high school on a technical track, for example, may not have taken a foreign language, history, algebra, or academic writing class, so if they decide to attend college, they are deficient in many college-level areas.

FIRST GENERATION STUDENTS

Community colleges are often the choice for first generation students, but being the first person in the family to attend college is intimidating. Bureaucratic red tape, which is frustrating for most all students, is almost insurmountable for students who have no family or peer mentors. Technology has made it possible to put many of the traditional print-based institutional documents online, including class schedules, the catalog, and the student handbook. In addition, the admissions process, financial aid process, class selection process, and registration process at many institutions are also online, so students may feel like they have no face-to-face help to advise them either at school or at home. In addition, first generation students are often unprepared for college demands; Pas-carella et al. (1996) suggest that first generation

students enter college academically at risk and are not likely to experience conditions positively related to persistence, performance, and learning. They have weaker reading and creative thinking skills, lower degree aspirations, study less, take fewer humanities and fine arts courses, work more, complete fewer hours, less frequently attend racial or cultural awareness activities, and receive less encouragement from friends to continue enrollment.

MINORITY STUDENTS

Even though community colleges attract a high percentage of minority students, the degree attainment rates for minority students are dismal. Laden (2004) reports that in 2000, over 230,000 students earned community college degrees, with three-fourths of those degrees going to white students. "Despite the growing presence of nonwhite students, only 9.6 percent of associate degrees were awarded to African Americans, 10.1 percent to Hispanics, 5.3 percent to Asian American and Pacific Islanders, and 1.0 percent to American Indians and Alaska Natives" (p. 9). Many factors play a role in why many minority students fail to complete a degree, so institutions should continue to focus on the social, financial, and academic problems facing students and provide prompt assistance when warning signs appear.

SOCIOECONOMIC FACTORS

Community students often have financial issues. Tuition and fees have increased at community colleges, but not as fast as four-year institutions. Kasper (2002-2003) states that in-state tuition for community colleges for the academic year 1976-77 was an average of \$283 and by 2001-2001 had increased to \$1,359, an increase of 380 percent, while four-year public institutions' tuition rose

from an average \$617 to \$3,506, an increase of 468 percent.

Two out of five students enrolled in developmental courses receive some form of financial aid (Boylan, 1999) and Knopp (1996) found that nearly one quarter (22 percent) of those taking developmental courses reported an annual family income of less than \$20,000, while only 14 percent of those not enrolled in these courses reported the same income level. Many of these students do not have computers at home, so they may be as unsure of the rules of the Internet as they are the methods of online research, factors that might lead to unintentional plagiarism.

ADULT LEARNERS

In "Facilitating Responsibility for Learning in Adult Community College Students," Howell (2001) states that more than 2.5 million adult students (age 25 and older) attend community colleges, and Phillippe (2000) uses statistics from the National Center for Educational Statistics to show that in 1997, 32 percent of community college students were 30 years of age or older and 46 percent were 25 or older. Nordstrom (1997) found a 50 percent increase in the number of college students in the U.S. who are 25 years old or older, and the total number of adult students increased from 32 percent of the population in 1991 to 40 percent in 1995.

Many adult students need remediation, according to Roueche and Roueche (1999), who state that high school graduates who do not enroll in college immediately after leaving high school are more likely to need remediation in more than one subject area than graduates who enroll immediately. Therefore, as the adult population in college swells, so does the number of under-prepared students.

Even though adult students may need developmental courses or extra support services to brush up on academic skills they may have forgotten,

most studies including one by Whisnant, Sullivan, and Slayton (1992) find that older, nontraditional students perform at a higher academic level than younger, traditional students. Most college faculty are happy to have nontraditional students in their classes because they bring experience, life-lessons, maturity, and what Whisnant et al. call “an educationally focused personality” with them, attributes which motivate them to have a serious academic bent. Many are paying for their classes themselves since they are no longer dependent on parental support, so they intend to get their money’s worth.

Focusing on adult learners as a separate area of study from younger learners was first championed by Knowles (1984) who proposed a new label for adult learning, *andragogy*, to distinguish adult learning theory from *pedagogy*. Knowles’ model lists the following characteristics of adult learners:

1. Adults both desire and enact a tendency to be self directed;
2. Adults’ experiences are a rich resource for learning;
3. Adults are aware of specific learning needs generated by real life tasks or problems;
4. Adults are competency-based learners: they want to apply newly acquired skills or knowledge to their immediate circumstances; and
5. They are problem-centered rather than subject centered.

Although there is a debate about whether andragogy can be defined as a distinct learning theory (see Merriam & Caffarella, 1999, pp. 272-278), it offers educators a new way of looking at their students, allowing them more opportunity to choose, plan, and evaluate their educational experiences. Because adults want to apply their learning to their immediate circumstances, they may become frustrated with writing a research paper for its own sake, especially if the topic seems irrelevant or the task seems overly burdensome. Adult learners want to be able to connect mate-

rial to their own experiences; learning needs to be relevant and practical, so adults may feel that typical writing or research assignments are busy work. Bloomfield (2004) states, “If students believe an assignment is ‘busy work,’ some will be busy cheating.” Pearson (2004) states that “given the pressures students feel to produce a number of papers and to get good grades, they may feel it is not worth their time to write an original paper for a class not in their major.”

Adult learners bring a certain set of characteristics with them according to Horne and Carroll (1996): they are more likely to attend part-time, to enroll intermittently, to work full-time, and to support dependents, often as single parents. In the technology-filled classroom, adult learners may feel far inferior to their traditionally-aged fellow students who seem to have been born with a computer in their hands. They may make more inadvertent plagiarism mistakes because they are not familiar with Internet research.

Adults may take their classroom experiences more personally than traditional students, according to Zemke and Zemke (1988): “Self-esteem and ego are on the line when they are asked to risk trying a new behavior in front of peers and cohorts. Bad experiences in traditional education, feelings about authority and the preoccupation with events outside the classroom affect in-class experience” (p. 610). They may be embarrassed to ask for help from the teacher, especially in front of their classmates.

Adults who have worked in business before coming back to the community college for their first or second degree are familiar with the “just-in-time” system of inventory. Most businesses cannot stay profitable if they must store unneeded inventory. Many adult students transfer this idea to their learning and ask difficult questions of teachers. Exactly why do I need to learn this material? Exactly how will this class help me in my job and my life? According to Ryan (2004), “A just-in-time theory of knowledge says that it’s actually a waste of effort to learn things that

can be easily referenced. And as time becomes a premium commodity in our society, this may be an attractive concept” (p. 64). Ryan continues, “Yet educators know that the life-changing effects of thinking require introspection and examination, neither of which can be achieved through just-in-time knowledge acquisition” (p. 64).

Although this discussion has given examples of adult characteristics and reasons why adult students could be tempted to plagiarize intentionally, there is no evidence that adult learners would be more likely to do so than traditional college students. In fact, most evidence is to the contrary. Ercegovic and Richardson (2004) cite a large-scale study of students in the United Kingdom that found that cheating declines with age. Unintentional rather than intentional plagiarism may be the bigger problem for adult students because they have been out of school for several years and may not be aware of academic conventions.

TIME MANAGEMENT

One of the most common excuses students use for intentionally plagiarizing is lack of time (Breen & Maassen 2005, WPA Statement on Best Practices). According to the American Association of Community Colleges (2006), 80 percent of community college students work full or part-time jobs, and work often interferes with study time. The National Center for Education Statistics Report, “Special Analysis 2002: Nontraditional Undergraduates,” states that 46 percent of students who worked found that working limited their class schedule, 39 percent thought that working limited the number of classes they could take, and 30 percent found that working limited their access to the library. Almost half of the students reported that working has a negative effect on their grades.

Many students do not intend to plagiarize. Those who do usually have run out of time for their school work, and because of pressures from scholarships, family, or work, or because of un-

realistic goals, they see plagiarizing as a better choice than failing the assignment (Pearson, 2004; WPA Council). It often does not occur to them that the penalties for being caught plagiarizing can be much greater than failing a paper or even a class. Teachers who have not built contingencies into deadlines may actually be inviting plagiarism. A more balanced approach might be to give students who have a reasonable excuse an extension or to deduct points for late assignments, but still allow them to be turned in. This approach may encourage students to complete their assignments successfully rather than being tempted to plagiarize.

Many community college students lack time management skills. They are not just students; they are workers, husbands and wives, parents, volunteers, and daughters and sons, with tremendous responsibilities and real-life problems outside the classroom. Many community college advisors notice that students want to schedule their classes back-to-back, with no times for study or meals. Students try to squeeze every available second into attending class before they rush off to jobs, pick up children from school, or take care of aging parents. First generation or underprepared students may not have thought about the possibility of attending part-time to keep their grades high because they are so eager to complete a degree and move on with their lives and careers. Advisors could encourage students to schedule study time on campus. The campus library, computers, access to tutors, and technology access at most colleges is superior to what students have at home at their disposal, so students who stay on campus to study can do so without worrying about children’s needs, the doorbell ringing, and the pull of household chores.

Two-day-a-week classes are popular on community college campuses, especially with rising gas prices. Since most community colleges are commuter campuses, rising gas prices have hurt those students who have no options for public transportation or reasonably-priced dorms. Many community college students take a full load of classes on two days a week so they can attend

school full time and still work the other three days and weekends. First generation students may be unaware of the amount of studying time that college faculty expect, not taking seriously the statement in their class syllabus that two hours study is expected for every hour of class. They often slide by, attending class but not truly digesting material, until the results of first test confirm that they did not spend the appropriate amount of time outside of class studying.

Faculty who schedule more frequent assignments and tests help their students by making the amount of material that must be learned smaller and more concentrated. Boylan's (2002) *What Works: Research-Based Best Practices in Developmental Education* lists frequent testing as one of the most valuable study aids teachers can provide, a key component being testing over each unit of instruction (p. 78). Frequent testing can include paper and pencil tests, computer tests, practice tests, pre-post tests, quizzes, verbal questioning, recitation, group and individual projects written papers, reports, class presentation, or completion of exercises (p. 79). Another way teachers can help students with time management is for faculty to use a class discussion to take their students through a personal day by day calendar, having students input the number of hours per week they must attend classes, commute, work, and sleep to give students a picture of the requirements of their daily lives. Then students must include study, time with family, recreation, as well. The Academic Advancement Center at Ohio University has a useful exercise on their Web site called "The 168-Hour Exercise: How Do I Use My Time Now?" Students enter the number of hours they spend in class, in study, on personal care, on meals, on commuting, at work, and at sleep to get their total fixed hours. The computer will calculate how much flexible time they have left over and students can evaluate the results.

Many underprepared students have unrealistic goals. Giving them research projects that are set up in small steps—turning in a topic, then a working

bibliography, then notes, then a rough draft, then a peer-reviewed draft, then a final copy—helps them avoid procrastination. In addition, focusing on the process of writing a paper rather than the finished product means that students are less likely to buy a paper off the Internet and then backtrack to complete the required steps. Helping students manage their time is an important way faculty can reduce the possibility of plagiarism.

CRITICAL THINKING

Writing is thinking, so many of the problems community college students have with writing and research are actually critical thinking problems. Chaffee (1992) states that critical thinking is essential for college success, but few students are taught these skills in high school. In order to bridge the gap, problem solving and critical thinking should be taught as a part of each college course. Articles, research, resources, and conferences about critical thinking can be found at the Critical Thinking Community Web site. Boylan (2002) cites the model used by LaGuardia Community College in New York City which emphasizes the following skills: to solve challenging problems; to analyze complex issues and arrive at reasoned conclusions; to establish appropriate goals and design plans for action; to analyze complex bodies of information and make informed decisions; to communicate effectively through speaking, discussing, and writing; and to critically evaluate the logic, relevance, and validity of information (p. 96).

Students who are taught how to think logically and critically will be more ready to tackle writing and research projects with confidence and not be as tempted to plagiarize. Professors can use time at the beginning of the semester to suggest study strategies in their particular discipline, leading a class discussion about individual preferences and examples of students' successful or unsuccessful research attempts. Students might fill out a study

inventory with questions such as: what time of day do I study best? Do I prefer a quiet atmosphere? Does music help me study? What kind/s? How do my study techniques differ from course to course? Where do I like to study? Do I like to study alone or in a group?

Another helpful technique at the beginning of the semester would be to encourage students to take one or more of the dozens of online learning style inventories and write a short response paper about the results so that they may more completely understand their own learning preferences. A good source is Community College's Web site "How to Study," which has a list of learning styles sites (MacDonald, 2007).

MORE ACCESS TO TECHNOLOGY

Because one of the missions of community colleges is to provide career training, computers and technology are an integral part of many classrooms. However, this easy access to computers and the Internet may invite copy and paste plagiarism, which concerns teachers and administrators "who want students' work to represent their own efforts and to reflect the outcomes of their learning" (WPA Council). Scanlon (2003) states: "In the not-so-distant past, plagiarism at least required time-consuming physical work: going to the library, searching, reading, and copying. Now a student can cobble together a paper from online sources literally in minutes" (p. 164). Georgetown University's Web site confronts the copy and paste syndrome this way:

The trouble comes when you start to use someone else's words all throughout your paper. Pretty soon your paper looks like nothing but a field of quotation marks with a few country roads in between (your few sentences) connecting them. This does not represent very much intellectual work on your part. You have assembled a paper rather than writing one.

Technology has also meant that online classes have made higher education more accessible for students, especially for those who work swing shifts, are disabled, must take care of dependents at home, or have transportation problems. Enrollment in these classes is growing. However, faculty witnessing student plagiarism problems in the traditional classroom wonder if those problems are compounded by online classes because of the lack of face-to-face contact. Additionally, underprepared students may have particular problems with online classes since many of these students lack academic reading experience. Online classes demand a higher level of reading comprehension than traditional classes as well as careful time management, computer expertise, organizational expertise, and critical thinking skills, areas underprepared students may not have mastered. Without a face-to-face teacher to provide quick answers to the dozens of questions underprepared students might face in a typical research or writing assignment, inadvertent plagiarism should probably be expected.

Scanlon (2003) cites recent studies that suggest that instances of plagiarism have not necessarily grown because of easy access of the Internet. A study by Scanlon and Neumann in 2002 found the same levels of copy and paste plagiarism occurred as were found by a 1996 survey by McCabe and Trevino, approximately 25 percent. "Of course, no one should be happy that 'only' a quarter of college students surveyed self-reported Internet plagiarism, even if this number argues against popular notions of an epidemic of online cheating" (p. 162).

ADJUNCT FACULTY

Depending on adjunct faculty is one way community colleges fulfill their mission to connect education and the work world, and a high percentage of adjuncts teach developmental classes. Boylan (2002) cites a study by the American Association

of Community Colleges that found that over 65 percent of developmental faculty is part-time, and there is no evidence that adjunct teachers are any less successful than full-time teachers (Boylan, Bonham, Claxton, & Bliss, 1992). Many adjunct faculty members work full-time in business or industry and teach night or weekend classes, bringing the relevancy to the classroom that community college students demand. In addition, relying on adjunct faculty helps keep costs down for community college students. However, adjunct faculty, who are paid a fraction of the salary that full-time faculty receive and who may only be on campus for three hours a week, may not have the same kind of time or the same kind of academic bent that full-time faculty have, which could include trying to keep plagiarism issues at the forefront. Sterngold (2004) states, "Planning, managing, and evaluating research assignments are difficult tasks, and having to worry about plagiarism only adds to the burden" (p. 17). In addition, industry boilerplates and ghost writing are common occurrences in the business world, so some adjunct teachers may not be overly concerned by seemingly slight offences.

Because some adjuncts may not have taken education courses or may not be able to attend in-service professional development opportunities at the college, they may rely on the teaching methods that were used when they were in college, some of which Sterngold says, "invite cheating" (p. 16). He elaborates:

The traditional paradigm favors lecture-based courses, orderly classroom environments, and limited interaction between professors and students. . . [and] in the absence of strong institutional incentives to adopt learning-centered methods, many instructors rationally choose to continue using familiar, lecture-based teaching methods that are easier, safer, and less time-consuming to practice. (p. 17)

Most adjunct faculty are highly qualified, caring individuals who teach for little compensation because they have altruistic motives: they want to share their expertise with others. However, they probably cannot be expected to direct the same kind of attention to plagiarism problems as full-time faculty. Community colleges must provide adjunct faculty with the same kinds of in-service training about plagiarism issues that they provide full-time faculty, as well as giving information on the institution's Web page or in an adjunct handbook so that all instructors know the institution's stand on plagiarism and where to go for help if needed. Boylan (2002) states that adjunct faculty should be invited to attend faculty meetings, social activities, and professional development workshops. In staffing developmental classes, he suggests that institutions should only hire adjuncts who have a desire to teach those classes and that mentoring of adjuncts is important.

RESEARCH ACROSS A THE CURRICULUM

Many community college students arrive on campus with preconceived notions about plagiarism. Having an institutional policy that is clear and understandable for students is a beginning, but much more is needed. Discussing how the research process takes place in a particular discipline is every content teacher's responsibility, and no faculty member should assume that students know how to conduct research. Students in a history class need to know ethical ways to conduct ethnography research and students in a biology class need to know ethical ways to conduct scientific research. A Research Across the Curriculum emphasis is just as important at community colleges as a Writing Across the Curriculum emphasis because composition courses cannot possibly include all the ways different disciplines conduct research. When students hear about how to gather evidence, organize findings, write a report, and cite sources

ethically from all their professors, not just from their English instructors, they will realize that proper research is an issue that is important in their future jobs.

SOLUTIONS

In helping diverse community college students learn the writing and research process, no one teaching method has emerged as the best. Instead, faculty should use as many different kinds of methods as possible (Boylan, 2002). Although many community college teachers still use the lecture method followed by drill work, best practice institutions use a variety of methods including: distance learning, self-paced instruction, individualized instruction, peer review of student work, collaborative learning, computer-based instruction, mastery learning, small-group work, and other active learning techniques (Boylan, 2002, p. 73). Group projects and collaborative writing are methods many business, science, health, and agriculture faculty use to mirror real-world work practices. Faculty can give students information about learning styles, helping them understand their own preferences and perhaps experiment with different learning approaches. Many community college students are visual or kinesthetic learners, so the lecture method may not be the best way for them to learn. They should have the opportunity to use manipulatives, videotapes, computer graphics, models, labs, and field trips (Boylan, 2002, p. 75). The key is diverse teaching methods for diverse students.

Most sources agree that faculty should be proactive rather than reactive in their efforts to teach research and writing skills to students by using pedagogically sound course and assignment design rather than punitive after-the-fact methods (Akers, 2002; Bloomfield, 2004; Carbone; Davis, 1993; Ercegovic & Richardson, 2004; Harris, 2004; Martin, 1994; McDonnell, 1999; Pearson, 2005; Scanlon, 2003). For Ercegovic & Richardson,

2004, "It is simply not enough to define plagiarism, distribute neatly prepared citation templates for different formats, and say that plagiarism is wrong, punishable, easily detectable, and against honor code." Some sources suggest taking most of the punishment away from plagiarism. Martin (1994) states that plagiarism

is given too much attention and condemned in far too extreme terms. Given the pervasiveness of plagiarism, it should be treated as a common, often inadvertent problem rather like speeding on the road or cheating on income taxes. Most cases should be dealt with as matters of etiquette rather than 'theft'. (p. 44)

In his Web article, "Talking About Plagiarism," Carbone begins the plagiarism dialog with his syllabus. He disagreed philosophically with the typical syllabus in his course, which had a brief definition of plagiarism that concluded with the punishment a plagiarist would receive if caught. "My conflict here is that I don't lead any other discussion with threats, so why one on plagiarism? Why start off scolding? Why build anxiety and fear when I know that I'll be asking students to learn complex literacy skills, writing skills, and academic conventions?" He suggests that plagiarism is a matter of Dos and Don'ts in a list for students that he uses in class discussions throughout the semester.

McDonnell (1999) also suggests faculty use a proactive approach to plagiarism. He lists the following suggestions: 1) create and/or find assignments so unique to your teaching style that they can not be duplicated outside it; 2) use authentic assignments based on experiential learning such as service learning, writing for action, or writing for the community; 3) stress collaborative learning; 4) use the writing process and become involved in all five steps: prewriting, writing, evaluation, rewriting, and editing; and 5) include primary research in as many projects as you can such as interviews, telephone calls, or family documents.

The “Preventing Plagiarism” Web site from the University of Alberta Libraries suggests that plagiarism be discussed as a moral issue: “The relationship between faculty and students is based on trust; teach students the value of academic honesty and outline the responsibilities of being a junior member of the academic community.” In addition, this site suggests that faculty discuss the benefits of citing: “proper attribution shows that the student has done thorough research and that the student has been exposed to a diverse range of thought and opinion. As a result, the paper will likely be stronger.”

In her chapter “Preventing Academic Dishonesty,” Davis (1993) lists general strategies faculty should start with to help students understand academic conduct; defines plagiarism, paraphrasing, and direct citation; discusses how to pick appropriate paper topics; and lists ways faculty can provide students with help during the writing process.

Harris (2004) has a very helpful Web site for faculty, discussing the reasons why students cheat, strategies for prevention, and strategies for detection. Suggestions that Harris gives to help teachers prevent plagiarism include: make the assignment clear and specific; provide a list of specific topics and require students to use one of them; require specific components such as one or more sources written within the past year or incorporation of information the teacher provides; require a metalearning essay—an in-class essay about what students learned from the assignment. He also gives a list of detection strategies.

Coastal Carolina University’s Web site “Cheating 101: Easy Steps to Combating Plagiarism” suggests that the writing or research topic be tied into class experiences.

- Have writing assignments that have students analyze classroom activities or discussions in light of the text.
- Use local issues as topics.

- Ask students to include a section in their term paper that discusses their topic in light of what was covered in class.
- On the final exam, ask students to summarize the main points of their research paper.

The Electronic Plagiarism Seminar from Lemoine College (2005) by Gretchen Pearson, Public Services Librarian, also has good suggestions for faculty. Her list includes: talk about plagiarism, focus on research skills, lower the stakes so that a single paper is not the entire grade, require primary research, think about the primary purpose of the assignment, and be wary of the request for a last-minute change in a topic. She also has suggestions for using the writing process to prevent plagiarism and detect plagiarism.

Bloomfield (2004) reminds us that in order to prevent plagiarism,

...students need to be taught that the act of writing is intrinsically valuable to them. It crystallizes one’s thoughts in a way that nothing else can. As a physicist, I find that I often learn more from writing papers and proposals that I do from working in the laboratory. I rarely find writing easy, but I always find it rewarding.

ACTIVE LEARNING TECHNIQUES AND THE LEARNING COLLEGE

A radical educational shift from a focus on teaching to a focus on learning has motivated community college leaders in the past decade, a shift championed by the League for Innovation in the Community College. The Learning College is one which “places learning first and provides educational experiences for learners anyway, anyplace, anytime.” This emphasis on cultivating an organizational culture that supports learning as the major priority has as one of its project goals “to create or expand learning-centered programs

and strategies to ensure the success of underprepared students.”

Sterngold (2004) refuses to agree that plagiarism is a product of “students’ laziness, lax morals, or ignorance of the rules ... Before placing all the blame on students, we should consider how conventional teaching methods invite cheating, and how strategies designed to improve student learning can prevent it” (p. 16). He continues:

It turns out that many of the learning-centered teaching practices reformers have been advocating for years can help deter plagiarism as a byproduct of improving student learning and performance These strategies discourage plagiarism by making it difficult for students to cheat and also by eliminating many of the incentives to cheat. At the same time, these strategies allow instructors to treat most instances of plagiarism as fixable errors rather than fatal violations of academic policies. (p. 17)

Johnson (2004) also gives strategies for combating plagiarism in his article, “Plagiarism-Proofing Assignments” by listing Low Probability of Plagiarism (LPP) assignments. He states that LPP projects:

1. Have clarity of purpose and expectations
2. Give choices to students
3. Are relevant to students’ lives
4. Ask students to write in a narrative rather than an expository style
5. Stress high-level thinking skills and creativity
6. Answer real questions
7. Involve a variety of information-gathering activities
8. Tend to be hands-on
9. Use technology to spur creativity
10. Use formats that engage multiple senses
11. Can be complex but can also be broken down into manageable steps

12. Are often collaborative and can produce better results than individual work
13. Share results with people who care and respond
14. Are authentically assessed
15. Allow learners to reflect, revisit, and improve their final projects
16. Are encouraged by adults who believe that, given enough time, resources, and motivation all students are capable of original work

Scanlon (2003) suggests that using plagiarism checker software is not necessarily a good teaching strategy because the software could cloud whether the plagiarism was inadvertent and could “introduce an element of distrust” which turns faculty into “detectives with new—and as yet unproven—high-tech tools at their disposal, rather than teachers instructing students in what, for many of them are baffling principles and techniques” (p. 165). He suggests using mechanical means of detection during the writing process rather than afterwards “as a teaching tool... to provide an opportunity to discuss the proper handling of sources” (p. 165). Other examples of using well-designed assignments and topics to prevent plagiarism are discussed by Bolkan (2006), Carbone’s “Thinking About Plagiarism,” Fister, (2001), Leland (2002), McCullen (2003), McKenzie (1998), and Murray (2002). Fister lists a useful bibliography that includes general discussions of student research processes and problems as well as sources for specific assignments. Ercegovic and Richardson (2004) use Kohlberg’s States of Development in Moral Reasoning to chart how research can be put into practice at all educational levels.

PORTFOLIOS

Portfolios have been defined as a collection of student work (O’Malley & Pierce, 1996), so portfolios can be used effectively to collect all of the information gathered in the research process.

One method is to divide the research process into sections: topic selection, working bibliography, copies of source materials, first draft, peer-reviewed draft, final draft, and evaluation. The sections may have distinct due dates and may be kept together in a large mailing envelope, so the teacher can judge whether the student is making adequate progress or needs further instruction. Portfolio criteria often include a metacognitive essay in which the student evaluates his or her progress, learning process, goal achievement, and other categories. O'Malley and Pierce (1996) consider this self assessment to be the "key" to the portfolio process, so students are urged to become "independent evaluators of their own progress" (p. 38).

In his article "Using Portfolios to Avoid Plagiarism in Your Class," Carbone lists several ways that portfolios can benefit students: they help students manage time and set smaller goals and deadlines; teachers can tie the portfolio into issues of plagiarism; teachers can see how students research; teachers can see student work from the start; teachers can identify struggling students; failure to do a portfolio can result in the final paper graded as incomplete. Carbone also states that portfolios can also give students the opportunity to write before researching, which "helps avoid the get-a-stack-of-sources-cobble-quote-cite-and-then-patch-a-paper-together-thing that often results in voiceless, bland, unengaged research writing." Carbone suggests that the portfolio begin with a "knowledge of inventory: a list of everything [students] think they know about their given topic" which lets students "get their voice on paper."

LOWER CLASS SIZE

Community college faculty may be able to react to plagiarism problems more readily than four-year faculty because their class size is often smaller, making it possible for them to know their students

by name and by their writing style. Knowing their students means that community college faculty, who have more required office hours than four-year faculty, can personally meet with students who might be having problems with research. Trust builds between community college faculty and students, enabling faculty to deal with plagiarism problems "as educators first" (Scanlon, 2003). Large classes are listed as a factor that was positively correlated with academic cheating and plagiarism according to a study of nineteen colleges in the U.K. by Ashworth, Bannister, and Thorne (1997).

CONCLUSION

Although technology has made plagiarism easier than ever, educators have many strategies to combat both intentional and unintentional plagiarism. Bolkan (2006) says, "The final deterrent strategy, solid assessment and good teaching, can't be over emphasized....Motivation, of course, is the key. Motivated and engaged learners are much less likely to take shortcuts. If they're only in your classroom to get a grade and move on, the potential for plagiarism will be greater" (p. 12). Intentional plagiarism can be addressed by restructuring assignments, helping students develop better time management skills, and using learner-centered teaching methods. Unintentional plagiarism can be addressed using student/teacher conferences, portfolios, peer and self evaluations. Writing and researching are critical thinking skills that should be incorporated in every class. To Sterngold, "Indeed, acquiring strong research and writing skills may be more important to students' future careers than acquiring subject-matter expertise that may become outdated soon after the students graduate or that may become irrelevant when students switch jobs and careers."

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Section VI

Managerial Impact

This section presents contemporary coverage of the social implications of instructional design, more specifically related to the corporate and managerial utilization of information sharing technologies and applications, and how these technologies can be facilitated within organizations. Section 6 is especially helpful as an addition to the organizational and behavioral studies of section 5, with diverse and novel developments in the managerial and human resources areas of instructional design. Typically, though the fields of industry and education are not always considered co-dependent, section 6 provides looks into how instructional design and the business workplace help each other. The interrelationship of such issues as educational design, quality improvement, work ecology, teacher self-confidence, technology skills, and professional development are discussed. In all, the chapters in this section offer specific perspectives on how managerial perspectives and developments in instructional design inform each other to create more meaningful user experiences.

Chapter 6.1

Prevention is Better than Cure: Addressing Cheating and Plagiarism Based on the IT Student Perspective

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ABSTRACT

This chapter adopts a four-aspect model to address cheating and plagiarism in universities: education, prevention, detection, and consequence. The research focussed on the two aspects of education and prevention as the authors feel that this area has not been considered in detail by the research. Building on past research, a series of eight focus groups (72 students) were conducted with students from information technology degrees at an Australian university. The students were asked to comment and discuss the phenomenon of cheating from their perspective. The chapter presents in detail the responses of the students as analysed by the researchers and then builds a set of guidelines for educators to use in the areas of education and prevention in relation to student cheating.

INTRODUCTION

The problem of cheating is a long-standing one. Despite recent claims that the Internet and a decline in moral standards has caused a large increase in cheating, the evidence is that cheating has been a problem in universities over many decades (see for example: Bowers, 1964; Hetherington & Feldman, 1964; Stern & Havlicek, 1986). Yet most universities have not seriously addressed the problem unless forced to by events. The WIRA incident at the University of Newcastle in Australia where a blatant cheating situation was ignored by senior management as long as was possible is an exemplar of this approach and which led to an inquiry by the New South Wales Independent Commission against Corruption and the condemnation of the relevant senior management (Cripps, 2005; Longstaff, Ross, & Henderson, 2003).

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Where universities have addressed the issue of cheating, the predominant approach has been one of punishment. Taking a broader view, we see the process of addressing cheating as having four aspects:

- **Education:** putting in place educational processes that provide students the necessary skills and knowledge to allow them to avoid cheating and to understand why cheating is undesirable. It also covers the education of academics to ensure that they understand the processes of the university in relation to cheating and that they implement good educational practice that will reduce cheating.
- **Prevention:** designing assessment so that cheating is both difficult to do and counter-productive for the student to attempt.
- **Detection:** establishing processes that allow academics to detect cheating when it occurs and also establishing processes for students to identify problems with their work prior to submission, for example, allowing students to submit work to a plagiarism detection service.
- **Consequence:** creating fair and equitable processes for dealing with cheating situations appropriate to the circumstances of individual cases.

We believe that in order to properly address these four areas, it is necessary to have a good understanding of the major actors in the situation, that is, the students, the academics and the university. We address in detail only the first group of actors, the students, as this chapter intends to provide assistance to individual academics in their approaches to reducing cheating as opposed to the development of general university policy. Subsequently, the chapter examines the aspects of *education* and *prevention* because the aspects of *detection* and *consequence* have been covered in

detail in previous work (see Jude Carroll's work [Carroll & Appleton, 2001] for an excellent and comprehensive discussion of the policy issues surrounding cheating and plagiarism). The aspects of *detection* and *consequence* are more appropriate to the strategic approach needed in the policy area as opposed to the tactical approach needed in the teaching area. In addition, dealing with cheating once it has been detected is both time-consuming and difficult in the best of situations. By focusing on *education* and *prevention*, the overall time and effort required to manage cheating is reduced.

Education and *prevention* are not sufficient lenses in themselves to understand the student perspective. It is also necessary to determine the student's understandings of, and motivations for cheating. From this framework we aim to develop guidelines for educational curriculum and for designing assessment for academic programs.

BACKGROUND

This section addresses four questions that are raised by the current discussions of cheating in the community and which are necessary to inform our understanding of the student perspective:

1. What is cheating?
2. Should we be concerned about cheating in the university sector?
3. What influences students to engage in cheating?
4. How are universities currently addressing this problem?

What Is Cheating?

There are many ways that tertiary students may cheat, making it difficult to arrive at a simple definition of cheating. A search of the literature has shown that cheating is often defined using multiple dimensions. These typically are described

by sets of practices that encompass illegal, unethical and immoral behaviours, and behaviours that are against generally accepted institutional codes of practice. In some cases, however, whether a practice is cheating or not can depend on the rules set by an educator within a particular educational environment or for a particular task. For example, students may be encouraged to collaborate on a particular task but instructed to work individually on another. Cheating is a complex concept to define, leading to confusion as to what constitutes cheating (Ashworth, Bannister, & Thorne, 1997). We have defined a behaviour to be *cheating* if it violates the rules that have been set for an assessment task or it violates the accepted standard of student behaviour at the institution (Sheard, Markham, & Dick, 2003).

Why Is It A Concern?

Along history of studies indicate alarmingly widespread and high rates of cheating in universities (Bowers, 1964; Franklyn-Stokes & Newstead, 1995; Marsden, Carroll, & Neill, 2005; McCabe, 2005; Sheard et al., 2003)). Of further concern is that there are indications that the incidence of cheating is possibly increasing (Cole & McCabe, 1996; Diekhoff, LaBeff, Clark, Williams, Francis, & Haines, 1996). Major factors in this trend are changing assessment practices (e.g., online tests) and the increased use of technology enhanced teaching and learning environments (such as WebCT, Blackboard, and Moodle), which allow students more opportunities and a greater variety of ways to engage in cheating behaviour.

Levels of cheating and the changes in cheating patterns form a complex picture that needs to be viewed in light of changing educational practices, new learning environments and changing student work practices. Cheating can have many harmful consequences, but for the authors cheating is fundamentally about failing to learn. As educators we find that unacceptable and therefore a major concern.

Influences on Cheating Behaviour

When investigating cheating behaviour, it is important to determine the reasons why students cheat and the factors that prevent them from cheating. A number of studies of tertiary students have found that the most common reasons for cheating are time pressures and the need to pass or gain better grades (Davis & Ludvigson, 1995; Franklyn-Stokes & Newstead, 1995; Sheard & Dick, 2003). These studies also found that a commitment to learning and a desire not to engage in unethical or dishonest behaviour influenced students not to cheat. The comparative study of undergraduate and graduate students by Sheard, Markham, and Dick (2003) found that the reasons for cheating were the same for both groups of students; however, the reasons were rated more strongly for the undergraduate students and, in most cases, these were significant. In contrast, the factors that influenced students not to cheat were higher for the graduate students. A consistent finding across many studies is that fears of detection and punishment were not rated highly as factors that would prevent cheating.

Addressing the Problem

As stated in the introduction, the four major aspects for addressing cheating have been education, prevention, detection and consequence. Our particular focus on the education and prevention fronts has been predated by many studies and a brief review should provide a sense of development in both areas.

The establishment of honour codes has addressed both issues of education and prevention and seems to offer a reliable level of ensuring cheating is minimised, at least within the North American experience (McCabe & Trevino, 1993). Peer disapproval was assessed as having the greatest effect on cheating levels (McCabe & Trevino, 1997). Particular success seems to be found in the US, in smaller or military based colleges and

universities where students share common values (Maramark & Maline, 1993). But as the size of classes and institutions rises, so too does student anonymity and the honour code loses its potency (McCabe, 2005). Honour codes have also not been part of the largely non-residential university population in Australia, and therefore have not been used in the local response to cheating practices.

Davis and Ludvigson (1995) are also sceptical about external deterrents and emphasise the importance of students learning to take greater responsibility. They posit that it is "...only when students have developed a stronger commitment to the educational process and an internalized code of ethics that opposes cheating will the problem be eradicated" (p. 121).

Asophisticated concept that would have IT students taking on more responsibility over unethical practices both at university and in the workplace, can be found in the model proposed by Greening, Kay, and Kummerfeld (2004). Their proposition suggests an integration of scenario-based ethical problems into the computing curriculum as a means of institutionalising ethical study as core content. The authors would use a survey as a teaching implement rather than a research one, to spark interest and engagement, and in so doing, enhance student awareness of a vast array of questionable practices.

Plagiarism detection programs such as Turnitin which might otherwise cause fear and loathing can be used as educational tools to inform students of accepted academic practice (Barrett & Malcolm, 2006). In such programs, students are encouraged to scan their work until the program indicates it is clear of plagiarism.

In a similar attempt to allay student anxiety about inadvertent plagiarism, McGowan (2005) maintains that students must begin their academic careers with an appreciation of the conventions and values of academic inquiry. If the university can achieve this objective, then students will be far more positive in their approach to learning and

less concerned with plagiarism and its detection; as McGowan puts it: "plagiarism minimisation."

Reynard (2000) is mindful of both the unintentional and deliberate cheater and the efforts required to reveal and prosecute them. Her response is to bypass that process and design "Cheater-Resistant Assignments." Usually these tasks involve contributing something of one's own experience. Therefore, she suggests that an assignment that might typically ask for an analysis of the plot of *The Odyssey* could be framed as an exposition of a student's life journey, and how it might share some qualities with that of Odysseus. Reynard identifies several critical elements that help to cheat-proof a paper. For example, changing topics from year to year, being more specific when choosing topics for assignments, and monitoring all the stages of the writing process, are some of the many helpful suggestions.

Zobel and Hamilton (2002) address specific IT issues by recommending "verifiable submission" which involves presenting assignments electronically so that each will be identified by a user-name and a date-stamp. They suggest that students be required to submit draft submissions as well as source archives that will allow tracking the development of the assignment. This would overcome the last minute panic phenomenon that might otherwise encourage desperate responses.

In their comprehensive and insightful guide to dealing with plagiarism, Carroll and Appleton (2001) echo Reynard's suggestions, and add,

...reconsider the learning outcomes for the course and decrease those that ask for knowledge and understanding, substituting instead those that require analysis, evaluation and synthesis... (p. 10)

Perhaps Carroll and Appleton's most significant contribution is their emphasis on changing the atmosphere of the learning environment to one of engagement and commitment. This notion of cultural change is by no means new, with stud-

ies such as that by Dick, Sheard, Bareiss, Carter, Joyce, Harding and Laxer (2003) suggesting the provision of orientation programs for new students, as well as programs designed for academics to embrace cultural change.

RESEARCH METHODOLOGY

The goal of the research was to obtain a deeper understanding of the student perspective in relation to student cheating and plagiarism. In order to do that, we concentrated on the following issues with the students:

- Understandings of cheating and plagiarism
- Motivations for cheating and plagiarism
- Methods by which the university can reduce cheating and plagiarism

While survey research has been the mainstay of most cheating and plagiarism research, there have been exceptions (for example, Carter, 1998). In our study, we saw the need to extend the sources of data beyond that provided by surveys. A qualitative approach was used to provide a richer level of detail than that provided by the authors' past survey research. Observational techniques were considered to be impractical in this area, so this led us to the decision to use interview techniques. While individual interviews could have been used, it was felt that the interactive nature of focus groups led by a trained facilitator would be more likely to surface valuable material from the students than interviewing individual students in isolation.

Students were recruited to the study via announcements in a number of lectures. One of the authors presented the research process to the students and answered any questions. Students then nominated via a form, to participate in the focus groups. Students then were contacted and asked to attend one of the groups.

The distribution of students in the focus groups was stratified. Firstly, it was decided that it would be useful as well as practical to be able to distin-

guish between the traditional campus students and the technology campus students as there may be differences in the culture at the two campuses. This was considered likely, not only due to the different backgrounds of the campuses (traditional campus – originally a traditional university, technology campus – originally an institute of technology), but also because the students are enrolled in different degrees. Traditional campus students are enrolled in either a three-year bachelor of computer science or a four-year bachelor of software engineering. Technology campus students are enrolled in a three-year bachelor of computing. Our previous research had also indicated that there were some differences in levels of, and attitudes to, cheating at the different campuses.

Secondly, full-fee students were separated from Higher Education Contribution Scheme¹ (HECS) students for two reasons. Full-fee students are nearly entirely international in the student body and in the focus groups there were no domestic full-fee students. The first reason was that we felt that international students may feel freer to talk if there were no domestic students present. The second reason was the belief amongst some academics (Dick et al., 2003) and also in the general community that international students are more likely to cheat than Australian students. Our previous research does not support this belief, but we felt that it was worthwhile to explore the differences in opinion between international and domestic students. Our belief is that if there is any difference between international and domestic students, it is more likely to arise from the economic imperatives of full-fees than cultural differences.

Finally, the focus groups were divided on the basis of year level. Second and third year students were grouped together as they had both had significant experience of the university environment, and our previous research had shown little difference between the two year levels. First year students have had less experience of the university environment, therefore it seemed likely that separating them from the other year

levels would be useful. No fourth year students from the bachelor of software engineering were involved in the focus groups.

The eight focus groups were organised on the basis of campus, fee status, and year level. Table 1 shows the profile of the focus groups that took place.

The gender balance of the focus groups approximates the gender balance of the student populations in the relevant degrees.

The interviews were conducted in an open manner with the facilitator directing the discussion in a light way. The students were free to range around the general issues introduced by the facilitator. The focus group discussions were audio-taped and then transcribed. Transcriptions of the focus group interviews were analysed with the NVivo tool using a grounded theory approach (Strauss & Corbin, 1998).

Ethical Issues

In conducting the focus groups it was inevitable that examples and possibly even admissions of

cheating would occur. In order to ensure that no harm came to the participants in the focus group in the event that they admitted to cheating, a variety of measures were undertaken. An independent facilitator with no links to the university was hired to conduct the focus group; none of the academics who had any connection with the students was involved. The audiotapes were then transcribed by another independent person in such a way that students were only identified by their gender and it was not possible to attribute any statement to a particular student. Students also were advised of the process prior to participating in the focus groups to ensure that they were fully informed.

A final ethical issue was that the students were paid for their participation in the focus groups. As students were spending one to two hours in the focus group, the authors felt that it was appropriate to reimburse them for their time participating in the study. Students were paid a fee of Aus\$30.00 to participate. The research was approved by the Monash University ethics committee (Application number 2004/494).

Table 1. Focus group profiles

Focus Group	Campus	Fee Status	Number of 1 st Year Students	Number of 2 nd Year Students	Number of 3 rd Year Students	Male	Female	Total
1	Technology Campus	Full Fee	8			2	6	8
2	Technology Campus	HECS	9			7	2	9
3	Technology Campus	Full Fee		3	4	5	2	7
4	Technology Campus	HECS		5	3	6	2	8
5	Traditional Campus	Full Fee/HECS (6/2)	8			8	0	8
6	Traditional Campus	HECS	10			7	3	10
7	Traditional Campus	Full Fee		6	5	7	4	11
8	Traditional Campus	HECS		6	5	8	3	11
Totals			35	20	17	50	22	72

THE STUDENT PERSPECTIVE

This section details the results of the analysis of the focus groups based on the framework presented in the introduction. This framework consists of the four concepts of:

- Understandings of cheating and plagiarism
- Motivations for cheating and plagiarism
- Education to prevent cheating and plagiarism
- Prevention of cheating and plagiarism

In each section, the dominant concepts that arose from the focus groups will be presented with quotes to illustrate them.

Understandings

Student understanding of cheating phenomena is overall shallow and literal, as will be seen from the following concepts which arose from the analysis of the focus groups. As opposed to this shallow conceptual understanding, students displayed a sharp understanding of the practicalities of cheating when asked about the cheating methods that they were aware of.

Cheating is About Plagiarism

The first concept to arise from the interviews was that “Cheating is about plagiarism.” At the start of each interview, the facilitator asked the students to indicate what their understanding of the purpose of the focus groups was. The great majority of students indicated that the purpose was to address the issue of plagiarism, for example “It’s a focus group about plagiarism” or:

The university’s educational emphasis has been on plagiarism as opposed to other forms of cheating and students have taken this attitude on board. Further probing by the facilitator was usually able to elicit more broad understandings of cheating from the students, but it was clear that

for many students their salient understanding of cheating was restricted to plagiarism.

Cheating is Easy

One of the clear statements from students that arose out of the focus groups was that students believe that it is easy to cheat. A perception that cheating is not difficult is highly likely to encourage cheating amongst the student population.

It’s pretty easy especially with IT, the technology, just copy and paste from other files. A lot easier than pen and paper where you have to read it and then copy it.

Cheating is Inevitable

Many of the students saw cheating as the natural way of things and that it was inevitable. Exemplars of this attitude were:

For example, if you can get the material from someone else it’s easy. You can see it everywhere. It’s kind of like a human network. You know this person, you know another one. And if you can cheat you take the opportunity to cheat.

Seriousness of Different Types of Cheating

One of the understandings that arose from the focus groups was that they saw cheating as a range of behaviours and that the seriousness differed depending upon the type of behaviour. The most serious form of cheating was that done in exams as the students exhibited some trust in the exam to assess them fairly, despite as we will see later on, their considerable knowledge of ways around exam protocols.

I think we all trust the exam process though.

Overall, students reported that they considered exam cheating to be a “bad thing.”

But like if you go into an exam and you pull out cheat notes or something like that, I think that's much worse than just copying an assignment and then not referencing it properly.

Literal copying was also considered to be serious by many students:

Unacceptable, I think, would be like direct copy.

Though quite a few students did not find literal copying to be a particularly serious matter:

See if a friend of mine wanted to copy off me I wouldn't be too impressed. But it would only bother me in terms of not giving him the work if I thought there was a chance of getting caught. Otherwise I'd be happy for him to just take it

What was considered to be significantly less serious, was assistance for the purpose of learning, even where this might be considered by lecturers to be cheating. For example, the student above who referred to copying a substantial portion of a program extended his comment:

I've got no problem with someone looking at my program even if they look at every line of it and ask me why do you do this. ...I've got no problem with it because they've learnt that and the next time they do that it wouldn't be considered cheating.

This student amongst others made a clear distinction between copying where the purpose was to learn as opposed to just completing an assessment task without attempting to understand the material. The following student made a similar point:

It also depends on what people classify cheating as. Like if you look at someone else's work because you don't understand something and you write it

down and then you learn from it well then do you call that cheating? If you're learning from something that you've been given by someone else...

6 Words or More

In several courses in the degrees, students are provided with the following rule:

Six words or more in a row without quotes or references is plagiarism!

The aim of the lecturers in these courses is to provide students with a clear, objective measure of plagiarism and thereby allow the students to easily avoid it. Unfortunately, the student response is that they are far from reassured that this assists them to avoid plagiarism. In fact, it seems to create significant stress for the students with its arbitrary size:

If you get like 6 words the same you get caught and some people would do it by accident.

Boundaries of Cheating

The students were clearly confused about where the boundaries of cheating were, especially in the area of collaboration (acceptable) versus collusion (unacceptable). In all the degrees these students were enrolled in, many courses emphasized to the students that they should share ideas and work with other students. This was not always the case though, in some courses, the rule was that all work must be done by the individual and no collaboration was allowed.

I guess copying so much isn't so good but often lecturers will say it's good to try and teach other people. Because it helps reinforce the knowledge and I agree. I think to try and help somebody do the problems is the best way as well no, you got to write, it helps you know as well.

The lines are fuzzy. It's not defined really.

Pointlessness of Cheating

A key point for many students was that they considered cheating to be a pointless activity for two reasons. Firstly, cheating prevented them from learning and secondly they would be unprepared for their future careers.

What's the point of cheating if you don't learn anything.

I don't understand why you do it. ... Like when you get out of here you don't know anything and you pay this money you might as well learn it and understand it or change courses or do something else. Cheating is a waste of time.

Motivations

In attempting to reduce cheating in the classroom situation, it is important to understand the perceptions of students in relation to their and other student's motivations to cheat. It is also important to listen to what students say about what motivates them to choose not to cheat. The previous section on Understandings overlaps with student motivations in two areas. One of the reported motivations for cheating which has already been mentioned in the section on Understandings, is the inevitability of cheating. Where students believe that cheating is inevitable, it becomes a motivation for them to cheat themselves. On the other hand, clearly the student's understanding of cheating as pointless provides us with information as to the motivation for not cheating. Students who value learning will be far less likely to cheat. Other motivations that were presented by the students are reported in the following sections.

Laziness

The most commonly raised reason for cheating by the students was that cheating students were lazy. This is a rather damning statement about

their fellow students but it was consistently raised without any prompting by the facilitator.

Some people are just lazy and they just want to get by without doing anything.

I think what leads to cheating is just some people are lazy.

If students perceive other students as lazy, they are less willing to collude in cheating with their fellow students by providing assistance.

It depends why they need it as well. If somebody who really doesn't understand...has been going to lectures and doesn't understand and they've got a prac coming up and they need help with something its different from if somebody is just... they know what they're doing but they're just lazy and haven't done it and they just want to copy you because they couldn't be bothered.

Financial Pressure

Both local and international students reported that financial pressures can be a factor in causing students to cheat.

And with international students they have like... not all of them, but some of them have a financial burden. Like they got to look after their rent. Their general fees. They don't get concession on buses and trains and stuff and it all adds up in the end and they need to work for it. Do you know what I mean.

With HECS as much as it is people are under a lot of pressure. They don't want to fail. It'll cost you about \$800 to repeat a subject. And it's just not something most people can afford.

Family Expectations

It was mentioned several times that if students are under significant pressure from their family to perform well at university, then this can create a strong temptation to cheat.

I guess it's also the pressure from parents who push their children

The first time I brought home a C my mum flipped. I've never seen her so angry at me. And I know some parents are like that. Even when you're at uni. They can see how, but when it comes to grades they seem pretty harsh. And you get scared and you get desperate and...

Peer pressure

Far more commonly reported than family pressure was peer pressure to assist other students in their cheating. This took two forms: the first form was pressure from friends to assist them and the difficulty of refusing the friend because of the relationship.

I just reckon probably the top reason is like some people are pressured into cheating like giving their work to others.

Student: *Also that could be your friend who asks you. And you just don't want to...*

Facilitator: *...so you collude in their cheating because you can't get out of it.*

Student: *Yes*

The second form is where students feel an obligation to assist their friend when they have suffered some form of setback and that not helping causes the student to feel guilty.

When someone is under pressure or something you kind of feel bad and you want to help them out.

No Connection to the Degree

A motivation that was strongly supported by the students was that many students felt no real connection to the content of the degrees that they were studying and that many students had enrolled in the degree by default, rather than because they felt a passion for an IT career.

Some people do a course just to get the certificate, the degree. They just want a pass.

I know people that are doing the course just because they got into it. They put it on their VTAC² and they got in and they're stuck here.

Doing the stuff that you enjoy doing so that's probably a deterrent to cheating itself because if you're enjoying it you want to understand.

Lack of Relevance or Importance

Assignments where the students felt that the material was irrelevant or of little value to their final mark were likely to encourage cheating according to a number of students.

I personally take a fairly laid back approach and my style of thinking is if I need to cheat to get to a near pass or just to get a pass mark then I shouldn't be cheating, ... And the only exception is when you have a subject you don't feel it has any relevance, the core subject doesn't lead onto anything else and it's just an addition.

The exams seem to be worth a lot sort of 80% so that's why it doesn't bother me that people cheat on assignments cause they're going to make up maybe 5% of their mark.

High Stakes/Failing Hurdles

Related to the issue of work that was irrelevant or unimportant in the student view, were assessments that were high stakes in terms of the result, but did not have a major effect on the final mark. In this case, students felt that it was a reasonable response to collaborate/collude with other students.

There is this particular subject where in the pracs, it's either pass or fail so you finish the mile stones ... and you understand them and explain them and everything is there so you pass. So only 2 grades. Pass or Fail. But I remember it was so hard as they say you can't really finish it because you have like 10 milestones and no matter how early you started the prac, still until the end you can't finish it because it's that hard. Then suddenly what people started doing is okay I do the first 3 and then the last 4 and will explain to each other and you take part of mine and I take part of yours and we will work it out from there. Make it different or anyhow. So what do you call that, cheating as well. Or cooperating or helping.

In uni there's very strict conditions about hurdles and all that sort of stuff. So basically what they say is you failed 2 pracs. You failed a prac hurdle. You failed a unit. You know you're going to have to catch up in summer which is quite scary for some people. So they're willing to cheat just so they don't have to do that

Status with Peers

At the traditional campus, many computer science students feel that there is a real division in the student body between those who are good at programming and those who are not:

You'll assimilate in the first year, like computer programming, computer science, either you will get 50% of people getting HDs and 50% of people getting passes.

Students in the lower performing group, then feel a social pressure to improve their results and see cheating as one way of doing this.

... and what I was saying about stigma. If you get lower marks or whatever. There seems to be this thing you've got to be a star student or you're nothing. You know hero or zero.

Availability of Support

Students reported that the level of availability of support from tutors and lecturers influenced the likelihood of students cheating. When students were unable to access help, they felt that it justified cheating to some extent.

Like there's not enough time for the prac person to go around and help everybody. Like you ask them [the tutor] for help and they go oh it's prac, I can't help you with that.

Poor Time Management

A reason commonly put forward by students in the focus groups was that an inability by students to manage their time often led to the necessity of cheating.

Sometimes people do cheat. Like I've seen my friends because 3 assignments are due on Friday so what do you do? And the assignment they are carrying like 15% of the assessment. You have to do all 3 and if you're not catching this stuff as quickly as other people are, then you have to resort to other measures.

Sometimes you get stuck in some way and you will be very tempted to refer to someone else.

Internal Conscience

The reason that students most commonly put forward as a motivation for not cheating was

that it would be a burden on their conscience to have cheated.

So I need something internal that will tell me the reason for every movement I make or everything I do and say ah, this is not good, even if I really need it and I have to cheat in this situation but it's no good, the consequences will be worse.

I could never fathom it. I'd just have too much of a guilty conscience.

Other Motivations

A number of motivations that had been indicated in our earlier research as impacting on the decision to cheat were not strongly supported by the students in the focus groups. Language difficulties as a motivation to cheat was only raised by one student and received little if any support from the other members of their focus group. As well, there was little support for the theory that cheating was a matter of misunderstanding, except in the case mentioned earlier of the confusion between collusion and collaboration. Fear of failure and the fear of getting caught had weak responses in the survey (Sheard et al. 2003) as reasons not to cheat. Focus groups supported this result, barely mentioning these fears.

Education

This section on the student perspective addresses two issues. First, how do students perceive the educational instruction that they have received about cheating? Second, what education should be provided to them to help them understand cheating?

Awareness of Education Efforts

In general, students clearly knew of the educational efforts made by the university to inform them about cheating and plagiarism. Nearly all the students

acknowledged that the university provided some education in courses about these issues.

I guess this university makes a start when at the beginning of each lecture or lecture of each subject the lecturer tells you that plagiarism is not allowed. In tutorials they say you're not allowed to plagiarise or cheat or anything like that.

In the first semester we had something in class which was about how to cite stuff and how to quote it and what plagiarism was

Impact of Educational Efforts

However, while students were aware of the education efforts made by the university, the impact of those efforts was clearly marginal. A strong consensus from the students was that these efforts were not very effective. They perceived the educational efforts as perfunctory and paid little attention to them.

Student: *Yeah. Every subject has like a lecture dedicated to try and scare you into not doing anything at all, ever.*

Facilitator: *Okay. But the rest of you did it scare you? What was the impact of that? Those lectures.*

Student: *I kind of zoned out.*

Student 1: *I'm just saying generally I just don't read anything that's got to do with cheating. Just because I couldn't be bothered with reading it.*

Student 2: *We've heard it so many times.*

Some students who were studying double-degrees contrasted the educational effort in their IT courses unfavourably with the effort in their non-IT courses.

Prevention is Better than Cure

I think it was definitely helpful like as you were saying in Law like at the start of the year in our lectures they actually...when you had an assignment coming up they actually sat down and spent 15 minutes going through what plagiarism is and what does actually constitute cheating and plagiarism and what you can do and what you can't do. Whereas with computer science ... that was just give you a piece of paper that has rules on it and nobody actually explains anything.

Clear Definitions

When asked about ways to improve the education provided on cheating and plagiarism, one issue came up again and again; the need for the university to provide clear definitions. This supports the findings on confusion regarding collaboration and collusion we saw earlier.

I think student need to be explained clearly what is cheating and what is plagiarism really.

They should say exactly what you shouldn't do or say anything that's not expressly permitted is forbidden. Something like that.

Where as they say how big they are on referencing but they don't fully explain what they mean. So they'll give a student a P and say yeah you didn't reference properly but there've never really sat down and explained to people what is plagiarism. How even if you paraphrase you still need to reference.

Education Won't Work

A common, but not universal, attitude expressed by the students in the focus groups was that regardless of the efforts the university might make, it will not be able to eliminate cheating.

I don't think telling people would make a difference.

A lot of...like if you try to tell people what cheating is I think a lot of people just find it boring and don't...like when I put on the cheating paragraph to my projects or I read it or whatever I have to ... I just ignore it. I copy, paste and put my name in, that's it. I don't read anything to do with cheating.

Suggestions for Improvement

A variety of suggestions were received from students about measures the university could use in their educational efforts to reduce cheating. One suggestion was to provide examples to help students understand what cheating and plagiarism really meant.

Maybe if they gave examples. Like just made it kind of more interactive when they explained it instead of read this.

Another suggestion was to ensure that students were informed about the sources of help available to them, so that cheating became less necessary. It follows from this that the provision of adequate help systems is a necessary first step.

How to get help and where you get the help from and having lecturers tell you constantly this is a point...

Other issues raised were educating students on how to handle situations where they know of other students cheating or when they are pressured to assist students to cheat.

Students aren't told how to deal with other people plagiarising.

Facilitator: *Do you think you should be told how to deal with other people plagiarising?*

Student: *Yeah. Cause they say don't plagiarise and you don't plagiarise. You need to know what*

to do if someone is plagiarising or cheating on your work.

Finally, a common suggestion was to focus the educational efforts on why cheating is a bad thing, by pointing out that by cheating, the student reduces their learning to a minimal level and that this will impact upon their ability to perform in industry when they graduate.

Well you'd have like associate it to life experience. For example if you just cheated your way through university and then towards the end like you get out of university and you get a job like 6 months later, you have no clue what to do.

Prevention

This section looks at the student perspective in terms of how cheating may be prevented from occurring or at least reduced.

Interviews

A common practice at the technology campus was the use of oral exams to assess the assignment work of students. Students in the focus groups were strongly in favour of this approach as a means of preventing cheating.

I don't know if it's done in other code classes but with the Java [a programming course] that we're talking we're actually tested on whether our work is ours by taking it in there and reviewing. So I think that's a good way of dealing with it.

And after each assignment and stuff like they should like in one of our subjects the first year after you did the assignment a few weeks down the track or whatever they mark you and they have a mark on the side but they interview as well. Interview you to make sure that you know the stuff that you wrote down. Like that was a pretty good system

Teacher Approachability

A very common issue raised by the students was that lecturers and tutors needed to be approachable. If a student felt that they could not approach a teacher for help, they were more likely to cheat as they had no alternative.

I think somebody raised about the tutors. The fact that some tutors are unapproachable or some people are too scared to ask questions. If we could somehow encourage more interaction between students and tutors and student groups and whatever, whoever is responsible I think that would sort of alleviate the problem with plagiarising.

Student 1: *...well they tell you that you can ask any question they want. The silly question or whatever. But when you start asking them that's when the reaction is not all that good.*

Student 2: *They're always getting frustrated with the questions you're asking.*

Caring

Students in the focus groups were very quick to categorise lecturers and tutors according to whether they felt they cared or not. When teachers were considered to be uncaring, it was felt that this encouraged students to cheat.

That can be difficult to when the lecturers are swapping around. Especially if the lecturer has gone overseas ... and the replacement guy comes in and he just says well I'm here for a fortnight. I really don't care about you guys.

The ones who don't make it look like they're just doing it because they're getting paid. Like the ones who look like they actually want to teach something and they interact with you well.

Levels of Interaction

Students felt that high levels of interaction in the course were one means of preventing cheating from occurring.

The other thing is I think the best place for all these things to start solving all these problems is in a tute where you feel friendly. I mean free to talk with the tutor and some tutors are not all that experienced. They've just done their degree. They know their subject but then you also you should know how to get those student to interact with you on a really friendly basis. I think if you have that you learn. Anyone would ask questions and they learn.

But before the exam it's just that we have [consultation sessions] ...but if we have them throughout the whole semester it will reduce the number of cheaters.

Relevance of Work

In situations where students couldn't see the relevance of an assessment item, they felt that this heightened the incidence of cheating.

Where I've seen more occurrence of cheating is where people feel the topic is irrelevant to them on the assignments and they don't see where they all contribute to their final goal.

Positive Teaching Approach

A strongly held attitude expressed by the students in the focus groups was that teachers that had a positive approach to students really discouraged students from cheating.

Because he gave me that good help which is here a positive attitude. Instead of pushing me down when I'm already down. Instead of pushing me

down again because it seemed to be a very stupid question.

I remember I had this particular tutor, demonstrator; I really couldn't do anything in my first 2 pracs and he just started talking positive to me and he knew that I couldn't do it and he just went I know you are smart, you can do it, you can do it, you are smart, and that helped me to revive myself from the incident and I knew I could do it.

Poor Teaching Practices

Students were particularly scathing of teachers that used poor teaching practices and felt that this was likely to increase the amount of cheating.

We've got a programming [course]. We've got Lecturer 1 and Lecturer 2 and I find that Lecturer 1 is like he's good. Interesting. Talks through his stuff. He's really that involved with people making sure everyone understands. Explains. Does plenty of examples. And then you've just got the other one Lecturer 2, that's just like wave after wave waiting for information.

One tutor is like really shy so she wouldn't ask anybody to...she'll just stand there waiting for someone to put their hand up.

Dobbing In

While honour codes have had some success in the United States as was mentioned in the Background section of this chapter, students reacted quite negatively to the idea that they might report cheating by their fellow students. It was only raised as a possibility where another student had stolen their own work.

Facilitator: *Would you ever dob anyone in?*

Student 1: *No.*

Student 2: *Not a chance.*

Student 3: *Unless it was really blatantly obvious and bad.*

Student 4: *Unless they copied you, you didn't know, they just stole your work.*

Facilitator: *If you know of someone who doesn't have that motivation and has cheated what do you do? How do you deal with it?*

Student: *I don't care.*

Facilitator: *You don't care.*

Student: *Firstly I wouldn't report them.*

Group Work

A positive idea presented by the students in the focus groups as a means to prevent cheating was to use group work, so as to avoid situations where a student feels the need to cheat to cope with the work.

I think if a person just by themselves and they're trying to work it out then that's where they're going to feel oh no I can't do this. If they're in a group that's very, I mean it's not like 5 people are all not going to be able to do the problem. Because they can think together. Bounce ideas off each other. If you've just got one person and they can't do it well then there's going to be a high chance of them cheating.

An interesting accommodation to the reality of cheating was noted by one student in relation to group work.

Actually had an occasion last semester where one of the guys in our group assignment we knew that he plagiarised in a previous assignment so we sort of just...we actually limited the amount of work

that he did. Don't know if that was the right way to go about it.

Exam Cheating

While as we saw earlier, many students have a belief that the use of exams prevents cheating, a belief accepted by many academics, students were well aware of methods to cheat in the exam environment.

I think in major exam it's easy to cheat. The thing is the individual privacy and the cheat has no conflict. For example if the person wants to cheat, the toilet during exam you can't supervise them in the toilet. Some students maybe have some notes and look at notes in the toilet.

Student 1: *You can send in like mobile SMS. By the choice answer, multiple choice.*

Student 2: *From someone outside of the uni.*

Student 1: *Yeah. otherwise you finish first and then turn on my mobile and then he send me the SMS and look at....*

Student 2: *...actually cool.*

If you're going to bring your mobiles into the exams ..., there's nothing to stop you from storing everything in your mobile.

Examples

A suggestion to reduce the need for cheating and assist in learning was that lecturers should provide examples of the assessment items that they wish students to produce.

...because I know in one course the lecturer I had he actually provided past assignments you know this is what we're looking for. Like it was a totally different case study but he goes oh okay

Prevention is Better than Cure

you have to do diagrams that look like this. We have to produce documentation though. We knew what was required of us. So if they don't know what's required of them they're more likely to go and ask someone else and then take the easy way which is just copy most of it.

I think as she said, give the examples to the student. I'm thinking give the student past student assignment example when the student is doing the assignment

Access to Help and Facilities

An issue that arose very commonly in the focus groups was that cheating is often caused by a lack of access to help and facilities. If a student is unable to access the relevant computer facilities for example, or unable to talk to a tutor about their assignment, then cheating becomes a more attractive option.

Student 1: *...and just knowing there's going to be computers available at any time that you require it.*

Student 2: *Its not just access to facilities and access to tutors and access to lecturers.*

Student 3: *More consultation time with tutors.*

well you don't tend to get help [in pracs]. And you have to finish it. You didn't have enough time to ask the tutor because everyone else needs the tutor as well. It's not just you. It's like there's not enough resources in that way. Like the classes need to be a bit smaller maybe.

Staged Assessment

Another idea that students felt assisted in the effort to reduce cheating was that assignments could be submitted in stages rather than in one single submission.

I have a subject which the assignment it's based on stages and it progresses all the time so rather than submitting the whole thing at the end of the week you actually have to show to the tutor what you have done and you know for stages and I find that useful.

There's another way to do it. Put something to submit every week. It will be a big job. It will be possible to finish it like in one or two days and then submit it each week and you definitely wouldn't have [to cheat]

Repeated Assignments

One practice that students felt increased the likelihood of cheating was the repetition of assignments from one year to the next.

Facilitator: *Okay so you're saying it's easy to cheat from other people's work or from X. How do you get hold of work from previous semesters?*

Student 1: *Your friends.*

Student 2: *Networking.*

APPROACHES TO ADDRESS CHEATING

In this section, we examine the approaches in the areas of education and prevention that we feel arise out of the information provided by the students in the focus groups.

Education

Analysis of the focus groups' responses indicate that students are in need of education about cheating and plagiarism. Looking at this information provided by the focus groups, the curriculum of an effective educational program to reduce cheating and plagiarism would have these characteristics.

1. Some aspects of cheating are well understood by students to be unacceptable, for example, cheating in exams or the wholesale copying of material from other students, books and the Internet and therefore these don't need to be addressed in detail in the curriculum.
2. Students are clearly confused about the difference between collusion and collaboration. Any curriculum about cheating should concentrate on distinguishing between these two concepts. The line between collusion and collaboration varies from class to class, course to course, and university to university, so no single definition suffices. From our perspective, collusion is where the level of collaboration exceeds that which is permitted for a particular assessment task. It follows that the acceptable level of collaboration needs to be clearly set out for each assessment task.
3. Students are uncertain about what constitutes plagiarism and how they should handle references in their work. Simple mantras such as "No more than six words" are in some ways counter-productive. The curriculum needs to ensure that students have a deep understanding of the issue as opposed to trying to inculcate simple rules into the students.
4. Simple statements and definitions of what constitutes cheating are insufficient for students to understand the issues of cheating and plagiarism. Curriculum needs to be example-driven so that students can place cheating behaviours into a concrete context that they can relate to their own experiences as a student.
5. Students are easily bored by the repetition of statements about cheating and educational efforts in this area must be interactive and not be routine announcements. The curriculum must be placed so as to be distinguishable from the normal classroom activities.
6. The curriculum should not over-emphasise the issue of plagiarism in comparison with other forms of cheating.
7. It is highly recommended that the curriculum focuses on the long-term impacts of cheating on a student's career, rather than presenting cheating as simply something that is wrong to do and that will be penalised if caught.
8. It also is recommended that the curriculum addresses the issues of the impact on learning of cheating and the need to have a moral compass on this issue. Overall, the curriculum should get students to examine their own reasons for why they might cheat or not cheat and thereby raise their consciousness about the issue.
9. The concept that "cheating is inevitable" and therefore students shouldn't worry about the issue needs to be addressed in the curriculum.
10. The issue of time management skills needs to be addressed in any educational program that wishes to reduce cheating.
11. The curriculum needs to provide students with methods to handle the pressures from the peers to assist them in their cheating. It is not reasonable to expect students at this stage of their life to easily resist peer pressure.
12. The curriculum should not attempt to scare students or use fear of consequences to motivate students to not to cheat. Students are well aware that cheating is easy and unlikely to be caught, so scare tactics will for most students be ineffective. This is not to say that the consequences of being caught should not be discussed.
13. Educational programs about cheating need to emphasise the sources of assistance that are available to students to aid them in their studies.

Prevention

A variety of methods have been proposed in the literature to prevent cheating, as earlier sections have discussed. In addition, the students in the focus groups have raised significant issues with regards to prevention. This section looks at both

sources of data and applies the information from the student perspective to present a critical analysis of the various methods proposed to prevent cheating. It should be understood that we are not presenting any of these methods as a panacea for cheating or even all of them in concert as the solution. As the students made clear, there will always be cheating in university courses, but these ideas seem likely to assist in the ongoing process of reducing cheating.

Caring and Being a Good Teacher

One of the methods of preventing cheating that arises from the research is that having academics who clearly care about the students and their course and who apply good teaching practices to their courses is likely to reduce the level of cheating. Students clearly respond well in this situation. Students also appear to respond well in this area to increased levels of interaction in the classroom. The provision of high levels of interaction has been recognised as an indicator of good teaching practice for many years. Poor teaching practices such as repeating assignment material from year to year or presenting voluminous quantities of material in lectures without providing interaction opportunities is likely to increase cheating.

Interviews and Presentations

The practice of assessing student work via oral exams is seen by the students as being highly effective in reducing cheating. In an oral exam students need to be able to demonstrate mastery of the material and this is significantly less likely if the student has copied the material or received excessive assistance. It should be noted that it is not impossible for a student who has copied from other students to do well in an interview situation. Two of the authors who regularly use this technique have seen several examples of this happening (Dick, 2005).

Presentations can achieve similar results to an interview as the presentation of material also relies to some extent on the student's mastery of it. However, it is probably less effective as it is not the one-on-one environment of the interview and the level of interaction is reduced.

Set Literature

One possible method to reduce plagiarism has been the use of a set reference list for an essay. By limiting the possible references to be used by the students in a piece of work, it reduces the likelihood that they will plagiarise material. In such a situation students will still be able to gain the capability of synthesising a body of literature into a cohesive whole; however, it downplays the learning of skills such as gathering and evaluating literature. To some extent, it sidesteps the issue of developing the student's understanding of plagiarism and does not equip them for handling such issues in the future. We believe that this method is of limited utility in an overall degree, though it may be of some use in particular circumstances. An example might be where the major learning objective is for the students to master a particular body of knowledge embedded in the set reference list.

Individual Assignment Specification

Students are confused about the difference between collaboration and collusion and find it difficult to resist allowing their peers to copy from their assignments. A method of prevention that addresses this issue is to provide each student with an individual assignment. If each student is required to solve a different problem, then the solutions they propose must inherently be different and it thereby makes copying, to a large degree, pointless. In many technical subjects, a simple program can be used to generate many individual assignments, alternatively the techniques proposed by Reynard (2000) can be used in non-technical subjects. Another alternative is

to allow students to set their own question with guidance from the teacher and thereby ensure minimal collusion and copying. In multiple-choice assessment, the development of question banks can allow individualised tests. One drawback is that this often can require extra effort on the part of the academic to develop and/or to mark. The use of individual assignments may not be suitable in all circumstances, but a wide range of assessments may benefit from their use in relation to reducing cheating.

Peer Assessment

Peer assessment has many positive aspects and theoretically should be effective in preventing cheating as students are far more likely to be aware of the cheating of their peers than the teacher. The results of the research reveal a problematic aspect to peer assessment. Many students don't seem to care if other students cheat unless they are directly involved. Given this attitude, it is likely that students will not punish their peers for cheating and the possible deterrent effect of peer assessment may not exist. Of course there are many other good reasons to use peer assessment, but reducing cheating is probably not one of those reasons.

Monitored Assessment

The classic case of a monitored assessment is the traditional exam with invigilators, silence and strict rules, yet along with previous research, the focus groups reveal that students are well aware of how to subvert exam protocols. Academics would be well advised not to place too high a reliance on the use of exams and other forms of monitored assessments to control and reduce cheating. Universities need to consider measures to handle cheating practices in exams, for example deploying mobile phone jammers in exam venues.

Continuous Assessment

One method that seems to have promise, according to the focus groups, is assessment that is not concentrated into one or two major submissions, but instead has many submissions throughout the semester. A continuous assessment regime provides incentives to students to manage their time better and possibly reduces the stress associated with assessment. Both of these effects would be likely to reduce the possibility of a student cheating.

Relevant Assessment

When designing assessment, the relevance of the assessment to the students should always be considered by the academic. It should also be made explicit to the students. Academics should not assume that the relevance of an assessment or indeed of course material is obvious to the students. By avoiding assessment that the students see as irrelevant to them, the incidence of cheating on the piece of assessment is likely to be reduced.

Clarity and Consistency of Assessment Rules

Students can easily be confused if the assessment rules for an item of work are not made clear. If a piece of work must be worked on by a student alone, then this must be made very clear, as well the rationale for this approach to the assessment also should be made explicit to the students. The rules for assessment for a specific piece of work or a specific course should also take in to consideration the general rules of assessment used in that degree. If most other assessments in the degree encourage collaboration between students, a piece of assessment that insists on no collaboration often will find this assessment rule breached. Rules for assessment that are inconsistent with norms the student expects must doubly be emphasised.

Inappropriate Student Attitudes

Two of the major issues raised in the focus groups were that cheating is often motivated by laziness and/or students having no interest in the content of their degree. There is little that any one course can do to address large personal issues for a student like this. One possible solution at a higher level is different selection practices to try and ensure that commencing students have a genuine interest in the degree, rather than just rely on the ENTER³ score of applicants. A related solution is for universities to ensure that transfer between degrees is easy. It is difficult for a student at the end of their secondary education to be sure as to what path they want their career to take. Many students will pick the wrong degree, so within reason, it should be made possible for students to transfer to a different degree with minimal penalties and hurdles. Of course, there would need to be measures to ensure that this transfer mechanism was not used to bypass ENTER score requirements for a degree.

Honour Codes

While honour codes have met with some success in the USA, they rely on a culture amongst the students that places honesty and integrity above peer pressure and apathy. The results of the focus groups indicate that this culture currently does not exist amongst the students and that it would require long-term and large-scale efforts by the university to develop that culture.

CONCLUSION

We have examined the IT student perspective on cheating in order to generate ideas about education and prevention. It is clear that the traditional concentration of universities on detection and punishment is an insufficient response to cheat-

ing and plagiarism and that individual academics must take responsibility for their teaching and use a wide variety of techniques to reduce student cheating. It is the opinion of the authors that the application of many of these techniques will not only reduce student cheating but also result in increased student learning. If we can prevent students from cheating in the first place, through improved education and prevention techniques, many students and academics will be spared a discipline process that is traumatic for both and a more positive learning environment established.

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ENDNOTES

- ¹ The Higher Education Contribution Scheme is where Australian students must make a contribution of several thousand dollars per year to their university education but are able to postpone payment until they have completed their degree. The payments are then collected through the Australian income tax system when the student surpasses a threshold income level.
- ² VTAC is the Victorian Tertiary Admissions Centre. During their final year of secondary schooling, students submit a list of the nine degrees they wish to apply for in order of their preference.
- ³ Equivalent National Tertiary Entrance Rank—used to determine entry to undergraduate degrees in Australian universities.

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Chapter 6.2

Structuring a Local Virtual Work Ecology for a Collaborative, Multi-Institutional Higher Educational Project: A Case Study

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ABSTRACT

This chapter focuses on a multi-institutional shared curricular-build project (2009) out of Kansas State University, Johnson County Community College, Kansas City Kansas Community College, and Dodge City Community College. This project involved the building of a range of digital learning objects for modules for an online course that will be taught at the various institutions in both online and hybrid formats. This collaboration is unique in that it brought together experts from cross-functional domains (from both the empirical sciences and the humanities) for an interdisciplinary freshman level course. The team collaborated virtually through computer mediated communications and built e-learning based on instructional design precepts. The curriculum was built to the standards of the

public health domain field, the Quality Matters™ rubric (for e-learning standards), federal accessibility guidelines, intellectual property laws, and technological interoperability standards (with the curriculum to be delivered through four disparate learning / course management systems). This chapter focuses on the socio-technical structuring of a local virtual work ecology to support this “Pathways to Public Health” project.

INTRODUCTION

In higher education, with the geographical dispersion of talents and skill sets, many more subject matter experts work on virtual teams. A more recent phenomena has been that of local (vs. global) virtual teams, with peers from institutions of higher education that are within reasonable commuting distances, similar time zones, and even

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some co-located members. Demanding schedules make it difficult to meet face-to-face, but collegial and interdisciplinary work requires collaboration and shared decision-making. The nature of the work and team will determine some of the strategies for structuring the local virtual work ecology, which includes both a shared electronic environment and structured interactions between the team members. This chapter will be based on the research literature and practitioner research based on one recent case.

REVIEW OF THE LITERATURE

With growing interorganizational alliances, virtual teams have become commonplace (Kahai, Carroll, & Jestice, 2007). Virtual teams are generally defined as those where team members are not co-located, but are distributed geographically and connected via computer-mediated technologies to collaborate on a shared work project.

Virtual teams are “groups of geographically, organizationally and/or temporally dispersed individuals brought together by information and telecommunications technologies to accomplish one or more organizational tasks” (Powell, Piccoli, & Ives, 2004). There may be differing levels of team virtualization. Zigurs proposes four dimensions of virtuality: “temporal dispersion,” “geographic dispersion,” “organizational dispersion,” and “cultural dispersion” (Sarker, Sarker, & Schneider, 2009, p. 77). A local virtual work ecology refers to the interactions between virtual team members and their technological and physical environments.

VIRTUAL TEAM STRUCTURES

Differing levels of team virtualization may exist, with some virtual teams including sub-group co-location. Baskerville and Nandhakumar cite Mowshowitz’s concept of a virtual workgroup

as a basis for their thinking, which plays with the meaning of “virtual” as in virtual memory: “A team’s virtuality regards the potential for an imagined team to become a real team, giving the organization the ability to assemble teams on an as-needed basis for highly specific purposes” (Baskerville & Nandhakumar, 2007, p. 18). Virtual teams are new organizational forms enabled by more powerful computer technologies (Powell, Piccoli, & Ives, 2004, p. 6). Partially distributed teams (PDTs) involve sub-teams of co-located members working from different geographic locations (Peters, Ocker, & Rosson, 2008, p. 273). Dyadic teams are those that are formed by two people and have been found to result in higher team satisfaction, which is a predictor of virtual team effectiveness (Karayaz & Keating, 2007, p. 2593). The way work is designed may be one of the five critical factors that may support high creativity (Nemiro, 2004, p. xxvii).

THE CHALLENGES OF VIRTUAL TEAMING

The research on virtual teaming highlights a range of supervisory challenges that extend beyond typical management duties. These include:

- difficulty establishing trust (Coppola, Hiltz, & Rotter, 2004; Jarvenpaa & Leidner, 1999; Jarvenpaa et al., 2004);
- difficulty establishing a shared team identity (Armstrong & Cole, 2002; Cramton, 2001);
- managing conflict (Hinds & Bailey, 2003; Hinds & Mortensen, 2005; Montoya-Weiss, Massey & Song, 2001);
- maintaining awareness of members’ activities (Hinds & Mortensen, 2005);
- coordinating team member efforts (Maznevski & Chudoba, 2001; Malhotra et al., 2001; Sarkey & Shay, 2002);

- effective leadership (Bell & Kozlowski, 2002; Kayworth & Leidner, 2001);
- knowledge sharing (Cramton, 2001, Griffith et al., 2003); and
- determining the appropriate task technology fit (Qureshi & Vogel, 2001, as cited in Ocker & Fjermestad, 2008, p. 52).

Virtual teams may experience the forming of fragmentation and in-groups (particularly among collocated members vs. the distributed or distant ones). This researcher switched some team members' locations halfway through the experiment to see what effect it would have on in-groups:

People who changed from being isolated 'tele-commuters' to collocators very quickly formed new collaborative relationships. People who were moved out of a collocated room had more trouble adjusting, and tried unsuccessfully to maintain previous ties. Overall, collocation was a more powerful determiner of collaboration patterns than previous relationships (Bos, Olson, Cheshin, Kim, Nan, & Shami 2005, p. 1917).

The concept of resilience in virtual teaming is critical especially after intended or unintended disruptions, with some findings of high human adaptability and "bounce back" (Mark & Semann, 2008, p. 137). Virtual teaming requires on-going sense-making through technology mediation (Bansler & Havn, 2003, p. 135).

VIRTUAL LEADERSHIP

Virtual leadership requires an ability to create a virtual ecology. The supervisory work requires a mix of high engagement at times and hands-off interactivity at others. Leaders have to get a team established "on a good trajectory and then to make small adjustments along the way to help members succeed, not to try to continuously manage team behavior in real time." Applied to a virtual team

context, the work ecology is this context for the team's work success. Hackman suggests that successful teams need "a compelling direction, an enabling team structure, a supportive organizational context, and expert team coaching" (*Leading Teams*, 2002, p. ix). Leadership on virtual teams may be explicit and implicit, with the conclusion that good coordination involves a "subtle mixture of both approaches" (Boulthier, Charoy, Perrin, Saliou, Bignon, Halin, & Malcurat, 2001, p. 135).

According to the literature, different types of leadership may be brought into play in virtual spaces.

- *Participative leadership* is defined as the equalization of power and sharing of problem solving with followers by consulting them before making a decision.
- *Directive leadership* is defined as providing and seeking compliance with directions for accomplishing a problem-solving task. Participative leadership and directive leadership are considered parallel to transformational leadership and transactional leadership respectively (Zhang, Fjermestad, & Tremaine, 2005, pp. 1 - 2).

Managers often find a greater need to troubleshoot virtual team challenges (Thomas, Bostom, & Gouge, 2007; Crowston, Howison, Masango, & Eseryel, 2007; Sarker, Sarker, & Schneider, 2009, p. 75). Team conflicts may arise from "differences, discrepancies, incompatible wishes or irreconcilable desires" (Paul, Seetharaman, Samarah, & Mykytyn, 2005, p. 1). They may mitigate conflicts through video-conferencing (Rutkowski, Vogel, van Genuchten, Bemelmans, & Favier, 2002, p. 227). For those in some industries, the amount of work done virtually affects their satisfaction with their work lives and their retention (Ferratt, Enns, & Prasad, 2001). There have been gender preferences found in the virtual team experience (Lind, 1999, p. 280).

Technologies may be brought into play to replace some on-site leadership. Kerr and Jermier (1978) offered a leader substitutes theory that suggests certain enhancements of leadership through “mechanisms and alternatives for the various functions of the formal leader.” Enhancers augment the leader-outcome relationship; supplements contribute to the varied “effects on the subordinates’ performance but do not cancel out or augment the leader’s direct effects,” and substitutes make “the leadership impossible or unnecessary” (Bass, 1990, pp. 682 – 683). Applied to virtual teaming, the leadership substitute theory shows that technologies may “stand in” for a present physical team leader.

However, there are built-in constraints to virtual teaming that may make “effective coordination, visibility, communication and cooperation” more challenging (Casey & Richardson, 2006, p. 66). The more interdependency and the more complex the work flows, the more reciprocal coordination and collaboration are needed (Corbitt, Gardiner, & Wright, 2004). Virtual teaming may be used in both low-risk and high-risk situations. The research literature includes descriptions of tense interchanges and misunderstandings in time- and safety-critical situations that were mediated virtually (Bayerl & Lauche, 2008, p. 424).

Virtual leadership in the Internet Age “is communication” (Skovolt, 2009, p. 1). Individuals’ communications styles, which stem from personality factors (Balthazard, Potter, & Warren, 2002), may be categorized as constructive, passive, and aggressive styles.

The constructive style is characterized by a balanced concern for personal and group outcomes, cooperation, creativity, free exchange of information, and respect for others’ perspectives. The constructive style enables group members to fulfill both needs for personal achievement as well as needs for affiliation. The passive style places greater emphasis on fulfillment of affiliation goals only, maintaining harmony in the group, and

limiting information sharing, questioning and impartiality. The aggressive style places greater emphasis on personal achievement needs, with personal ambitions placed above concern for group outcome. Aggressive groups are characterized by competition, criticism, interruptions, and overt impatience” (Balthazard, Potter, & Warren, 2002).

Tensions stemming from outsourcing may also cause stresses on virtual teams. Challenges communicating the requirements for a project may be compounded “by cultural and language differences, lack of communication, distance from the customer, different process maturity levels, testing tools, standards, technical ability and experience” (Casey & Richardson, 2006, p. 66).

THE SELECTION OF COMPUTER MEDIATED COMMUNICATIONS (CMC) TECHNOLOGIES

Information Technology (IT) must help a virtual team maintain a sense of continuous communications discourse (Albin-Clark, 2008). There must be connective richness without overwhelming complexity. People may generally be assumed to function on the so-called Principle of Least Effort when it comes to computer mediated communications (Bos, Shami, Olson, Cheshin, & Nan, 2004, p. 430). Technologies have to fit in with the leaders’ choices (Samarah, Paul, & Tadisina, 2007) in the virtual team and must also be accessible (Sivunen & Valo, 2006, p. 57).

Successful virtual teams tend to have high message frequency characterized by positive messages and “appropriate feedback.” Such teams prefer a variety of communication media (Dekker & Rutte, 2007, p. 3). High performing virtual teams “out-communicate” low performing ones (Ocker & Fjermestad, 2000, p. 1). Rich dialogue techniques help teams make up for the loss of “proxemic, haptic, and environmental cues” (Guo, D’Ambra,

Turner, & Zhang, 2009, p. 3) and may promote team cohesion (Guo, D'Ambra, Turner, & Zhang, 2009, p. 5) and a sense of "mutuality and shared frame" (Sarker, Sarker, Nicholson, & Joshi, 2005, p. 201). Teams that are homogeneous in terms of "shared backgrounds, interests, attitudes, and values" may find it easier to be cohesive (Panteli & Davison, 2005, p. 192) but may have greater challenges with innovations.

TECHNOLOGIES FOR INTERCOMMUNICATIONS

Social presence theory suggests that the perceivable physical presence of partners in a communication would have better interpersonal relationships via greater apparent presence (Short, et al., 1976, as cited in Ehsan, Mirza, & Ahmad, 2008, n.p.). Social exchange theory suggests that individuals engage in social interactions for financial and social rewards, which might suggest reciprocity behaviors on virtual teams such as knowledge sharing (Chen, Zhang, Vogel, & Zhao, 2009, p. 2).

Media Richness Theory suggests that the greater the range of communications cues, the more an individual may personalize a message and control the interactions. Media richness is defined as the ability of information to change understanding within time interval (Dekker & Rutte, 2007, pp. 1 - 2). The richness of a medium is focused around five functions: the immediacy of feedback, symbol variety, parallelism, rehearsability, and reprocessability:

Immediacy of feedback is the extent to which the medium enables users to give rapid feedback on the communication they receive. Symbol variety is very similar to multiplicity of cues from Media Richness Theory. Parallelism is the number of communications that can exist simultaneously. Rehearsability is the ability to go over the message before communicating it to the sender. Finally, Reprocessability is the ability to reexamine the

message within the communication event (Dekker & Rutte, 2007, p. 2).

Medium-richness theory (Daft & Langel, 1986) suggests that two factors are critical for rich communications: "(1) The ability of communication medium to transmit personality cues of interaction partners. (2) The extent of the immediate feedback" (Ehsan, Mirza, & Ahmad, 2008, n.p.).

Without media richness or nonverbal cues, some researcher suggest a possible "downward spiral of decreased trust and commitment in a group," less information-sharing, misinterpreted messages, and eventually "conflict, damage group cohesion, and lower trust" (dePillis & Furumo, 2007, p. 93). These then would result in higher transaction costs, with team members double-checking each other and taking fewer creative risks. Fear and social inequities also have negative effects on a virtual team's innovativeness and team cohesion (Casey & Richardson, 2008, p. 170). Social dominance by group members may result in low levels of team creativity (Ocker, 2007, p. 204).

Mutual trust is built on the exchange of information (Alexander, 2002, p. 68). Recursiveness in interactions and interchanges may lead to the building up and maintenance of trust (Baskerville & Nandhakumar, 2007). Shared expressed and ethically-justifiable values may enhance trust and also bring a group closer (Xiao & Wei, 2008). High levels of trust can exist on virtual teams particularly in initial relationships among members but will need to be maintained through confidence-building measures and non-exploitation of members (Hung, Dennis, & Robert, 2004).

Face-to-face (F2F) is the richest communication medium, and is followed "by Telephone, Email, Letter, Note, Memo, Bulletin etc. in the medium richness hierarchy" (Ehsan, Mirza, & Ahmad, 2008, n.p.). Different types of messages require different mediums. Technologies may de-individuate individuals by restricting the amount of identifying information about each other: "Lack

of information regarding interpersonal differences among group members causes them to be more sensitive to available information about their personal or social identity” (Kahai, Carroll, & Jestice, 2007, p. 64). Group cohesion has been found to support group performance (Salisbury, Carte, & Chidambaram, 2006, p. 147), so a lack of human connectedness via the formal and informal communications may be inhibiting of virtual team work (p. 148).

Synchronicity may play a role in presence (Dennis & Valacich, 1999, as cited in Ehsan, Mirza, & Ahmad, 2008) and immediacy. Synchronous interactions on a team may often be done for collaborating on a common task; promoting group well-being, and supporting members in difficult situations, according to the Time, Interaction, and Performance theory (McGrath, 1991, as cited in Mirza & Ahmad, 2008, n.p.).

Research later found that the technologies used for computer-mediated groups could be more social than F2F interaction, via the Social Identity model of De-Individuation Effects (Postmes, Spears, & Lea, 1999; Reicher, Separs, & Postmes, 1995; Spears & Lea, 1994, as cited in Ehsan, Mirza, & Ahmad, 2008). Others argued that the human interactions and organizational contexts affect the richness of media (Dekker & Rutte, 2007, p. 2). Virtual teams’ preferences for particular media often resulted in a particular rhythm in media selected and used.

Immersive 3D spaces may also provide a venue for human-embodied avatar-based intercommunications. Here, the human imagination makes virtual worlds more potent and social, with engaging sense of telepresence and social presence. “The objective of virtual worlds was to achieve a feeling of telepresence, immersion and participation from a distance” (Jäkälä & Pekkola, 2007, p. 12). Cooperative online game experiences “even without any direct communication interactions” can impact people’s liking for others (Dabbish, 2008, p. 353), and immersive virtual games have

been employed as team ice breakers (Ellis, Luther, Bessiere, & Kellogg, 2008).

The research unequivocally suggests the importance of intercommunications, with a continual flow of creating, assessing and exchanging information around both task-driven and social-driven needs (Wang, Huang, & Wang, 2006, n.p.). Virtual team members co-build shared cultures (Andrews & Starke-Meyerring, 2005, p. 26). The social aspects of virtual collaboration are so critical that researchers conduct social network analyses to understand virtual teams (Lin & Chen, 2004, p. 1). Some collaborative technologies “facilitate ad hoc contact with remote professional expertise within the organization...as well as beyond the organization at reduced costs” (Sole & Applegate, 2000, p. 581).

UNDERSTANDING / NOT MISUNDERSTANDING ... SILENCE

How team members understand others’ silence depends in part on the understanding of what else is taking the time of team members or “distractions”. The accuracy of the attribution of silence depends on information sharing and access (TerBush, 2006). While such cues may be instituted into socio-technical collaboration systems, the author notes: “Participants themselves can improve their virtual team experience by learning to build and maintain mental maps about the environments of their remote partners and recognizing that environmental factors may be responsible for their partner’s periods of silence. By starting with situational attributions, group efficacy may be improved” (TerBush, 2006, p. 8). For others, silence comes from social politeness and cultural expectations but may be misread as agreement (Anawati & Craig, 2006, pp. 50 - 51).

Computer mediated communications involve both synchronous and asynchronous interactions, and light and media-rich interactivity. Optimally, socio-technical systems need to offer the greatest

ranges of freedom of expression (Nunamaker, 1999) for greatest utility.

SHARED MENTAL MODELS, COORDINATION, VISUALIZATION AND MODELING, AND KNOWLEDGE-SHARING AND LEARNING

The technologies employed not only promote communications but the building of shared mental models of the work. Per Dourish & Bellotti's work, group awareness refers to "an understanding of the activities of others which provides a context for your own activity"; technologically, this awareness is achieved synchronously with presence indicator widgets (such as on instance messaging systems), user lists, and remote viewports (Schümmer & Lukosch, 2006). Virtual team members have a need for on-going sense-making (Bansler & Havn, 2003).

Technologies may help team members coordinate their schedules and collaborative strategies. They may help individuals be aware of the work processes (Dustdar & Gall, 2002). They may indicate the different phases of teamwork. They may help with the structuring of tasks and work flows. Project management methods and tools need to be built into systems to benefit virtual teams and to accommodate for various types of diversity in the team members (Beise, 2004). In systems where these are not yet coded in to the software, human coordination has to be stand in the gap.

They may promote the exploration of creative and "outlandish" ideas (Ocker & Fjermestad, 2008, p. 53), their multi-dimensional visualization, and digital modeling. There needs to be a virtual team climate to support innovation, with a tolerance of diverse opinions and constructive conflict. Research into computer-supported collaborative work (CSCW) offers some insights on virtual spaces that support co-design, for example. Technologies extend the affordances of human endeavors.

Technological systems may raise team members' awareness of knowledge possessed by their co-workers, which may be valuable for "team effectiveness in learning, viability, and overall performance" (Shen, 2007, p. 228). Information sharing has a positive effect on virtual team performance and satisfaction (Dekker & Rutte, 2007, p. 3). The designs of socio-technical systems may foster knowledge sharing (Powell, Piccoli, & Ives, 2004). Information exchanges need to be technologically secure (Pripuzić, Gjenero, & Belani, 2006, p. 266) to maintain virtual team trust.

Trust or the extent to which a person is confident in another—has been linked to "virtual team efficiency, collaboration and performance" and the sharing of various information types (Mogan & Wang, 2007, p. 43). The ability to create trust may be seen as a virtual skill: "The work by Jarvenpaa & Leidner (1998) suggests that factors associated with online competence, responsiveness, leadership and performance, as well as communication aimed at socialisation become inextricably involved in the process of creating trust in GVTs" (global virtual teams). (Clear & Kassabova, 2005, p. 55).

Discovered knowledge has to flow back into the virtual environment (Biuk-Aghai & Simoff, 2001, p. 61). Virtual work needs to be structured in a space and environment to create a "landscape of work artifacts" (Churchill & Bly, 1999, p. 40). The credibility of the knowledge transfer information is based on trust and reputation (Sarker, Sarker, Nicholson, & Joshi, 2005, p. 204).

Virtual teams also need to capture events and decisions taken by one subgroup or the main group, with sufficient details for later review (Bayerl & Lauche, 2008, p. 425). Such collaboration systems may help in the archival and delivery of digital resources and artifacts. Researchers point to the importance of learning collaboration and also learning while collaborating (Kildare, Williams, & Hartnett, 2006).

SOME CRITIQUES OF VIRTUAL COLLABORATION SYSTEMS

There have been various criticisms of the technologies supporting virtual team ecologies. The design of collaborative virtual spaces may involve insufficient consideration for the “exigencies of living with the system” (Tan & Kondo, 2008, p. 2046), which may force a virtual team to be more adaptable. Others suggest that collaborative technologies need to create symbioses between “project management tools and collaborative ones” for effective virtual project management (Donker & Blumberg, 2008, p. 41). Others suggest that bridging the socio-technical gap will require new computing paradigms, potentially without “rules, hierarchies and control” (daSilva, de Souza, Prates, & Nicolaci-da-Costa, 2003, p. 145).

THE IMPORTANCE OF TEAM CONTINUITY

Continuity is seen in the research as something positive in terms of team trust and mutual understandings (Panteli & Davison, 2005, pp. 192 - 193). Researchers have found risks to short-duration virtual projects: “Our results indicate that at least for projects of short duration, virtual teams yield significantly lower performance, lower satisfaction, and a lower results-to-effort ratio. Virtual teams appear to excel only at lowering commitment, morale, and performance...” (dePillis & Furumo, 2007, p. 95).

Teams that have a sense of continuity outperform new teams. “Members develop familiarity with one another, their collective work, and the work setting, so they are able to settle in and focus on working together rather than waste time and energy getting oriented to new coworkers or circumstances. They develop a shared mental model of the performance situation, one that, with time and experience, is more integrative than the individual models with which they began. They

develop a shared pool of knowledge, accessible to all, and build what social psychologist Dan Wegner calls ‘transactive memory’ (that is, members themselves serve as memory aids to one another, providing the possibility of collective recollection that exceeds the capacity of any single individual)” (Hackman, *Leading Teams*, 2002, pp. 55 - 56).

Teams also seem to have a mid-point inflection in terms of performance. This is a time of a major transition.

*In a concentrated burst of changes, they dropped old patterns of behavior, reengaged with outside supervisors, and adopted new perspectives on their work. Following the midpoint transition, groups entered a period of focused task execution, which persisted until very near the project deadline, at which time a new set of issues having to do with termination processes arose and captured members’ attention” (Gersick, as cited in Hackman, *Leading Teams*, 2002, pp. 177 – 178).*

Time seems to be a critical factor in bringing virtual team members together: “In the case of computer-supported groups it has been shown that given adequate time teams will exchange enough social information to develop strong relational links” (Beranek, “A comparison of...,” 2005, p. 1; Casey & Richardson, Project management with..., 2006). Relationship history has also been found “to positively impact openness, trust, and information sharing in computer-mediated teams” (Lojeski, Reilly, & Dominick, 2007, p. 3); this shared past affects current work (Hung, Dennis, & Robert, 2004, p. 1).

Researchers have found more “deadbeats” with non-contributing behavior and “deserters” on virtual teams (dePillis & Furumo, 2006, p. 318). Others note the loss of “organizational memory, corporate history and process knowledge” with ad hoc virtual teams (Sengupta & Zhao, 1998). Bringing on the team members with the right skill sets, virtual teaming skills and level of commitment is critical (Cordes & Spine, 2007). Virtual

team members need to have an ability to work independently and to execute on the promised work by deadline. There are also motivational patterns in virtual team collaboration (Clear & Kassabova, 2005).

Managers should consider the full lifecycle of social ties in terms of virtual teaming between local and remote sites. This is especially true for projects which unify professionals in a state with staff members who represent elite and mission-critical skill sets, as was this case with the Pathways to Public Health endeavor. Oshri, Kotlarsky, and Willcocks suggest that development of social ties move from Introduction to Build-up to Renewal. They also suggest that F2F meetings are not a panacea for distributed teams (2008, p. 78). Mixed factors may contribute to virtual team success (Paré & Dubé, 1999, p. 480)—technologies, project context, team dynamics and processes, leadership and project management, and even wildcard factors.

PATHWAYS TO PUBLIC HEALTH: THE PROJECT'S BACKGROUND

The project involved the collaboration between Kansas State University and three colleges (Johnson County Community College, Kansas City Kansas Community College, and Dodge City Community College) to build a freshman-level public health course. This would be an entry-level semester-long course to draw learners into this field to fill a deep personnel gap in Kansas; this would optimally bring in those who are working in the field with plenty of experience but potentially little formal training. This would be an online prototype, the first course of an undergraduate program and then a graduate program, all in development, as part of a state-wide endeavor. This would also serve as an anchor in the statewide endeavor to professionalize and establish credentials for public health. The processes, the forms, and the relationships formed during this project would have large potential impacts into the future.

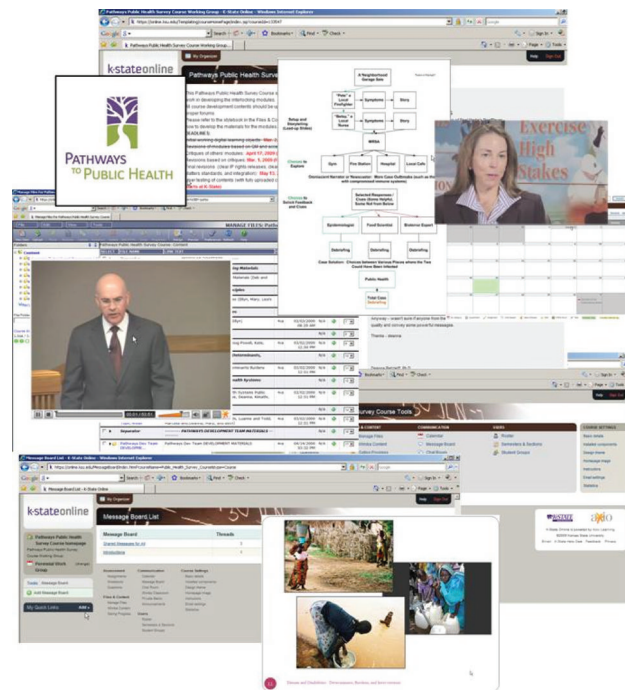
One way to understand a project is to understand its progress “trajectory” and shared local virtual team experiences. Important project milestones may be analyzed. Nemiro (2004) highlights three work design approaches used in the creative process. The Wheel Approach focuses on the use of one individual to be the hub for communications, and that individual is usually a high-powered one. The Modular Approach begins with a brainstorming approach by the group and then individual teams breaking up to address different parts of the build. The Iterative Approach involves back-and-forth development cycles where work is presented to the team, critiqued, and returned to the individual developers to revise (pp. 15 – 16). All three methods were used, except The Wheel Approach did not use a high-status team member but rather an outside support staff member. This was by necessity given the busy schedules of the principal investigators. Figure 1: A Composite of Images from the Virtual Work Ecology represents the complexity of the curricular elements at play. The logo represents the branding endeavor. A screenshot of Axio™ L/CMS evokes some of the work spaces. Some stills from video presentations and interviews highlight the expert contributions from across campus. The slide captures show the global nature of public health with open copyright releases from world health organizations. Another screenshot shows the deep structure of the various modules and the rich mix of HTML-delivered directions, audio-narrated slideshows, transcripts, videos, and learning activities.

IMPORTANT “PATHWAYS” PROJECT MILESTONES

The Creation of the Team

An interesting challenge with dispersed virtual teams is that the members hail from different institutions with different organizational mandates, stakeholders, and authorizing environments. Orga-

Figure 1. A composite of images from the virtual work ecology



nizational culture plays a role in the “acceleration of virtual world technology adoption” (Fuller, Hardin, & Scott, 2007, p. 43) and the adaptivity to virtual spaces. Some members are full-time faculty at their universities or colleges, and others are full-time staff who are sub-contracting on the project. In a sense, this organizational structure fits with Weick’s definition of a loosely coupled system, with relatively autonomous and independent units that influence each other and little need for coordination. A loosely coupled system may allow for a greater “number of mutations and novel solutions” to problems given that “the identity, uniqueness, and separateness of elements is preserved” (Weick, 1976, p. 7). Orton and Weick note that a loose coupling is not a decoupling with less “connectedness, responsiveness, and interdependence” (1990, p. 207); rather, these connections are a critical part of the virtual structure promoting both the strategic cohesions and sparks of innovation. Such social modularity reduces “the number of necessary relationships”

(Page-Jones, as cited in Orton & Weick, 1990, p. 210), which implies streamlined efficiencies.

A Centralized Digital Ecology

The virtual work ecology for this half-year multi-institutional curricular build focused on the Axio™ Learning / Course Management System (L/CMS). The technological setup allowed collaborators from off-campus to create accounts and to have full access to the socio-technical system. Using a democratic participative leadership model, all the principal investigators on the four campuses would need full ability to act as primary instructors (in terms of role-based access)—to build contents to the shared course. This access level would mean each member could ostensibly edit anyone else’s contents, and each could actually delete the entire work site. (The Axio™ system’s “indestructible” back-up would actually protect all contents though in case of a total work site deletion.) This team used a loosely coupled and flat structure. If the

control of communications and information is a form of virtual leadership (Skovolt, 2009), then it's critical that all members of the distributed participative team have equal access and equal voice—even at risk to the larger project. After all, each of the campuses would be taking ownership of the shared course, once completed.

Technologically, this site would provide plenty of collaboration tools: a third-party Wimba Classroom™ web conferencing tool, an asynchronous text message board, built-in audio capture and distribution capabilities, a shared calendar, and grouping tools. It also offered a space for the archival of digital learning objects, their annotation, and their organization into modules. There was a shared announcement board. There was a built-in survey system to allow for the surveying of live learners. A broadcast email system is also built into Axio™. The extensive context-sensitive help system made the acclimating easier for those new to the system.

Getting the team onto the work site early on was important, particularly with the need for early successes (Weick's concept of "small wins") to raise user confidence and self-efficacy. This involved posting necessary contents online but also making it available through email and other means.

Lean Communications Channels

Lean-channel communications technologies—telephones, emails, electronic mailing lists—were also tapped to enhance the connectivity of the development team. The different institutions had their own ways of maximizing the co-location of their team members, through electronic mailing lists, face-to-face meetings, and others. The idea was to have both formal and informal channels for information sharing, to promote both.

Researchers point to the importance of structure in virtual teaming (Rutkowski, Vogel, Ven Genuchten, Bemelmans, & Favier, 2002). That need for structure applies to role definitions;

work definition; socio-technological structures, and policies.

Shared Curricular Design

Team members had met face-to-face to determine the contents of the co-created curriculum. Once this was designed, the various faculty and their campus teams worked with their respective curricular committees to get the courses approved. This was a critical part of the project in terms of shaping shared academic aims. This also gave all members a voice at the table, so their expertise would be represented in the curriculum. The curriculum was designed as follows:

- Module 1: Overview and Basic Principles
- Module 2: Epidemiological Principles
- Module 3: Population Health Tools
- Module 4: Disease and Disability: Determinants, Burdens, and Interventions
- Module 5: Healthcare and Public Health Systems (Public Health Administration)
- Module 6: Special Topic Areas (These areas included ones focused on One Health; Infectious Disease and Zoonosis; Food Safety, Security, and Defense—Food Chain Security, Public Health Nutrition and Physical Activity, and Public Health Future Direction and Challenges.)

A Pre-module was proposed but was eventually folded into some other modules. The concept of the Pre-module was to offer "scaffolding" for learners totally new to the field with a particular focus on the biological sciences, biostatistics, and e-learning.

Stylebook Design

A critical step in the curriculum design was meeting face-to-face to co-create a stylebook, which would set the standards and expectations for the work; define accessibility and intellectual property

guidelines; set technological expectations, and start the clock on the distributed development. The Quality Matters rubric standards would also be integrated, with the needs for curricular coherence and segues. This stylebook also recorded the importance of building and infusion of diversity and learning scaffolding for both novices (freshman students) and “experts” (those who may have worked in public health for years but not studied formally in the academic field or a related field) in the curriculum.

The stylebook was created also to have a “common language to facilitate the work” (Suchan & Hayzak, 2001, p. 174). Virtual teams need a clear sense of mutual purpose (Keyzerman, 2003) and role coordination (Sutanto, Phang, Kuan, Kankanhalli, & Tan, 2005, p. 1), which the stylebook recorded. Determining understandings early was done to head off wasted effort. For example, the team members were trained on intellectual property, to head off possible illegalities in the use of information, imagery, audio, or video. The team also reviewed the importance of maintaining raw footage and imagery for possible non-lossy uses.

A stylebook works as an evolving document. It supports the planning stages, the curricular build, and the standards design for future changes to a curriculum. For example, this particular stylebook has projections into possibly building tangibles (such as CDs or DVDs), related e-books, and an instructional handbook. Considering options—depending on the time, energy, and resources available once the core curricular build was done—was motivating to the group.

Distributed Digital Learning Object (DLO) Development

The various distributed teams then met on their own to develop their portions of the curriculum, usually either whole modules or whole modules with additional segments. People concurrently worked in small-teams on their campuses and

through computer mediated communications with a centralized instructional designer.

Virtual and F2F Meetings

The team met virtually to discuss progress and concerns once the first deadline for initial digital learning objects had been met. This meeting set future “soft” deadlines for intermediate work against the backdrop of hard grant-driven deadlines. Team decision-making was created using virtual voting procedures, an approach that suggests a more democratic approach (Ferscha & Scheiner, 1999). A “checklist” of quality factors were captured at this meeting and distributed to the team.

Another critical point came with the structured critique of the different modules. Here, the team used their self-created “checklist” that had been co-created in a collaborative virtual meeting in order to create feedback for their colleagues.

This team found it helpful to have several core “go-to” people for various basic functionalities: project oversight and logistics, technology troubleshooting, funding, and subject matter expertise.

Curricular Revisions

The critiques resulted in a flurry of discussions among the team members. Based on the specific feedback, the team members revised their curriculum. They added audio files as over-lays to existing slideshows. They filled in the missing contents.

As the main modules were getting near finalizing, the project leaders came up with new ideas for more value-added learning. One endeavor involved the use of video captures of leading experts in related fields. The other involved the creation of Web-based automated mysteries highlighting aspects of the content domain. The group had created a culture of flexibility, innovation and efficiency that allowed these add-ons to be included into the final curricular build. Near the end of the build, the team decided to add student guides to

help learners navigate the curriculum through the selection of important learning points.

The finalized curriculum was aligned with the Quality Matters™ standards, with a special focus on the annotation and flow of contents and on accessibility standards. Extra contents would be used for other electronic trainings in public health.

Alpha and Beta Testing

Alpha testing involved in-house testing of the technologies and curriculum among the team members. Beta testing involved taking the e-learning out to a larger public, with live-testing of learners in a blended course in the summer of 2009. Continuing information collection and formal testing would involve datamining (of the L/CMS) and continuing learner surveys. (These were not formally addressed before the submittal of this chapter.)

ELEMENTS OF A LOCAL VIRTUAL TEAM ECOLOGY

The factors that created the virtual work ecology for this local virtual team involved four main elements:

1. social elements (both formal role structures and social relationships),
2. time elements (shared mutual time, asynchronous time, and deadlines),
3. informational elements (domain knowledge structures and quality standards), and
4. socio-technical elements (virtual spatial structures and communications channels).

A structured ecology enables a group to collaborate by setting shared expectations, upholding group standards, promoting professional rapport and camaraderie, and guiding and enabling the shared work. A local virtual team ecology supports individual and shared work across time and

through digital environments. These four factors are represented in Figure 2: Elements of a Local Virtual Team Ecology.

LEARNING ABOUT LOCAL VIRTUAL TEAMING

While the members of the team were all professionals in their respective fields, there was a range of attitudes towards e-learning and collaborative technologies. The research suggests that technology acceptance depends on computer self-efficacy and perceived usefulness of IT support mechanisms for group work (Yager, 1999, p. 73). One rural-based campus had continual issues with low Internet connectivity, and another was getting rewired with a new security system which caused connectivity challenges. A web conferencing meeting was missed by one local team because of scheduling challenges, and others who did participate had latency challenges.

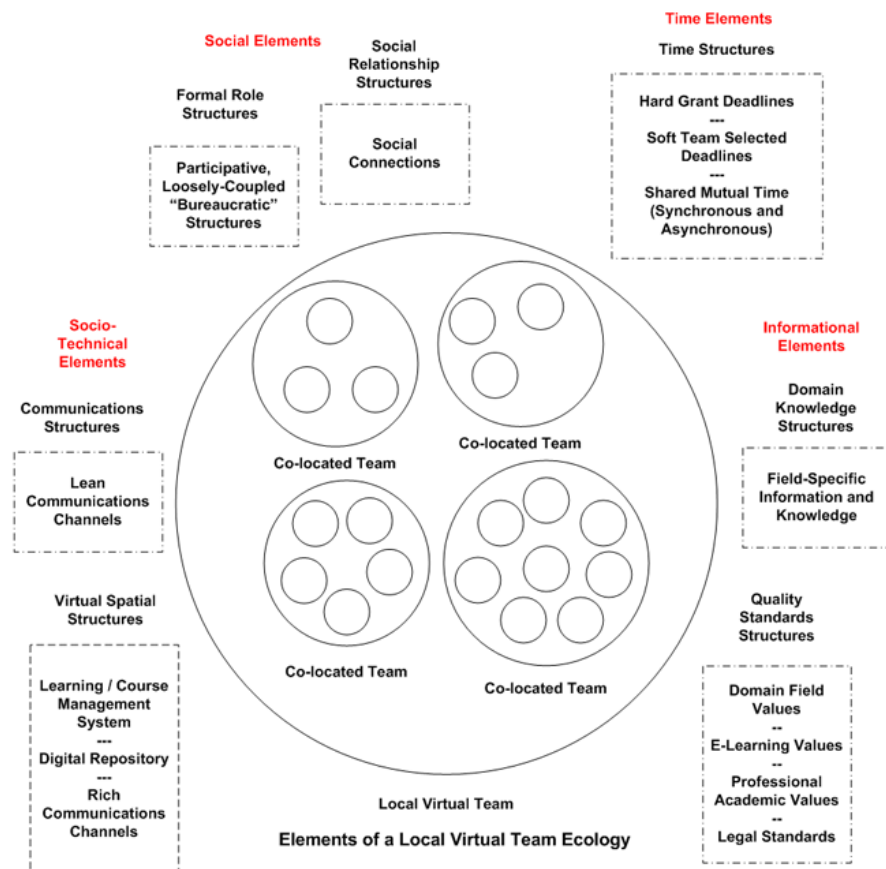
Outsider Leverage and Distributed Hubs of Expertise

The concept of social capital appeared in this virtual team experience, with an “outsider” brought in to support the e-learning curriculum design, in part to preserve the social relationships of the subject matters experts who will be collaborating well into the future.

Changes to the Virtual Work Ecology

The virtual work site (on the Axio™ L/CMS) evolved over time, with much activity just prior to, during and after shared deadlines. The work site was the center for all the shared work. In the building and co-design phases, the work folders got congested and a little disorderly. However, when it came time to formally present curriculum to colleagues, the work areas were tidied, with raw files and research moved so as not to confuse those

Figure 2. Elements of a local virtual team ecology



critiquing the work. The work site also changed before the various co-located teams were about to download the curricular contents to their various L/CMses. A work site's purposes are very different than a cleaned-up ready-to-go-live site, so much of the development materials and raw files were archived and hidden away for the master course (the pristine version that would be maintained by one of the partners and which would be revised over time based on the best practices by each of the teams). While team members' names played a major role in the development of the contents early on (for clear work assignments), the team decided to remove their names from each of the respective slideshows (but not the videos) and instead have an "Introduction to the Pathways Development Team" form developed, which included brief biographies, headshots, contact

information, and data about what each member contributed to the course.

Uploading onto L/CMses

Once the curriculum was finalized, the curriculum was uploaded on the four learning / course management systems (L/CMses). The lack of interoperability between these systems meant tedious manual uploading and deployment of contents using zipped files. Each of the "playable" elements had to be re-tested in each system. The e-learning trajectory and branding also had to be rebuilt in each course, along with the assessments, message boards, and grade books. In another endeavor, the master course had to be moved onto a different server, so one of the teams from a college could use teach using this more flexible platform. While

the move went smoothly, the master worksite was essentially erased off the server, and all the team members had to be re-enrolled in a back-up master of the finalized course. Some interchanges and messages, though, would be unrecoverable from the Message Board.

The Human Touch

Interestingly, the various team members seemed to prefer communicating in-person or by telephone and email. They used the online site to share and archive their digital learning artifacts but not so much for direct collaboration or communications (synchronous or asynchronous). The direct human touch played an important role in team bonding and collaborating. The collaborators chose to meet face-to-face to wrangle through some difficult curricular decisions, such as what parts of the draft course to keep in the final version and what revisions had to be made to each other's work. This reluctance to use the L/CMS mediated resources for direct communications may have been a factor of the poor connectivity of some of the colleges to the Internet. Some of the collaborators had never taught online before and were familiarizing themselves with the L/CMS technologies as the collaboration proceeded.

Open Source Contents

The team had challenges pursuing "public domain" contents made available through federal agencies and some non-governmental health organizations, both in getting documentation of release and in getting the actual digital contents. These involved alt-texted imagery, videos, audio podcasts, and transcripts of these multimedia contents.

Consistency and Expectations Management

Templates of slideshows were used to offer some consistency and quality standards. While guide-

lines were created for the building of various contents, most development teams needed actual live samples and critiques of those samples to understand what was desirable (based on their peers' insights). Templates were also used to maintain a design look-and-feel consistency for each module, as multiple members of distributed teams would contribute to each of the modules.

Building for the Hand-off

One central practice of the project was to archive and protect all the work created by each team member for the eventuality of a hand-off. During the 6-month curricular build, there were occasions for the sharing of work, but no major team member dislocations occurred.

IT'S A WRAP: INTRODUCTION TO PUBLIC HEALTH

The course was finalized in the summer, and two sections of it were offered at two of the colleges for Fall Semester 2009. An external office has been enlisted to formally evaluate this course to identify ways to strengthen the curriculum and learner experience—based on learner feedback at the end of this first semester. The launch of a One Health Kansas site later that summer hailed the beginning of a long-term publicity plan. A playlist off of the K-State portal on YouTube™ was under consideration at press time, to showcase some of the expert videos captured for this course.

A multi-year schedule has been tentatively planned for this course, and other endeavors to build up a public health track are in the works. This course will be a central introductory and feeder course for this undergraduate and graduate public health series. In-house at Kansas State University, this course is also used as a model for developing other courses in epidemiology and public health. The standards of e-learning quality, accessibility,

intellectual property, documentation, and faculty comfort will be carried over to other online courses.

CONCLUSION

Local virtual teaming offers a hybridized way of collaborating with colleagues who are within a reasonable interactional distance from each other. This combination of realities offers opportunities to maximize the co-location (Saxenian's concept of "regional advantage") of team members as well as the distance of distributed colleagues. Examining local virtual teaming also shows the collaborative need in the selection of technologies. This chapter highlights the importance of setting up team member expectations and structures based around social, time, socio-technical and informational elements to support the work and frame the virtual ecology. This also shows the benefits of the loose coupling of a team at a higher abstract level but with tighter coupling up close on particular campuses to actualize the work.

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KEY TERMS AND DEFINITIONS

Accessibility: The nature of being attainable or able to be used; meeting guidelines for being usable (in a technological and human sensory sense).

Attribution: Interpreting, assigning a quality or idea to someone or some action.

Co-Location: The state of being in the same vicinity.

Collaboration: The act of working together on a shared project, from planning to development to critique; teamwork.

Critique: A criticism or constructive feedback.

Discourse: A formal conversation.

Dispersed: Spread over a wide geographical area.

Ecology: The interdependence of people within a particular environment, and their interactions with that environment.

Hybrid: A blend of types, usually referring to electronic learning (e-learning) and face-to-face (F2F) learning.

Inflection: A point of change; a turning.

Intercommunication: Mutual communications between people.

Interdisciplinary: Combining two or more fields of study, consisting of the influences of multiple disciplines.

Leverage: Power.

Local: Close by geographically; nearby.

Loose Coupling: The concept of less interdependence between entities for greater adaptivity in an organization or organizational unit.

Media Richness: The state of having high communications cues through mediated communications.

Mental Model: The conceptualization of a particular system, held by individuals (vs. conceptual models, which are held by subject matter experts in a particular knowledge domain).

Milestone: A significant event or stage in a process.

Module: A separate stand-alone learning component that may be interchangeable with others.

Non-Verbal Cues: Body language as a tool of communications.

Rehearsable: The ability to go over a message before sending it out.

Reprocessibility: The ability to re-examine a message within a particular communications event.

Resilience: The power to recover from difficulty.

Rubric: An assessment device that is characterized by its presentation via tables with informational cells.

Social Exchange: The relationships between people as a basis for work and interactions.

Stylebook: A document used in digital project management that defines standards.

Trajectory: A particular path or course.

Transactional: A type of relationship based on mutual exchanges.

Virtual Teaming: The work collaboration by individuals who are geographically (and often temporally) dispersed.

APPENDIX A

Draft Stylebook for the Pathways to Public Health

Subject Matter Experts (SMEs) and Developers

A stylebook guides the development of the curriculum and digital learning objects. It is unique to a project and is co-created by the members of the team. (**Redaction:** The team members' names, contact information, institutional affiliations, and areas of domain expertise were deleted here. A "To Do" list specific to the project and work flows also were redacted. A table of deadlines was also omitted.)

1. Team Work Flow

Note: A separate workflow is annotated and color-coded to show the three main phases of the project: (1) development, (2) alpha and beta testing, and (3) deployment and archival. Also, that included annotations of where decisions would get made and by whom—to assign responsibilities and to ensure clear cross-team understandings.

Figure 3. A team work flow

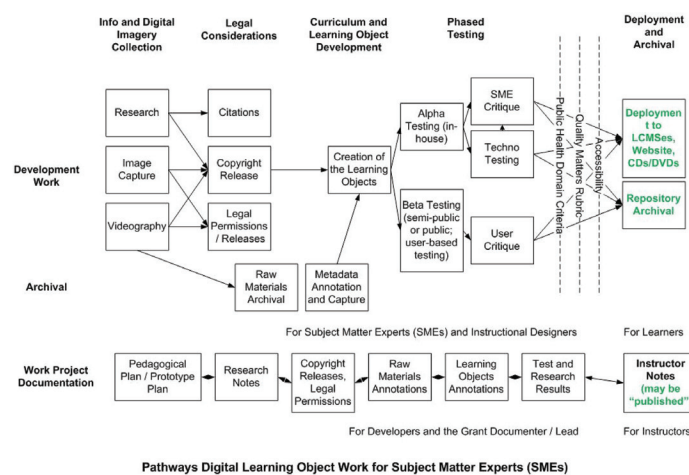
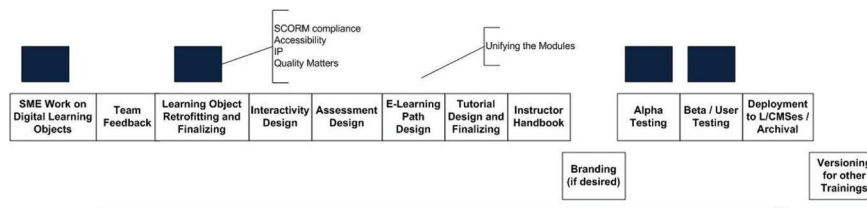


Figure 4. General steps to the online course design process



Note: The above flow communicates the general steps to the online course design process. The project-specific due dates have been redacted.

2. Modular Contents

This segment set expectations for the team about the sizes of the modules in terms of the hours that learners would spend on each and the length of each module (two weeks of learning per module for 9 hours of learning per week—or 3 hours online and 6 hours of homework).

The group defined the modular contents, so there would be a shared understanding of what was being built:

Table 1.

Defined Learning Objectives: Learning objectives (5-10 total) (related to the digital learning objects, activities and assessments)
Self-Explanatory Topical Slideshows: 1-3 slideshows (approximately 20 – 25 slides each, with between 4-8 images per each slideshow)
Multimedia: Audio and / or video files
Relevant External Links: 2-5 links to professional, related resources on the WWW (simulations, immersive learning, videos, slideshows, informative websites, and other contents)
Discussion / Interactivity Plans: case studies, current events, controversial issues
Field Study Ideas: Field trips, site visits
Practice Exercises: based on learner opt-in (flashcards, crosswords, automated multiple-choice, true-false, matching, and other exercises)
Assessments: An objective assessment (multiple choice, true/false, matching, etc.)

Based on the face-to-face meeting by the project subject matter experts, the curriculum was divided into a pre-module (to help novice learners acclimate to both online learning and the subject matter), and six other modules. There were learning outcomes linked to each module, and there were chapters of a shared textbook linked to each.

3. Development / Authoring Technologies

Tech Standards and Tools: Given the technological standards of the project, this part set the URL for the work site. It also pointed to various freeware that could add value to the project—such as a site that allows for the low-cost easy-moving of large digital files. The authoring tool software programs and their versions (2007), digital file types (for text, slideshows, still images, audio, video, automation, and others) were defined specifically. Included also were specs on imagery in terms of file sizes, for the greatest flexibility in terms of versioning. The three learning / course management systems that would be used in the execution of this project were also listed.

Raw Files: Content creators were asked to keep proper raw video, photos, diagrams, and other elements in their modular folders for possible later use and for the most information-rich versions of the files (before compression and / or integration into a polished, finalized digital learning object or experience).

4. Course Development Standards

To develop this online course, it was critical to have clear definition of standards. A special segment at the end addressed issues of copyright and intellectual property, and another addressed federal Section 508 compliance for accessibility.

Annotation, Record-keeping and Citations: All subject matter experts and content creators were asked to annotate imagery for alt text. They were asked to keep records of all intellectual property / copyright releases. Citations were to be done using the American Psychological Association (APA) citation method. Guidelines for the labeling of diagrams were included.

File Naming Protocols: This section addressed how to name files in a consistent way without limiting how the digital files could be used. (The idea of modularization is not to lock individuals into a set curriculum but to make digital learning objects interchangeable to different e-learning and hybrid-learning situations.)

Credits: Another segment explored how to add a credits page at the end of a digital learning object, if desired.

Instructor Telepresence Strategies: A way for an inheriting faculty member to create telepresence was addressed. A digital instructor's manual would be created to go along with this curriculum.

Quality Matters™ Curricular Standards: A live URL link to the Quality Matters™ rubric was offered as part of the standards setting along with a brief overview of the contents of the QM standards.

5. Course and Module Assessment and Feedback Loops

This section addressed a survey feedback instrument to gather user feedback from learners (See Appendix C.) during the summer hybrid test-run of the course. A version of this survey instrument could be used with each course offering for continuing feedback loops and revisions. (Logistically, there would have to be one “pristine” master course, which all members of the team would have access to...and a way to capture changes and have those delivered to learners.) This noted, too, that datamining would be set up on the various learning / course management systems to observe learner behaviors and to gather information about how to improve the course and the student learning.

Stylebook Appendix A: Why IP in E-Learning?

A segment addressed intellectual property issues in terms of the rationale behind intellectual property, Creative Commons® releases, and public domain objects. The tenets of intellectual property and the various laws [the US Copyright Act (1976); “fair use” via Section 107 of the Copyright Act, 1976; the Digital Millennium Copyright Act (1998); the Technology, Education and Copyright Harmonization Act (TEACH Act, 2002) related to performances; trademark tenets; patent tenets, and trade secret protections were all covered. There was a tips section for faculty to help in their establishing provenance of information. The proposed “orphaned works” legislation was not addressed given a lack of an official decision. The subject matter experts also were given links to open cost-free educational resources that could offer topic-specific resources which they could use in this curriculum. They were also asked to use links to various sites.

Stylebook Appendix B: Accessibility

Lastly, there were tips given to make courses accessible. These involved efforts to use universal product format file types and versioning file types for more robust accessibility. Text documents would not be digital image graphics but text-readable files. Documents would be tagged for document structure and markup, so users may understand headers from body text. The language would be clear, simple English, to help those using computerized language translators or reading the English as a second or foreign language. Informational graphics needed alt text labeling, and all audio and video needed transcription. PowerPoint slideshows would have to be made accessible based on using their extant templates instead of inserting text boxes (which are skipped over by some text readers). Color needed to be accessible for those who have low vision or color-blindness, so the use of color *alone* to communicate was discouraged. Data tables had to be summarized and created in a screen-readable way for clarity. Live events that were planned for the course needed to be accessible, with preliminary, during-event, and post-event work. If automations or sequenced actions were created, these had to be controllable by users to the largest extent possible.

APPENDIX B

Peer Feedback on the Modular Contents

1. Based on the **Pathways to Public Health Check List for Course Materials** (in the Stylebook Criteria folder in the online workspace), did you find (a) **anything missing** or (b) **needing revision** from the module? (**Note:** Please be specific. Name the lecture or item, and note the exact slide. If referring to a video, refer to an exact time. Provide specific suggestions for improvement.)
2. Based on **the Quality Matters rubric** in the Stylebook Criteria folder in the online workspace), did you find the following elements in the module you assessed? And did these come up to the course standards? If any parts do not come up to course standards, list below and specifically state why they do not. Provide suggestions to help bring them up to course standards. Please be specific in your comments.

Table 2.

Quality Matters review: (See Project Stylebook at K-State Online. Use QM Best Practice Guidelines)
Module Overview and Introduction
Learning Objectives
Assessment and Measurement
Resources and Materials
Learner Engagement
Course Technology (see -- stylebook pgs. 10, 12 and 13)
Learner Support
Accessibility (see Pathways stylebook)

3. Based on the **subject matter for the module**, did you find any curricular **information missing**? If so, what would you add?
4. Did you have any **technological problems** accessing the curricular contents? Please describe these in depth. (What were the file types?)

Submittal: Please keep a copy of this for your team, and make sure to send a copy to ---. She'll make sure that all the developers for a particular module receive a copy of the comments. She'll also maintain an archive of the critiques in the online workspace.

If you and your team have suggestions for the overall development of the modules, feel free to share that with the team. (You may email all team members via the Roster area of the worksite.) Thanks. (**Note:** A separate form will be used for critiquing the overall course later on.)

APPENDIX C

Proposed Learner Survey for Pathways to Public Health Curriculum Assessment

This 24-question survey will be used to enhance the online course "Pathways to Public Health." The first section consists of a series of statements, which may be evaluated based on your learning experience.

The second short section consists of two short-answer questions. This survey may take about 10 minutes to complete. Your help is appreciated.

Directions: Please read the following statements. Rank how true each statement is with the following scale.

Table 3

N/A	1	2	3	4	5
Non-applicable	Disagree	Somewhat disagree	Neutral	Somewhat agree	Agree

LEARNER BACKGROUND

1. I had the proper amount of prior knowledge to understand the contents of this introductory public health course.

LEARNER NEEDS

2. I needed more materials in order to understand the subject matter of this course.
3. My learning styles or preferences were met in this course.

CLARITY OF COURSE EXPECTATIONS

4. I was clear about the course expectations early on (through the syllabus and course postings).

TECHNOLOGIES

5. I was able to access all the digital files related to this course.

If not, I had problems with the following file types:

- Images
- Slideshows
- Audio
- Video
- Animated tutorials
- Simulations

6. The learning / course management system (the software through which you accessed the online course) was user-friendly.

COURSE CURRICULUM

7. The course curriculum was clear.
8. I had sufficient opportunities to apply the learning during this course.
9. The course materials related clearly to the course textbook.
10. The case studies helped me understand some real-world aspects of public health.
11. The field trips (if applicable) helped me better understand public health.
12. I have a better understanding of careers in public health.
13. My interest in public health careers has been enhanced.
14. I felt the learning showed diverse populations in an inclusive way.
15. The course assessments (quizzes, tests) aligned with the learning.
16. The textbook was helpful for my learning.
17. The external readings (in addition to the textbook) were helpful to my learning.

INTERACTIVITY

18. I felt engaged and interested throughout this course.
19. I experienced sufficient communications with my fellow students / peers.
20. I experienced sufficient communications with my instructor.

INSTRUCTOR SUPPORT

- 21. The instructor(s) was / were responsive to my learning needs.
- 22. The instructor(s)' response time and availability to answer my questions was adequate.

Short Answer Questions

- 23. Were there topics you wanted to learn more about in this introductory --- course that were not addressed? If so, please list them below.
- 24. Any suggestions on ways that this online course may be improved for future learners?

Thanks for your participation in this course and survey. If you would like to be contacted by a faculty member, please include your email below:

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Chapter 6.3

Motivation and Multimedia Learning

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ABSTRACT

In the field of multimedia learning, although research on cognitive effects and their implications for instructional design is rich, research on the effects of motivation in a multimedia learning context is surprisingly scarce. Since one of the major goals of providing multimedia instruction is to motivate students, there is need to examine motivational elements. In this chapter, we focus on 4 major motivation theories—expectancy-value theory, self-efficacy, goal-setting and task motivation, and self-determination theory—and two motivation models—ARCS model and the integrated model of cognitive-motivational processes—that are derived from multimedia research; review the literature on motivation in multimedia learning contexts, suggest that researchers and practitioners

take into account a number of essential aspects to ensure that motivation features incorporated in multimedia learning resources optimize learners' experience; and point out future research directions in model building, hypothesis testing, examining individual differences, and carrying out longitudinal studies.

INTRODUCTION

Research in the area of multimedia learning so far has focused on the effectiveness of instructional methods and course design. Various approaches of delivery have been investigated and basic principles in terms of memory and associated cognitive processes identified (e.g., Fletcher & Tobias, 2005; Low & Sweller, 2005; Mayer, 2005). Research in this direction appears to be fruitful, although puzzling, sometimes conflicting results,

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do occur. As a convention, in an attempt to integrate or develop “mini theories”, more theories or models from information processing perspectives are proposed and further tested (e.g., Butcher, 2006). However, as pointed out by a number of researchers (Astleitner & Wiesner, 2004; Bernard et al., 2004; Clark & Feldon, 2005; Keller & Suzuki, 2004; Pass, Tuovinen, van Merriënboer, & Darabi, 2005; Volleyer & Reinberg, 2006), motivational aspects in multimedia learning should be regarded as essential elements and research with sound theoretical bases and methodological rigor is much needed.

In this chapter, we attempt to analyze and discuss motivational determinants in effective multimedia learning from social cognitive perspectives. The main issues covered here are as follows. First, we discuss why researchers and practitioners need to adequately consider motivational issues in multimedia learning. Second, we present well-founded motivation theories that are relevant to learning processes and task performance, and review models that can be specifically applied to multimedia learning, teaching and course material development. Finally, we highlight important factors, topics and directions for future motivational research to guide multimedia teaching and learning.

THE NEED FOR MOTIVATIONAL RESEARCH IN MULTIMEDIA LEARNING

It has been almost axiomatic since ancient times even before Aristotle and Confucius that meaningful learning is associated with motivation. However, despite the efforts of some experts in multimedia learning motivation (e.g., Astleitner & Hufnagl, 2003; Gao & Lehman, 2003; Keller & Suzuki, 2004; Song & Keller, 2001), research in multimedia learning at large has not taken motivational issues into account. Instructors may deem that multimedia material and associated operations

are more interesting (e.g., text + pictures + sound) or more accessible (e.g., e-learning at the user's convenient time) than conventional methods. The underlying assumption is that learners who have the opportunity to use multimedia resources should be highly motivated. However, if we scrutinize the literature, we will soon find that multimedia technology together with a certain type of course design may not lead to elevated motivation and superior learning performance. For instance, in a well-controlled study with initial motivational screen and randomization of subject assignment, online evaluation shows that medical students initially with positive attitudes towards computer-based learning (CBL) were not enthusiastic at the end of course, and learning outcomes were significantly affected by students' prior knowledge but not by their CBL use (Hahne, Benndorf, Frey, & Herzig, 2005). The implication is that CBL may hold too much promise in a curriculum scenario, and that hasty implementation of such curriculum-driven CBL program may carry a risk of deteriorating students' positive attitude towards CBL.

In another study which examined the data quality of questionnaire administration, the paper-based group was better than both computer-based and web-based groups, and the affective responses of participants favored the paper-based mode over computer- and web-based modes (Hardré, Crowson, Xie, & Ly, 2007). These results indicate that adopting information technology does not necessarily lead to high motivation. Hoskins and Van Hooft (2005) reported in a study on Web Course Tools (WebCT) that only those students already highly-motivated and academically-able benefited from bulletin board use, suggesting that motivation and academic ability are determinants of achievement in hypermedia learning.

The effect of motivation on multimedia learning was also highlighted by Hwang, Wang and Sharples (2007) in a quasi-experiment. The study found that although the experiment group using VPen (a multimedia annotation tool) appeared to be superior to the control group (learning without

a multimedia annotation system) in several learning activities, there was no significant difference between the groups in the final examination. This is a typical example of a Hawthorne effect in multimedia learning, that is, academic outcome is due to motivation to learn and not necessarily owing to the adoption of sophisticated multimedia support.

Previous reviews on the effectiveness of multimedia learning are consistent with the suggestion that motivation plays an important role in multimedia learning. In a comprehensive, strict criterion-based meta-analysis of empirical literature comparing classroom (face-to-face) instruction and distance multimedia instruction, Bernard and colleagues (2004) have identified a bi-modal pattern of multimedia learning effectiveness. They also report that the variability surrounding the mean effect size for achievement is considerably large, indicating that distant multimedia learning works extremely well in some cases and extremely poorly in other cases. According to their explanation, whether the learner is engaged in active learning is an essential issue. They further argue that interest (or satisfaction) may not automatically lead to high achievement, because learners may be just happy to choose a convenient study mode but do not make sufficient effort to study. They suggest that future research should explore student motivational dispositions such as task choice, persistence, effort, self-efficacy, and perceived task value. According to Clark (1983, 1994), the potentially unlimited and inclusive capacity of multimedia instruction does not necessarily facilitate learning. Arguably, the capacity of multimedia instruction to include learner's participation can give rise to motivation to be engaged in multimedia courses learning. However, studies have revealed that such interest does not incontrovertibly translate into achievement (Clark, 2005).

There is research evidence to suggest that instructional support in the form of animations may distract and interfere with learning rather than facilitate it (see Clark, 2005), and one common

problem in the use of hypermedia environments is the phenomenon of getting lost in the environment thus losing track of learning (Svinicki, 1999). In addition, meta-analytic evidence suggests that learning tends to decrease in multimedia courses as interest (and thus enrolment) in such courses increases, because learners may believe that such courses require less work (Bernard et al., 2004). Furthermore, in a recent review, Tallent-Runnels et al. (2006) concluded that learning outcomes of web-based courses are the same as traditional ones and suggested that the understanding of learner's goals, needs, and motivations in taking a course is essential for the instructional design of multimedia learning. It is necessary to scrutinize motivational factors in multimedia learning processes.

ACHIEVEMENT MOTIVATION: THEORIES AND APPLICATIONS TO MULTIMEDIA LEARNING

Many achievement motivation theories have been developed in psychological research to explain people's choice of achievement tasks, persistence on those tasks, and resulting performance (Wigfield & Eccles, 2000). Although there have been attempts to integrate these theories, the theories retain their distinctive features (Naylor, Pritchard, & Ilgen, 1980). In this chapter, we focus on expectancy-value theory, self-efficacy, goal-setting theory, self-determination theory, and specific models that have been applied to various multimedia learning processes.

Expectancy-Value Theory

According to Vroom (1964), valence, instrumentality, and expectancy (VIE) are the three major motivational determinants. Valence refers to the anticipated desirability (i.e. importance) of an outcome; instrumentality is the belief that performance will lead to a desired outcome; and expectancy refers to the subjective probability of

effort leading to a specific outcome. For example, in choosing a multimedia course, the ultimate outcome for an individual may be a good grade for the selected course. Therefore, valence in this case is the desirability of a good grade in the chosen course. Instrumentality is operationalized as the degree to which the student believes that doing well in the final exam (performance) will lead to a qualification or promotion, and expectancy is the student's belief that his or her effort will lead to a good grade. In the VIE theory, volitional and calculative processes play a critical role in human decision-making. Influence by Lewin's (1939) psychological field theory, Vroom (1964) use the term "force" as a metaphor for the integration of motivational components.

Despite its long history and the considerable amount of empirical support for the expectancy-valence theory, the underlying assumptions of the theory have been questioned. According to Vroom (1964), the choices individuals made are determined by their affective reactions to certain outcomes (valences), their beliefs about the likelihood of the actions leading to those desired outcomes (expectancies), and their perception of the relationship between primary and secondary outcomes (instrumentality). One comment of this type of model is that in making a decision, an individual will have to consider a wide variety of options, outcomes, instrumentalities, and probabilities before taking actions. This will require many mental computations and huge processing capacity (Lord, Hanges, & Godfrey, 2003). However, the human cognitive architecture often does not permit simultaneous processing of all available information. Such processing of information will involve an inordinate amount of working memory. In an attempt to sort out the discrepancy between Vroom's postulation and the limits of the working memory capacity, Lord, Hanges and Godfrey (2003) have presented simulation data to show that Vroom's motivation model holds if computations to reach a decision are performed by neural networks instead of serial processing. It

should be noted that the use of neural networks is possible only when there is extensive experience with a problem situation and with the knowledge structures organized in the form of schemas for automatic processing.

Moreover, in practice, individuals are not always privy to information that is needed. According to Simon (1945), individuals usually only consider a limited amount of information and stop searching alternatives once they believe that they have reached satisfactory (though not necessarily optimal) solutions. Consider the case in a multimedia on-line course, once learners know they have attained a satisfactory level of achievement, it is possible that some learners would stop engaging in the learning activities provided in the on-line course even though their valence, instrumentality and expectancy are high.

Another comment of Vroom's theory is at the operational level. The motivation score can be obtained as either a multiplicative or additive result of the three components, namely, valence, instrumentality, and expectancy. Originally, Vroom proposed a multiplicative model. Consequently, a number of researchers have used this method. However, in a meta-analysis, Van Earde and Thierry (1996) found that the additive model yielded higher effect size in relation to attitudinal criterion variables (e.g., intention and preference) than did the multiplicative model, and therefore argued for the use of the former over the latter. Using the additive model, Sanchez, Truxillo & Bauer (2000) reported that expectancy was positively related to test performance.

In the context of multimedia learning, Rheinberg, Vollmeyer and Rollet (2000) have posited a model of self-regulated learning which includes three types of expectancies: action-outcome-expectancies (the probability of success), outcome-consequence-expectancies (instrumentality), and situation-outcome-expectancies. The situation-outcome-expectancies (SOE) represents "the assumption that the just given situation will lead to the desired outcome on its own without the

need to take any action” (Rheinberg et al., 2000, p.510). SOE is regarded as a relatively stable, trait-like factor. Using the SOE model, Astleitner & Hufnagl (2003) investigated the effect of motivation on the learning outcomes of web-lectures consisting of both audio and visual presentations. The findings are: 1) high SOE learners tended to rate the statement “I do not need any activity for critical thinking because I understand everything at once” totally true or true; and 2) low SOE learners tended to rate the same statement not true or not at all true (p.369). Astleitner and Hufnagl (2003) argued that students with low SOE were motivated to be engaged in active learning and sought support to reach a given goal, whereas students with high SOE were not sufficiently motivated to learn because they were not convinced that engagement in learning would change learning outcomes in any significant way.

Self-Efficacy

While the traditional expectancy-value models have focused on outcome expectancies, Bandura (1977, 1993, 1997) has argued that efficacy expectations should also be considered as they are more predictive of performance and choice than outcome expectations. Self-efficacy and outcome expectations do not have the same meaning. Outcome expectations involve beliefs about the anticipated outcomes of those actions. For instance, a student may believe that a positive outcome will result from certain actions but also believe that they lack the competence to produce those actions. The concept of self-efficacy, developed from social learning theory, refers to perceptions of one’s capabilities to engage in courses of action that will lead to desired outcomes (Bandura, 1977, 1993, 1997).

There are two important features in Bandura’s construct of self-efficacy. First, self-efficacy operates within a specific context (e.g., incorporating internet resources to prepare a PowerPoint presentation on global warming). The second element of

the construct refers to judgments of the behavior one is capable of performing independently of the value one attached to the given actions. For example, an individual may have a high self-efficacy for doing a presentation but draws little self-worth if the task is perceived to lack value.

Research shows that self-efficacy can influence behavior in achievement settings (Bandura, 1993; Pajares, 1996, 1997; Schunk, 1989, 1991). Students with low efficacy for learning may avoid attempting tasks; those with high efficacy would participate more eagerly by expending greater effort and persist longer in the face of difficulties. In a study estimating the unique contribution of self-efficacy to work-related performance controlling for personality, general ability, and job or task experience, Judge, Jackson, Shaw, Scott and Rich (2007) found that self-efficacy predicted performance in low complexity task but not in medium or high complexity tasks. Based on Bandura’s (1986) guidelines of assessing self-efficacy for specific tasks, scales for computer self-efficacy were developed and validated (e.g., Murphy, Coover, & Owen, 1989; Zweig & Webster, 2004). In our study of students undertaking a teaching qualification, we look at the motivational factors involved in a compulsory computer skills course that consists of face-to-face instruction and self-paced web-based learning. We found a moderate correlation between self-efficacy and test results (Jin & Low, 2007).

Goal-Setting Theory and Task Motivation

As early as 1950s, Atkinson (1958) reported that task difficulty, as indicated by the probability of task success, was related to performance in a curvilinear, inverse function. However, in a meta-analytic investigation, Locke & Latham (1990) found a positive, linear function in that the highest goal produced the highest levels of effort and performance. They also discovered that specific, difficult goals tended to result in

higher performance than urging people to do their best. The explanation given to this finding is that do-your-best goals have no external framework of reference, whereas goal specificity can reduce ambiguity regarding what is to be attained. They suggest that goals with specific standards of performance increase motivation and raise self-efficacy because goal progress is easy to judge, and that challenging but attainable goals raise motivation and self-efficacy better than easy or hard goals. According to Locke and Latham (2002), for goals to be effective, feedback is a necessary component; if people do not have information about how they are doing, it is difficult for them to adjust their effort or strategies to match what the goal requires. In addition, individuals who participated in setting goals tended to set higher goals and performed better than those whose goals were assigned.

Based on findings from the empirical research on goal-setting, Locke and Latham (2002) proposed an expanded model of motivation relating assigned goals, self-set goals, self-efficacy, and performance. According to the model, assigned goal affects both self-efficacy and personal goal; self-efficacy influences personal goal; and both self-efficacy and personal goal are predictive of performance. Thus, the goal-setting theory appears to be compatible with Bandura's conceptual framework of self-efficacy in the wider context of social cognitive perspectives.

Goal-setting theory seems to be incongruent with Vroom's theory in that, whereas expectancy is linearly and positively related to performance, expectancy of goal success could be negatively related to performance under difficult goal conditions where goals are hard to attain. This apparent incompatibility is resolved, according to Locke and Latham (2002), when a distinction is made between expectancy within a certain goal level and expectancy between goal conditions. Locke, Motowidlo, and Bobko (1986) found that when goal level is constant (a situation assumed by valence-instrumentality-expectancy theory), higher expectancies lead to a higher levels of per-

formance. Across goal levels, lower expectancies, associated with high goal levels, are associated with higher performance. More recently, Louro, Pieters, and Zeelenberg (2007) suggest that in multiple goal environments, in addition to goal expectancies for success and goal proximity, positive and negative goal-related emotions contribute to goal-related behavior.

In the learning context, achievement goals or goal orientations refer to the motivational basis of learning (Karabenick & Collins-Baglin, 1997). Research shows that there are four types of goal orientations: learning (mastery) orientation, learning avoidance orientation, performance orientation, and performance avoidance (learned-helplessness) orientation (DeShon & Gillespie, 2005; Elliot & McGregor, 2001; Lee, Sheldon, & Turban, 2003; Midgley, Kaplan, & Middleton, 2001; Zweig & Webster, 2004). Researchers have conducted a number of studies on learning and performance orientations (cf. DeShon & Gillespie, 2005). Learning orientation is characterized by a desire to increase one's competence by mastering new skills while performance orientation reflects a desire to demonstrate one's competence (Bruning, Schraw, Norby, & Ronning, 2004). In the face of failure, individuals with learning orientation tend to adopt an adaptive response pattern while those with performance orientation are associated with a maladaptive response pattern. A typical adaptive response pattern is related to persistence, spending more time on-task, adopting more complex strategies, and seeking appropriate help in the face of difficult tasks. In contrast, a maladaptive response pattern is characterized by a tendency to quit in the face of difficult tasks, and a tendency to seek less challenging materials and tasks on which success is a likely outcome.

Although research on goal orientations and motivation is aplenty, in multimedia learning research, the contribution of goal orientations receives scant attention while the relation between instructional design and cognitive load (see Mayer, 2005) has been a major focus. According to a

series of studies on the effects hypertext-based instruction on learning outcomes conducted by Gerjets & Scheiter (2003), configurations of teacher goals, learner goals, as well as learners' processing strategies, may be important mediating variables. Researchers (Gerjets & Scheiter, 2003; Goldman, 1991) suggest that the cognitive load theory, which emphasizes the relationship between instructional design and learning outcomes (Sweller, 1994; Sweller, van Merriënboer, & Pass, 1998; Yeung, Jin, & Sweller, 1998), can be further expanded by inspecting the suitability of instructional procedures for attaining specific goals. For instance, in Gerjets & Scheiter's (2003) experiment using a hypertext environment that contained work-out examples, when the goal of instructor was just to encourage participants to learn very fast to solve problems in a way as shown in the instructional examples, the structure-emphasizing condition elicited more demanding cognitive processes and thus imposed additional cognitive load than did the surface-emphasizing condition. Consequently, participants spent longer time learning and had poorer performance under the structure-emphasizing condition than those under the surface-emphasizing condition. They suggest that different types of goals and learning strategies should be incorporated into the cognitive load theory.

Self-Determination Theory

According to self-determination theory (Deci & Ryan, 1985), one of two types of motivation, extrinsic or intrinsic, gives rise to an action. Intrinsic motivation refers to doing something because it is inherently interesting, and extrinsic motivation refers to doing something because it leads to a separable outcome (usually some kind of reward). Intrinsic motivation is viewed as an innate human need for competence and self-determination (Deci & Ryan, 1985; Deci, Vallerand, Pelletier & Ryan, 1991) and is therefore influenced by environmental and interpersonal

variables that affect experiences of competence and self-determination (Reeve, Nix, & Hamm, 2003). In self-determination theory, motivation is conceptualized as a continuum with intrinsic motivation at one end and extrinsic motivation at the other. In between are behaviors that were extrinsically motivated initially but have become internalized and self-determined. More recently, Ryan and Deci (2000) have added another construct, amotivation, to the theory. Amotivation refers to the state of having no intention to act and it resides next to extrinsic motivation.

Intuitively, intrinsic motivation is an important construct in educational contexts. Consider the situation where students enrolled in a compulsory multimedia computer skills course may want to avoid some difficult web-based activities but work on them to avoid failure (i.e., the students are extrinsically motivated). As they become more competent, they perceive a sense of control and self-determination over the multimedia learning (i.e., they become intrinsically motivated). The activities become more intrinsically motivating and positive social factors (feedback) assist the learning process. However, as some researchers (e.g., Pintrich & Schunk, 2002; Reeve, Nix, & Hamm, 2003) have pointed out, relatively little attention has been paid to educational implications of self-determination theory. Ryan and Deci (2000) have suggested that the basis for maintaining intrinsic motivation and becoming more self-determined lies in the social contextual conditions that support feelings of competence, autonomy, and relatedness. Therefore, in learning contexts, it is important to create instructional conditions that satisfy the innate needs to feel connected and effective as one acquires knowledge and skills. Recently researchers (e.g., Deimann & Keller, 2006; Kuhl, 2000) have reintroduced and validated a relevant construct "volition" (originally raised by James, 1902) to educational research. According to Deimann & Keller (2006), volition (or willpower) is "one's capability of maintaining attention and effort toward goals in spite of

possible distractions due to waning motivation or competing goals” (p. 139). They point out that, since multimedia learning design and processes are likely to encounter problems such as learner’s uncertainty, distractions, “seductive” details, and cognitive overload, research and teaching programs in the direction of volition enhancement are much needed.

The Attention, Relevance, Confidence, and Satisfaction (ARCS) Model

The ARCS model is an approach to instructional design using multimedia technology based on a synthesis of motivational concepts. Keller and his colleagues (Keller, 1987; Keller & Suzuki, 2004; Song & Keller, 2001) have identified four conditions that are essential for the learner’s motivation in e-learning contexts. The first condition is that a lesson must attract and sustain the learner’s *attention* (A). This requirement is based on research on curiosity, arousal, and boredom. The second condition for motivation is to build *relevance* (R). This requirement is based on research on intrinsic motivation and competence as highlighted in self-determination theory. The third condition for motivating learners is *confidence* (C). This requirement is based on research on self-efficacy and attribution. The fourth condition is *satisfaction* (S). This requirement is based on reinforcement theory and equity theory that have been commonly used in other areas such as I/O Psychology.

The ARCS model is a systematic ten-step design process for developing motivational elements in instructional settings: obtaining course information, obtaining audience information, analyzing audience, analyzing existing materials, listing objectives and assessments, listing potential tactics, selecting and designing tactics, integrating with instruction, selecting and developing materials, and evaluating and revising (see Keller & Suzuki, 2004). The model and its simplified versions have been validated in various learning

contexts (cf. Astleitner & Hufnagl, 2003; Gao & Lehman, 2003; Keller & Suzuki, 2004; Means, Jonassen & Dwyer, 1997; Small & Gluck, 1994; Song & Keller, 2001; Visser & Keller, 1990). For instance, Song and Keller (2001) conducted a motivational analysis of attention, relevance, and confidence in biology classes to examine the effects of a prototype of motivationally adaptive computer-assisted instruction (CAI). They found that the motivationally adaptive CAI resulted in higher effectiveness, motivation and attention than did the motivationally saturated CAI and the motivationally minimized CAI. In this experiment, the ARCS model was used to construct motivation measures, guide motivational design processes, and provide detailed motivational strategies. In the ARCS model, there are two types of motivational strategies: (1) motivation sustaining (e.g., “keep instructional segments relatively short with progressive disclosure”, p. 11), and (2) motivation enhancing (e.g., “use inverse and flash in text and patterns in pictures as attention getters”, p. 12). According to Song and Keller (2001), the motivationally adaptive CAI was effective because it was based on the ARCS model to provide optimal motivational stimulations to learners who were bored and to eliminate excessive motivational features that might be annoying or distracting for learners who were already motivated. In general, findings from research on the ARCS model demonstrate that a systematic analysis of learner motivation is an important aspect in the design and implementation of multimedia courses.

An Integrated Model of Cognitive-Motivational Processes

Astleitner and Wiesner (2004) have proposed an expansion of the multimedia learning theory summarized by Mayer (2001) and Hede (2002). The current multimedia learning theory is based mainly on evaluating research on cognitive processing of sensory (visual and audio) inputs (e.g. Low & Sweller, 2005; Mousavi, Low & Sweller, 1995;

Yeung et al., 1998). Such research is concerned basically with working memory limitation, an essential element of the cognitive load theory. Astleitner and Wiesner (2004) argue that, because motivation influences learning, and motivational processes need memory resources and therefore affect cognitive load, motivational aspects such as goal-setting and action control should be incorporated in a theory of multimedia learning.

Astleitner & Wiesner (2004) have suggested several avenues for motivational research to facilitate multimedia learning: a) the motivational quality of multimedia elements such as the relation between the utility of content and goal-setting, and the relation between variability in audio and visual effects and attention; b) the effects of learners' characteristics such as success- or failure-oriented learners and action- or state-oriented learners; and 3) motivational features that affect cognitive load in multimedia learning environments such as distraction, disruption, diversion, and saturation. Obviously, these research questions need to be systematically investigated with sound methodology.

ESSENTIAL ASPECTS OF MOTIVATIONAL RESEARCH IN MULTIMEDIA LEARNING

Theoretical Development

For multimedia teaching and learning to be effective, it is necessary to conduct appropriate motivational analyses before and during the implementation of courses. Such analyses should be derived from evidence-based motivational theories. Hence, it is important to develop relevant theoretical perspectives. According to Maddux (1999), major theories of the social-cognitive perspective of motivation share a limited number of important principles, processes and variables. Common basic conceptual elements include behavior-outcome expectancies, stimulus-outcome expectancies, self-efficacy expectancies,

outcome value, goal-setting, and competencies. Such similarities suggest that they are not different models of motivation but different versions of some basic elements. As such, it is sensible for the development of an integrated theoretical framework to guide research so as to determine the optimal conditions for best practices in multimedia learning contexts.

Recent research shows some promising developments. For instance, as mentioned earlier, in Astleitner and Hufnagl's (2003) study consistent with the ARCS model, situation-outcome-expectancies (a construct neglected in previous educational psychology research), in addition to action-outcome-expectancies and outcome-consequences-expectancies, was found to play an important role in multimedia learning. They reported that students who did not have strong assumption of "one can fulfil the tasks automatically in a given situation" tended to benefit from the ARCS strategies.

In another study implementing the ARCS strategies in WebCT learning environments, Gao and Lehman (2003) show that feedback plays a significant role: students in both reactive and proactive conditions performed better in achievement tests than those in a controlled condition; and students in the reactive interaction condition demonstrated higher motivational perceptions toward the instructional material than those in the control condition. The control condition was one where the website only incorporated typical, static hyperlinks; the reactive condition was one where the website incorporated an immediate feedback strategy which provided responses during learning; and the proactive condition was where the website incorporated a generative activity strategy which asked learners to generate a new situation after a learning section.

Future research in those aspects covered by Astleitner and Hufnagl (2003) and Gao & Lehman (2003) appears to be warranted. Other explorations to integrate motivational approaches in multimedia learning should be encouraged. For

instance, because self-efficacy is task specific and multimedia learning programs have many variations in the design of tasks and procedures, there is room for the expansion of self-efficacy research in this aspect.

Motivational Features and the Design of Multimedia Instruction

In a series of studies to develop and validate a taxonomy of reasons that gives rise to academic amotivation in high school students, Legault, Green-Demers and Pelletier (2006) have found that task characteristics affect task engagement, and unappealing characteristics of an academic task may lead to academic disengagement. This finding has instructional implications for multimedia teaching and learning. Ally (2004), Reed (2006) and Svinicki (1999) have suggested that designs that keep learners active doing meaningful tasks, and allow learners to construct their own knowledge, to control the learning process, and to evaluate their own learning (meta-cognition) are some features that can engage learners.

Learner Characteristics

Learner characteristics are another important aspect to consider in multimedia learning and teaching (Bernard et al., 2004; Tallent-Runnels et al., 2006). For instance, Mayer and Massa (2003) found that some individuals are visual learners while others are verbal. These two types of learners are distinguishable by three facets: cognitive ability, cognitive style, and learning preference. Multimedia learning resources should provide appropriate avenues and options for different types of learners. In a recent study, when learning style differences were considered in designing an interactive multimedia courseware of Mathematics, the program produced high learning motivation and positive learning experiences (Shiong, Aris, Ahmad, Ali, Harun, & Zaidatun, 2008).

Judge et al. (2007), in a meta-analysis, have found that personality (the Big-Five traits), as well as self-efficacy, affect work-related performance. The Big-Five traits are Neuroticism (the tendency to show poor emotional adjustment in the form of stress, anxiety, and depression), Extraversion (the tendency to be sociable, dominant, and positive), Openness to Experience (likely to be creative, flexible curious, and unconventional), Agreeableness (tendency to be kind, gentle, trusting and trustworthy, and warm), and Conscientiousness (likely to be achievement-oriented and dependable). In another meta-analytic review of research on relation between the five-factor model of personality and performance motivation, Judge and Illies (2002) found that the Big-Five traits are an important source of performance motivation. Among them, Neuroticism and Conscientiousness were the strongest and most consistent correlates of performance motivation. Effects of the other three personality traits on achievement motivation need to be investigated in future research.

Other learner characteristics that warrant consideration are goal orientation (Locke & Latham, 2002; Midgley et al., 2001; Lee et al., 2003), technological acceptance (Palaiogeorgiou, Siozos, Konstantakis & Tsoukalas, 2005; Saadé, Nebebe & Tan, 2007), adaptive learning environments including learner involvement (Song & Keller, 2001; Paas et al., 2005), procrastination in self-paced learning (Steel, 2007), and disappointment and motivation loss (Miceli & Castelfranchi, 2000). In an era of mass education and student-centered learning, especially in multimedia technology-rich settings, learner characteristics should be scrutinized and accommodated in the entire learning process.

Self-Regulated Learning Strategies and Motivation Training

Research in interactive learning environments, participatory multimedia learning, and learner control in hypermedia environment have recently

gained momentum (see Järvelä, & Volet, 2004; Kiili, 2005; Renkl & Atkinson, 2007; Scheiter & Gerjets, 2007). Narciss, Proske and Koerndle (2007) have argued for the promotion of self-regulated multimedia learning which can be applied to WebCT. Self-regulated learning (in the form of problem-based learning, blended learning, project-based learning, etc.) is a specific form of learning distinguishable from learning that is externally regulated in that self-regulated learners use cognitive strategies, metacognition, volition, and motivation to monitor their own learning process (Vollmeyer & Reinberg, 2006). Self-regulated learning involves many strategies of which time planning (involving time management, scheduling, and planning study time) and self-monitoring (involving goal-setting, attention focusing, and monitoring study activities) are important skills to be possessed (Boekaerts & Cascallar, 2006; Van Den Hurk, 2006). The assumptions underlying self-regulated learning are: 1) students construct their own meaning, goals and strategies based on the availability of internal or external information; and 2) students are capable of monitoring and managing aspects of their own cognition, motivation, behavior and learning environment (Pintrich, 2000).

Attractive multimedia platforms contain interesting but sometimes irrelevant information. Competent self-regulated learners need not only to use appropriate cognitive and meta-cognitive skills to determine relevant information for the tasks selected and effort invested in undertaking such tasks, but also are required to properly regulate motivation and attention (Narciss et al., 2007). In self-regulated learning, initial motivation affects learning outcome. According to Vollmeyer and Reinberg (2006), initial motivation is determined by probability of success, anxiety (or fear of failure), interest in the learning material, and challenge (to succeed in an important task). They also suggest that the influence of initial motivation on performance may be mediated by duration and frequency of the learning activity, systematic

learning strategies employed, motivational state during learning, and state of concentration/engagement during learning. Apart from incorporating motivational elements in multimedia learning and teaching, we may also consider motivation training, although evaluation of motivational programs is not an easy exercise (Schober & Zieger, 2002).

Evaluating Quality of Motivational Features in Multimedia Learning Resources

As highlighted by Keller and Suzuki (2004), motivational analysis should be an on-going process to ensure that multimedia resources are compatible with transient motivational factors as the learning progresses. The ARCS model (Keller & Suzuki, 2004; Song & Keller, 2001) has provided a number of specific measures to examine relevant motivational features in multimedia learning. In addition, Leacock and Nesbit (2007) have presented a framework for evaluating the quality of multimedia learning resources named LORI (Learning Object Review Instrument). LORI contains some items that can be used to assess the quality of motivation features incorporated in multimedia learning. These items are learning goal alignment, feedback and adaptation, motivating power (that is, the ability to motivate and interest learners), interaction usability, and accessibility. Items are rated on a 5-point scale. For example, for the aspect of motivating power, if a learning task (or activity or material) is irrelevant to a learner's goal, is too easy or too difficult for a learner, or draws attention at a superficial level, the task would receive a score of 1. In contrast, if a task is perceived as relevant, is able to gain and hold learners' attention, and offers the learner difficulty levels for learners to gain confidence and satisfaction from the learning activities, it would receive a rating of 5. To optimize learners' experiences, multimedia course developers and instructors are encouraged to use tools such as

LORI and ARCS to assess motivational qualities of programs.

CONCLUSION

In the field of multimedia learning, research on cognitive effects and their implications for instructional design is rich. Given the importance of motivation in learning and the extensive use of multimedia learning in educational contexts, research on the effects of motivation in a multimedia learning context is surprisingly sparse. One of the major goals of providing multimedia instruction is to motivate students. Abrahamson (1998) sums up this objective very well when he states that “a primary function of the use of television, computers, and telecommunications in distance learning is to motivate students rather than just to provide information to them” (p. 34). However, evidence for motivation in multimedia learning contexts is not solid. In this chapter, we identify four major motivation theories (expectancy-value theory, self-efficacy, goal-setting and task motivation, and self-determination theory) and two motivation models that are derived from multimedia research (the ARCS model, the integrated model of cognitive-motivational processes), review the literature on motivation in multimedia learning contexts, and suggest that researchers and practitioners take into account five aspects to ensure that motivation features incorporated in multimedia learning resources optimize learners’ experience. These aspects are: 1) theoretical development; 2) motivational features and the design of multimedia instruction; 3) learner characteristics; 4) self-regulated learning strategies and motivational training; and 5) evaluating quality of motivational features in multimedia learning resources. It is hoped that researchers and teaching professionals will devote more attention to the motivational issues in multimedia learning and teaching.

FUTURE RESEARCH DIRECTIONS

Future research should be theoretically driven and evidence-based. There are at least four lines of motivational research that is important in multimedia learning and teaching. First, the ARCS model has been used by researchers interested in motivational aspects of ‘multimedia learning and has generated some promising results. One line of research can continue to validate the ARCS model in various subject domains (e.g., second/foreign language learning, engineering, anatomy, etc.) and cultural contexts.

Second, there have been attempts to combine motivational factors with cognitive elements in an integrated model of multimedia learning. In practice, when engaging in learning, the individual usually does not separate cognitive processing from emotional involvement. Hence this integrated model resembles the natural learning process more than conventional models which tend to treat cognitive and affective aspects separately. Following this line of research, Astleitner and Weisner (2004) propose a comprehensive model from which a number of predictions can be derived. These predictions, including general predictions (e.g., the variability in audio and visual presentations will have differentiated effects on learners’ attention; excessive, irrelevant motivational stimuli will impose extraneous cognitive load; limiting links by embedding information will require less working memory thereby reducing negative motivations), and specific predictions (e.g., seductive details will disrupt the learning process; adaptive motivational strategies will improve learning outcomes) should be tested in future research with appropriate methodology.

The third line of research which appears to be fruitful is to examine individual differences in multimedia learning. On the one hand, researchers can identify dispositions and attitudes that are compatible with the nature of multimedia learning, such as self-efficacy, effective goal-setting

strategies (setting small, relatively difficult but achievable goals), and volition. On the other hand, researchers can investigate personal factors associated with attrition in multimedia learning, in particular, the nature and mechanisms of the loss of motivation (learned-helplessness tendencies). Previous research has, in general, neglects “students-at-risk.” Arguably, both success and failure in multimedia learning should have important educational implications. In addition, sometimes multimedia learning is undertaken collectively (e.g., group project). Group dynamics associated with this particular learning mode and its effect on individual motivation can be investigated.

Fourth, most previous studies conducted in the area of multimedia learning have thus far focused on achievement and task completion in the short term. There is evidence to show that conventional and “innovative” multimedia instruction may result in similar academic outcomes after a longer period of learning. Well-designed longitudinal studies are very much needed to assess the mediating effect of motivation on program effectiveness.

More and more researchers have realized that motivation is an indispensable aspect in multimedia learning and teaching. Despite the urging and suggestions of various researchers in this area, research is surprisingly limited. It is time to conduct systematic investigations in this potentially rich area.

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Chapter 6.4

Making E–Training Cost Effective through Quality Assurance

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INTRODUCTION

Since the 1990s, more and more corporate learning has been moved online to allow for flexibility, just-in-time learning, and cost saving in delivering training. This trend has been evolved along with the introduction of Web-based applications for HRM purposes, known as electronic Human Resource Management (e-HRM). By 2005, 39.67% of the corporate learning, among the ASTD (American Society for Training and Development) benchmarking forum companies, was delivered online in comparison to 10.5% in 2001.

E-learning has now reached “a high level of (technical) sophistication, both in terms of instructional development and the effective management

of resources” in companies with high performance learning function (ASTD, 2006, p.4). The cost per unit, reported by ASTD in its 2006 State of Industry Report, has been declining since 2000 despite the higher training hours received per employee thanks to the use of technology based training delivery and its scalability. However, the overall quality of e-learning either public available in the market or implemented at the workplace remains unstable.

Findings from a recent European survey on quality and e-learning indicated that 65% of the 433 respondents (European training professionals) rated the overall quality of e-learning as “fair” or “poor.” Only 1% rated it “excellent” and only 5% rated it “very good” (Massy, 2002). Criteria used to evaluate quality in e-learning are in order of priority:

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1. Functions technically without problems across all users.
2. Has clearly explicit pedagogical design principles appropriate to learner type, needs, and context.
3. Subject content in state of the art and maintained up to date.
4. Has a high level of interactivity.

Lack of better match between learning design and learner needs and context could significantly reduce the intended impact of training. This shortcoming could be more effectively remedied by introducing a quality management system for training in general and for e-training in specific. However, most managers do not know how to measure the benefits of training and the return on training investment. ISO 10015: 1999 *Quality management—Guidelines for training*, provides answers to the crucial question: how to make training cost effective and more?

BACKGROUND

In response to global competition coupled with technological innovation, companies from European and North American economies have been shifting from industrial to knowledge-based production of goods and provision of services. Traditional advantages such as manufacturing know-how have been eroded due to competition from companies based in newly industrialized countries. For the advanced industrial nations, competitive advantage now depends on superior innovation, intellectual property, and intellectual capital—which, in turn, demand increasingly sophisticated human skills and knowledge. In this context, during the last decade

there has been a shift of attention from the formal education system as provider of knowledge and skills, towards the role of training in enterprises; the latter is increasingly recognized as already

having a significant contribution to knowledge and skill formation. (OECD, n.d., p.2)

On the other hand, developing countries are facing similar challenges as their competitors in OECD countries in terms of their need to ensure higher quality workforce based productivity gain. These countries can no longer count on cheap labor as key factor for their market success since least developed countries can offer even more favorable labor conditions and attract labor intensive foreign direct investment. For companies in developing countries, the move towards higher value added production and services has already become a reality and cannot be avoided any longer. Consequently, the old human resource stratagem of providing no training but relying on ample supply of cheap and unskilled labor to drive down the cost and push up the productivity became unattainable (Saner & Yiu, 2005).

Porter and Sölvell (1998) offer a more holistic explanation of regional competitiveness. Discussing innovation and sustainable competitive advantage of firms, he states:

... While some knowledge is embedded in materials, components, products and machinery, other knowledge is embedded in human capital, part of which is tacit. (p 447)

Findings from studies focusing on regional competitiveness support this view that availability of highly skilled labor is the most important factor in determining a region's competitiveness and prosperity (Koellreuter, 1997).

"knowledge" based production and services demand higher percentage of knowledge based jobs and a higher share of utilizing technology for innovation; both points to greater investment in human capital development through effective training. Lifelong learning is therefore not just "slogan" for the developed economy, but a must for all countries wish to move forward in terms of their economic development.

To keep pace with these changing market conditions and workplace practices, companies must continuously increase their re-investment in the upgrading of the competence of their human resources. Yet while most managers recognize the need to attract, develop and retain a highly skilled and innovative workforce, few feel comfortable with the idea of investing in people, especially with profit margins under pressure. Instead, reducing expenditure occupies top management thinking, and training budgets are cut without considering the effect on competitive advantage in the future and on the company's innovation capital (Edvinsson & Malone, 1997). Should training managers be able to provide documented evidence that training do contribute to business results, such occurrence would sure be dramatically reduced, if not avoided.

Most managers do not know how to assess the return on investment in training (Phillips, 2002), nor are they equipped with the necessary management tools to monitor the decision-making process of such investment and the quality of its implementation (Yiu & Saner, 2005).

So, how does one know if investment in staff training will return in the form of better performance, higher productivity, or new and more competitive goods or services? How can one measure the benefits of training and amortize investments in human capital? How can an organization be sure that recently trained employees will not simply walk away with their newly acquired knowledge and skills? Indeed the persisting question regarding training management has long been—*how can an organization ensure the quality of its training investments so that optimal return is guaranteed?*

Integrating the ICT as part of the delivery modality does not change the validity of this question. Instead it adds more urgency to it by the fact that technology-based learning requires substantial upfront investment and less amenable to customization and change.

This article examines the necessity of investing in training and of adopting technology based learn-

ing modality for upscaling of training coverage. It also highlights benefits of implementing the International Standard ISO 10015: 1999 *Quality management—Guidelines for training* within companies. While ISO 10015 may have been a relatively new and lesser known standard of the successful ISO 9001:2000 family, it is proving to be a highly effective tool for solving the problem of measuring the effectiveness of training thereby helping organizations to justify investment in training and in maximizing technology-based learning infrastructure.

INVESTMENT OR EXPENDITURE?

There is a discrepancy between what organizations may say—"people are our most valued asset"—and what they actually do. This gap is often self-evident when one scrutinizes the human resource management policies and practices of a company. One reason why few companies report on their training is because organizations are not required to report on its human capital in general and training investments in specific to shareholders, nor to society in general. Therefore, there is no external accountability regarding managerial responsibility for safeguarding the organization's human and intellectual capital.

According to the American Society for Training Development (ASTD) *2006 State of the Industry Report*, many major companies in North America and Western Europe spend up to 2%-3% of total payroll on training, amounting to tens and billions of U.S. dollars in expenditure. ASTD estimates that,

U.S. organizations spend \$109.25 billion on employee learning and development annually, with nearly three quarters (\$79.75 billion) spent on the internal learning function, and the remainder (\$29.50 billion) spent on external services. (2006 State of Industry Report, p.4)

However, the big corporations do not scrutinize such training investment as thoroughly as they do with other investments (Durfee, 2003). This is because training continues to be treated as an expense, rather than as an investment in an organization's capacity to compete and innovate (Yiu et al., 2005). This is also because the companies lack the tools in measuring the effects of training on business results (Phillips, 2003).

WHY INVESTMENT IN TRAINING IS A MUST?

Managers are understandably concerned about justifying and protecting their investments. However, since mobility of labor is part of the market economy, employees can leave without the organization recuperating an adequate return on its training investment. On the other hand, when downturn happens managers tend to seek short-term solution to the economic hardship by cutting the head counts as the first intervention in reviving the company's fortune. Therefore, a vicious cycle starts to perpetuate itself whereby companies are reluctant to invest in people for fear of employee turnover.

To be successful, companies must nonetheless manage this dilemma and invest in people, or lose ground as competitors abroad continue to do so. For example, U.S. employers spent an average of USD 677 per employee in 2000 and increased the spending to USD 1,424 per employee in 2005, representing about 2.2% of payroll, in spite of seemingly relentless price competition and a significantly more mobile labor market than Europe (2006 *State of the Industry Report*, p. 3). Continued investment in skill development and human capital in the U.S. coupled with the application of ICT (information and communication technology) and continued drive toward innovation help explain the economic dynamisms and sustained productivity gains in the U.S. (OECD, 2007).

However, similar examples *can* be found in Europe. A recent survey of 1,200 companies in Ireland showed that training averaged 3.01% of payroll in 2001 (Training Survey 2001). This is probably one reason why Ireland has become one of the most dynamic European economies. As OECD (1998) indicated in its international comparative studies that,

Human capital thus constitutes an intangible asset with the capacity to enhance or support productivity, innovation, and employability. It may be augmented, or may decline or become redundant. It is formed through different influences and sources including organized learning activity in the form of education and training. (p. 9)

MEASURING RETURN ON INVESTMENT

Measuring return on investment (ROI) from training is difficult—but not impossible. Since 1997, ASTD has been collecting data on company training investment in order to answer the question: *does it pay to train?*

Data collected from over 2,500 companies, measured against TSR (total stockholder return), indicated that organizations making higher training investments in 1996, 1997, and 1998 yielded higher TSR the following year (Bassi, Ludwig, McMurrer, & VanBuren, 2000). The sample included some European companies with similar links between higher training investment and TSR. These pioneering findings help confirm that training does pay off in terms of organizational performance. It supports the argument that investment in people *can* impact the bottom line. However, as with all investment portfolios, investment in training does not automatically result in performance improvement without smart strategy and competent management. Training management requires vision, strategy, expertise, *and* management tools.

ISO 10015: THE SOLUTION TO QUALITY IN TRAINING

Different quality management tools are available, such as TQM (total quality management), EFQM (European Foundation for Quality Management), EduQua (Education Quality Standard). However, they are either too cumbersome or too general; none address the decision making aspect of the training investment which affects the outcome of training.

International Standard ISO 10015: 1999 *Quality management—Guidelines for training* is something of an undiscovered gem in the ISO 9000 family of standards. It provides guidelines to assist organizations and their managers when addressing issues related to training. ISO 10015 offers three key benefits:

- Benefit 1: It offers a clear road map in terms of making training decision.
- Benefit 2: It makes explicit at the training design stage the measurements to be used in assessing training results.
- Benefit 3: It offers guidance focused on training technology and organizational learning, since it is designed specifically to meet training needs.

In addition, ISO 10015: 1999 has two crucially important features which provide management with a scientific base in managing people and performance related challenges. It provides the “soft” discipline with hard facts in taking strategic decision. These features are:

- Feature 1: ISO 10015 links training investment to organizational performance.

Testing the professional competence of trainers and verifying the pedagogical concepts of training programmes are vital. But the key to assessing return on training investment is its link to organizational performance and business results.

When asked, “Why do you pay for training?”, an organization should be able to track the decision process back to its defined performance objectives. In other words, the key “customer” is the organization itself, even more than the individuals being trained.

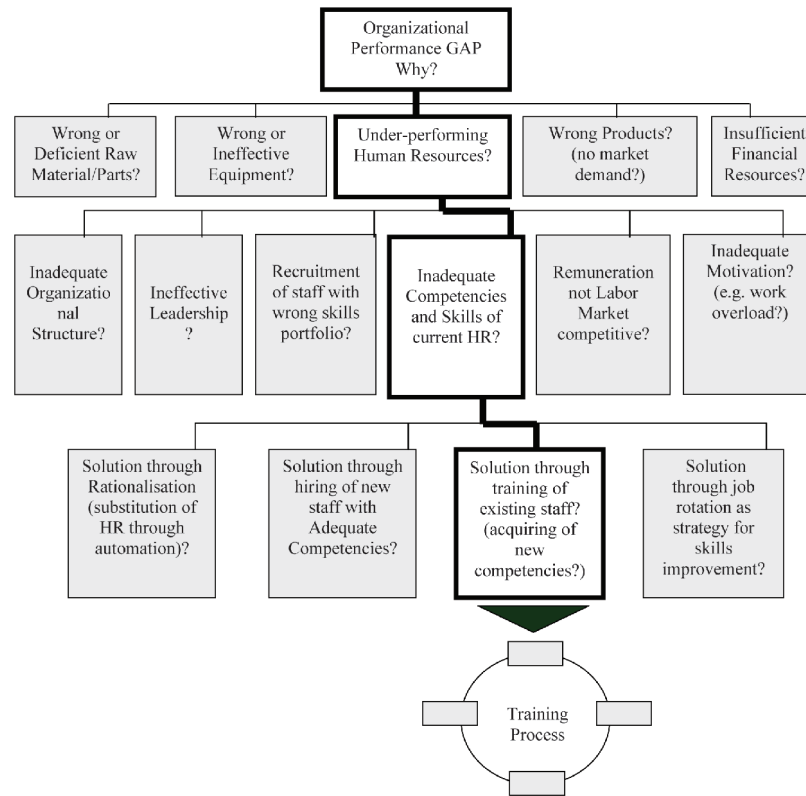
An organization must first recognize the performance challenge it faces and the causes (see the “decision tree” in Figure 1). For example, if sales have slumped, the obvious starting point is to find out why. Are the wrong products being produced, or are the right products being targeted to the wrong markets? Is product quality deficient because of old and unreliable production machinery? Is service quality poor because employees are not equipped to deal with customer requirements and complaints?

Following the decision tree exercise, if the performance gap is linked to under-performing human resources, then the organization should again ask itself why. are employees demotivated by poor pay levels, or by lack of leadership? Is it because their competencies do not fit the job requirements, or because of a differential between the skill levels of established and new employees? If either of the last two factors exists, then training could well be the solution (Figure 2).

ISO 10015: 1999 offers a clear road map towards sound training investment decisions by requiring top management to connect training to performance goals, and use it as a strategic vehicle for individual and collective performance improvement. As a result, training effectiveness is not only measured by improvement in individual professional competence, but also by the extent to which individuals have contributed to the organization’s performance. Feature 2: ISO 10015 requires training to be based on pedagogical and organizational learning principles.

Staff training should be implemented as an intervention strategy once an organization has identified it as the optimal approach to closing the performance gap. Consequently, the next critical phase of investing in people is to establish appro-

Figure 1. “Why training?” decision tree



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priate training design and learning processes. This is where ISO 10015 can be a valuable management tool by helping to ensure that training is organized

- *Efficiently* in the use of finances, time, and energy, and
- *Effectively* in enhancing performance.

Quality principles of the ISO 10015 ensures that knowledge, skills, competences, and other attributes are combined in different ways according to the individual and the *context of use*. It is in this design imperative resting the power of this training management tool.

ISO 10015 defines training as a four-stage process (see Figure 3):

1. defining training needs,
2. designing and planning training,
3. providing the training (including e-learning), and
4. evaluating the outcome of training.

Each stage is connected to the next in an input and output relationship (see Figure 3). As a quality management tool, ISO 10015 helps to specify the operational requirements for each stage and establishes procedures to monitor the process. Such a transparent approach enables training managers to focus more on the substance of each training investment, rather than merely on controlling expenditure.

Unlike other quality management tools, ISO 10015 helps an organization to link training

Making E-Training Cost Effective through Quality Assurance

Figure 2. The performance diagnosis and training decision

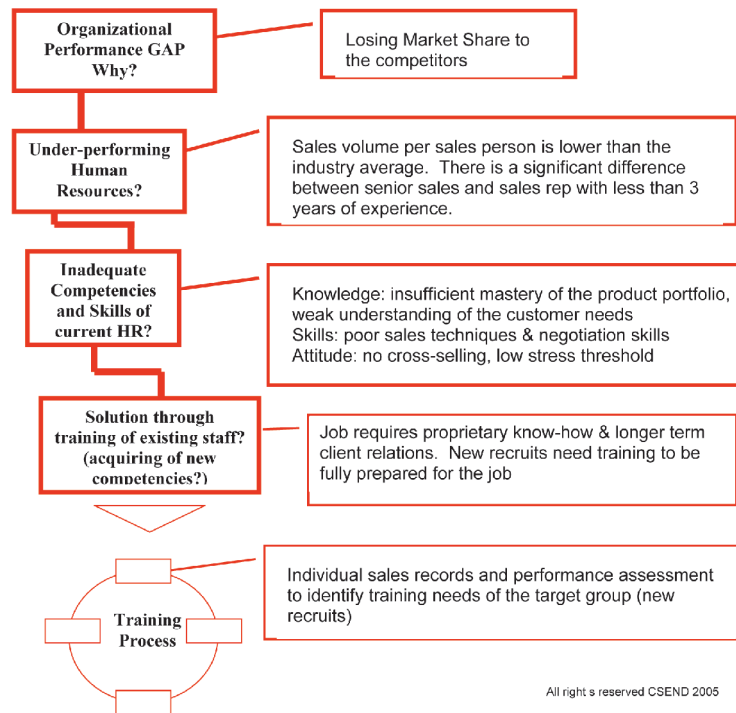
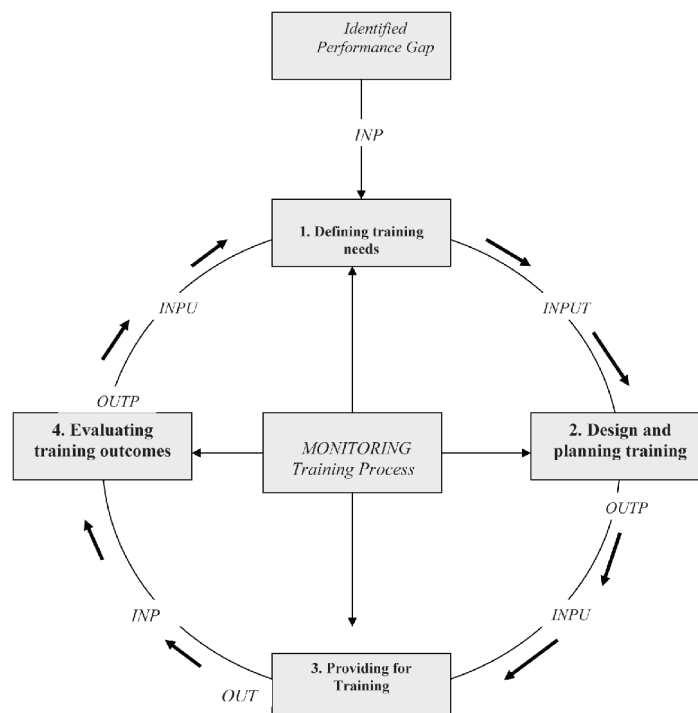


Figure 3. The input-output process of training (Copyright. Centre for Socio-Eco-Nomic Development, 2003)



pedagogy and evaluation to performance objectives. This approach provides an organization with constant feedback regarding its investment in human competencies. The International Standard also encourages companies to examine their training models, and validate their training approaches and premises via comprehensive data and documentation.

This data based approach to training management provides a unique opportunity for continuous improvement of training operation. Most importantly, it provides evidence based feedback to the training solutions adopted in solving performance issues at the workplace. Data concerning individual learning, opportunities to apply on the job, impact on productivity are collected to corroborate with the initial performance diagnosis thereby closing the loop of training intervention. Thus making it possible to actually measure the impact and contribution of training to business operation.

CONCLUSION

To sustain business development, companies need to invest in people more urgently than ever. Training is “mission critical” in a knowledge-based economy and should not be considered dispensable at times of economic difficulty. Only by raising the quality of its human capital can an organization ensure long-term competitive advantage.

In view of the fast changing customer requirements and continued product and service innovation, employees need to be trained more frequently on diverse topics. Learning will continue expanding its presence on-line in synchronous and asynchronous modes. How to avoid the quality deficit of traditional training in e-training processes is a concern needs to be addressed in order to avoid ineffective use of the technology and potential loss of investment.

Like any other major investment, (e)Training must be managed carefully. ISO 10015 offers a

transparent, logical and easy to follow four-stage process which can benefit any training programme. Above all, ISO 10015 is a training-specific quality management tool to strengthen the link between e-training and the organization's performance requirements and objectives. ISO 10015 based training management system provides a sound structure to carry out training that is critical to the long-term financial success of the company. It ensures that training will deliver results in improving the productivity of the company.

“What can't be measured can't be managed! What can't be measured and managed can't be improved” as the saying goes. Companies that act early in identifying and measuring the salient factors affecting their human capital development and (e)Training investments shall be able to leverage more effectively their human capital in achieving organizational objectives. To create value from (e)Training, managers must start viewing “(e) Training” not as expenditures but investments, and devising ways to bring such a process approach to training management. While recognizing that human capital is an intangible asset and its development might need time to bring to fruition in terms of productivity gains and innovation, a management system that links business objective and training intervention, regardless whether it is done through classroom teaching or on-line, must be the first step.

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KEY TERMS AND DEFINITIONS

E-Learning: Learning activities conducted through Internet or Web-based course materials or activities. Learners engage in this activities alone or in groups. These learning groups could be geographically dispersed.

E-Training: Training delivered through the electronic means, which could be Web-based training programmes and activities.

ISO 10015 Quality Management (1999): It is an international standard provides guidelines

to assist organisations and their personnel to address issues related to training. It is applicable to all types of education and training.

Quality Management System: It is management system to ensure quality of performance and consists of quality policy, work processes, procedures, quality measures, and documentation system.

Regional Competitiveness: Competitiveness is seen as the economic capability to generate higher productivity and monetised values. The factors underlying regional competitiveness include human talent, innovation capacities, connectivity of the region and entrepreneurship.

Training: Process to provide and develop knowledge, skills, and behaviors to meet performance or task requirements.

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Chapter 6.5

Using the Interpersonal Action–Learning Cycle to Invite Thinking, Attentive, Comprehension

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ABSTRACT

This chapter shows how the interpersonal action-learning cycle (IALC) can be used to invite thinking, attentive comprehension from learners in conversation. It explains what the IALC is, where it comes from, how it works, and why. In particular, it offers a logical demonstration that all interpersonal learning takes place within the IALC, and that all competition for dominance lies outside it—suggesting conscious use of the IALC as a desirable practice. The chapter goes on to explore linguistic factors that routinely disrupt use of the IALC, and that can hide its very existence. Strategies for restoring and stabilizing it are offered. Routine use of the IALC can have profound implications for teaching and instruction, collaborative learning, assessment, course evaluation, and professional development. These are explored.

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INTRODUCTION: YOUR OWN THOUGHTS

This chapter starts with a form of advance-organizer (Ausubel, 1968). You are invited to think about instructional design, by considering how you would answer six questions. If you think that you are in the business of meeting learners' needs, you might find these questions startling—they invite you to focus on a need of your own:

1. What do you most notice about how learners respond to you?
2. What do you imagine are the reasons?
3. How do you feel about that?
4. What is it that you need, that this feeling suggests?
5. What are you doing as a teacher to meet this need?
6. What responses from learners would help you most in doing so?

Although I cannot hear your thoughts, I imagine that as a teacher you would like to help people learn—so that in answer to Question 6, I imagine that the responses you would find most helpful from learners might be summarized as:

- Their attentiveness toward you
- Their accurate comprehension of what you regard as important, and possibly
- Their own relevant creative thinking

If so, then this chapter is addressed to you. It describes the three learning behaviors above, and presents an argument that just three conversational actions are needed in order to invite them. These three actions form the interpersonal action-learning cycle (IALC).

The following sections describe:

- Where the IALC comes from and how it works
- What routinely disrupts it
- How in practice it can be sustained

BACKGROUND: WHERE THE IALC COMES FROM AND HOW IT WORKS

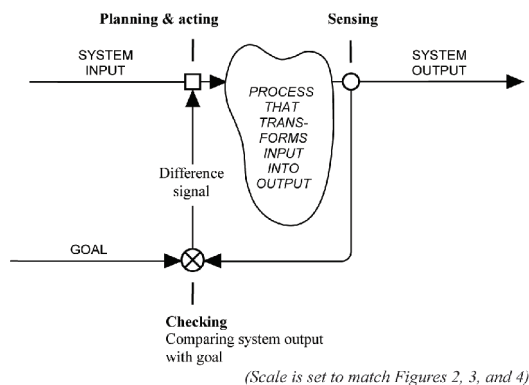
The interpersonal action-learning cycle (IALC) results when the generic action-learning cycle is applied to interpersonal communication.

The Generic Action-Learning Cycle

Figure 1 shows the generic control model. Around it are arrayed the actions, ‘sensing / checking / planning & acting,’ which take place respectively at the sensor, comparator, and effector. They take place whenever a goal-oriented process is in play, and they make up the generic action-learning cycle.

The process itself, denoted by the blob in the centre of the diagram, is a transformational process of some kind—it transforms an input into an output.

Figure 1. The generic action-learning cycle: Sensing / checking / planning & acting



As time progresses, the output is sensed and then is checked against the goal. The difference between the two is used to plan the action that will be taken, in order to modify the input so that the output will more closely approach the goal. Once the action is taken, the output is sensed again to see how well the action worked—and so on around the cycle. Each time around, both the environment and the actor’s capabilities are being learned about.

The Subjective Action-Learning Cycle

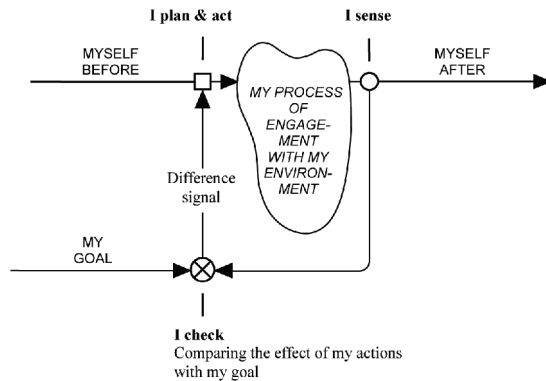
Figure 2 shows how the cycle looks when it is made subjective—that is, when I myself do the sensing / checking / planning & acting. The transformation process becomes my engagement with my environment, and the transformation is from ‘myself before’ each turn around the cycle to ‘myself after.’

A well-known example of this subjective form of the action-learning cycle is Kolb’s cycle of experiential learning (Kolb, 1984). (see Box 1)

The Personal Action-Learning Cycle

Figure 3 shows what happens in addition, when I take conscious note of what I am doing. The cycle becomes my personal action-learning cycle:

Figure 2. A subjective form of the generic action-learning cycle



(Scale is set to match Figures 3 and 4)

Box 1.

Subjective cycle	Kolb cycle
I sense	Experiencing
I check	Reflecting
I plan	Abstracting
I act	Experimenting

- My sensing becomes noting what I notice in my environment and what I imagine about it

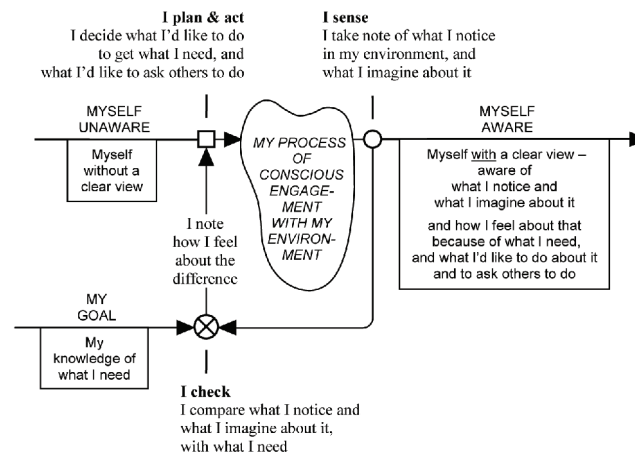
- My checking becomes comparing what I notice and imagine with what I need, and noting how I feel about the difference (Hussey, 1980)
- My planning & acting become deciding what I would like to do in order to get what I need, and what I would like to ask others to do to help

The output from the transformation process, 'myself after,' then becomes myself consciously aware of:

- What I notice and what I imagine about it
- How I feel about that because of what I need
- What I would like to do about it and to ask others to do

This formulation for capturing my own view has roots in several fields. 'I notice ..., I imagine ..., I feel ..., I want ...' is a standard sequence that is used for clear self-expression in Gestalt psychology (Houston, 1995). Variations of it are used in assertiveness training and in other areas of awareness training.

Figure 3. My personal action-learning cycle



(Scale is set to match Figure 4)

In addition, the principle that how we feel about what we notice depends on what we need, as in the second line of the formulation, is a cornerstone of non-violent communication (Rosenberg, 1999). Indeed, it can be argued that not only how we feel, but also what we notice in the first place, depends on what we need—for example, a barn owl’s hearing is tuned for the rustle of a vole in the grass, a film-projectionist’s vision is tuned for the end-of-reel marker, a mother’s hearing is tuned for the cry of her child, and so on.

The three-line formulation brings all of these strands together. It represents a concise way of capturing a clear view.

It also does something else. Traditional writing for instruction often assumes that there is an objective truth to be imparted, and that the author should not intrude. It perpetuates the myth of objective consciousness (Roszak, 1969). This entire paragraph is written in that objectivist style.

By contrast, the formulation above lets me take personal responsibility for what I notice and imagine, so that I can write explicitly from my own perspective—that is, report my own experience—which is the only truth that I actually have. Accordingly, I will be writing the rest of this chapter in this first-person, I-language (Gordon, 1970, 1974) way.

In my view, one of the most important properties of a view captured in the formulation above is that it never can be in disagreement with another person’s similarly-captured view, however different the two views might be. That is, difference does not mean disagreement.

In particular, ‘What I notice and what I imagine about it’ is a report of my own experience, and it leaves room for someone else’s experience to be entirely different. For example, I think that two people in a darkened room describing an elephant by touch are likely to produce very different descriptions, depending on which part of it they are touching. Their views will be different, but they would be mistaken to think that this difference meant disagreement.

Equally, I think that two people looking at a whole elephant—one from the side and one from the front—also will produce very different reports of what they see. Again, their views will be different, but they would be mistaken to think that this difference meant disagreement.

Likewise, ‘How I feel about that because of what I need’ is also a report of my own experience, again leaving room for someone else’s experience to be entirely different from my own. Even, ‘What I would like to do about it and to ask others to do’ is a report of my own experience, leaving room for someone else’s view to be different.

Indeed, so far as I can see, not even my need itself can be in conflict with the needs of other people (Gordon, 1974). The kind of need to which I am referring is not a desire to *do* something in particular, but is always a need *for* something—that is, a basic human need like the need for autonomy, for physical well-being, and so forth. There is an inventory of such basic human needs on the Nonviolent Communication Website (Center for Nonviolent Communication, 2002).

In other words, even when it comes to needs, difference does not have to mean conflict. My favorite way of saying it is that conflict is caused only by inadequate solutions for meeting people’s differing needs (Gordon, 1974). That is, it arises only when people take action to meet their needs, without ensuring that their chosen actions will be beneficial or at least acceptable for other people as well.

The result is that I can use:

- What I notice and what I imagine about it
- How I feel about that because of what I need
- What I would like to do about it and to ask others to do

As a basis for reporting my own view on any topic that I choose, without differences with other views having to cause disagreement or strife.

The Interpersonal Action-Learning Cycle (IALC)

Derivation

Once I am aware of my own view in these terms, I can contemplate engaging in learningful conversation with another person. For simplicity, I will take that other person to be you, the reader.

Figure 4 shows what happens when I use the action-learning cycle to interact with you. The action-learning cycle on the left is my personal action-learning cycle from Figure 3. Its output—my awareness of my own view—then becomes the reference criterion for the action-learning cycle on the right, which is where I engage with you. The result is a form of double-loop learning which transforms my experience of you and myself in potentially competitive debate, into an experience of you and myself in learningful discussion.

In classic double-loop learning (Argyris & Schon, 1978), the question that is asked at the right-hand comparator is, ‘How are we doing?’ The deeper question that is asked at the left-hand comparator is, ‘What is it that we are doing in the first place?’ In the more general form of double-

loop learning shown here, the question that I ask at the right-hand comparator is, ‘How does your view compare with mine?’ The deeper question that I ask at the left-hand comparator is, ‘Can I imagine a way in which my needs will be met?’

The right-hand cycle is what is referred to in this chapter’s title as the interpersonal action-learning cycle (IALC) (Zimmer, 2004a). It is the cycle that I use to engage with you in learningful discussion. For ease of reference, Figure 5 shows this cycle by itself.

As Figure 5 shows, when I use the action-learning cycle to engage with you:

- My sensing becomes my attentive *listening* to you
- My checking becomes comparing your view step-by-step with mine—that is
 - What *you* notice and what you imagine about it
 - How *you* feel about that because of what you need
 - What *you* would like to do about it and to ask others to do which becomes my comprehending *acknowledgment* of your view.

Figure 4. My double-loop learning to engage in learningful discussion with you

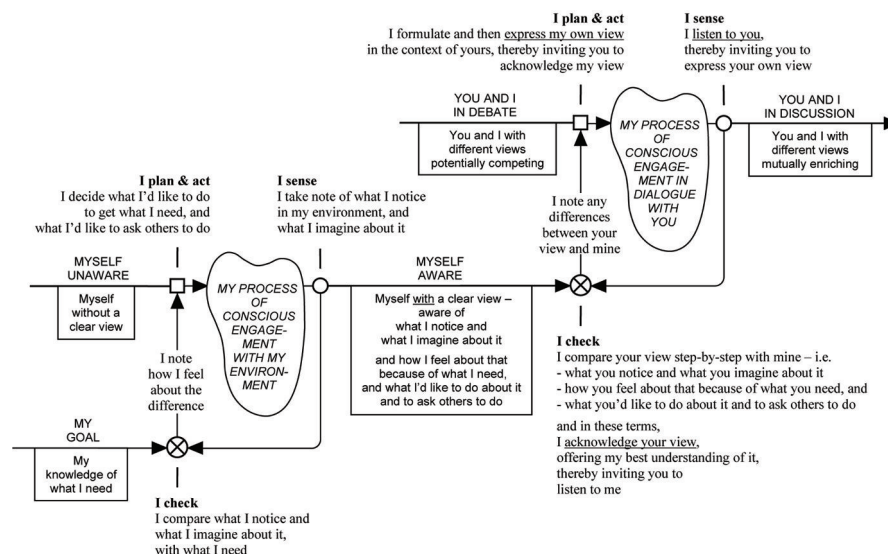
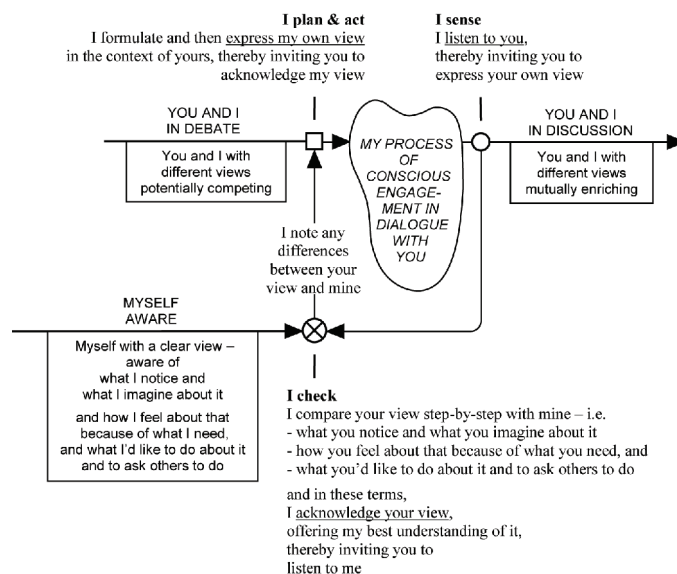


Figure 5. The interpersonal action-learning cycle (IALC)



- My planning and acting then become my thinking *expression* of my own view in the context of yours—that is:
 - What *I* notice and what I imagine about it
 - How *I* feel about that because of what I need
 - What *I* would like to do about it and to ask others to do

So these three components together can be summarized as offers of attentive listening, of comprehending acknowledgment, and of thinking self-expression.

You might recognize these three components of the IALC as essentially the three that Carl Rogers identified as the core of successful communication (Rogers, 1959, 1962). Their derivation here from the generic action-learning cycle specifies their operational sequence. An alternative derivation, from the principle of respect for autonomy, is also available (Zimmer, 2004a).

The third component of the IALC—thinking self-expression—represents a complete ‘I-statement’ (Zimmer, 2004b) made in ‘I-language’ (Gordon, 1970, 1974)—language that is used for

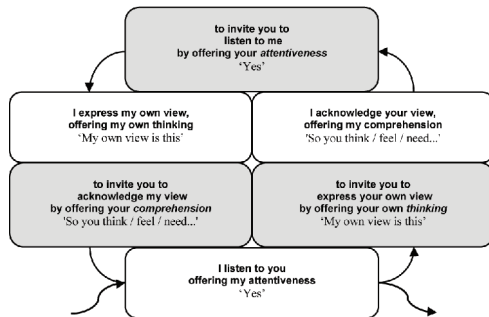
expressing one’s own view while leaving room for other views. An offer of the very similar second component—comprehending acknowledgment—is often referred to as ‘active listening’ (Gordon, 1970, 1974).

This means that in using the IALC, I am treating you as a sentient being like myself, so in systems terms I have to make sense of the ways in which you yourself make sense of things. This means that two layers of sense-making (Weick, 1996) are involved, so that I am operating at the level of second-order cybernetics (von Foerster, 1992; Zimmer, 2001) within social cybernetics (Geyer & van der Zouwen, 1998), also known as sociocybernetics (Geyer, 1995; Geyer & van der Zouwen, 2001). A discussion of orders of cybernetics is available in Umpleby (1997).

Dynamics

What I find most interesting about the IALC is that it invites itself in return, as Figure 5 shows, with the three appearances of the word ‘inviting.’ Figure 6 highlights this phenomenon, showing specifically how I can use the IALC to invite your reciprocal use of it.

Figure 6. How my use of the IALC invites your use of it



In more detail:

- I listen to you, offering my attentiveness, my essential response being a receptive ‘Yes’ to invite you to express your own view, that is, to offer your own thinking
- I acknowledge your view, offering my comprehension, my essential response being, ‘So you think / feel / need ...’ to invite you to listen to me, that is, to offer your attentiveness
- I express my own view in the context of yours, offering my own thinking, my essential response being, ‘My own view is this’ to invite you to acknowledge my view, that is, to offer your comprehension

I would emphasize that these essential responses are only schematics—many different wordings are possible, and sometimes they are conveyed by body language alone. That said, the essence of the conversation sounds like this:

Box 2.

My responses		Your responses
‘Yes’	►	‘My own view is this’
‘So you think / feel / need ...’	►	‘Yes’
‘My own view is this’	►	‘So you think / feel / need ...’
‘Yes’	...	...

In short, I offer my attentive, comprehending thinking to invite your thinking, attentive comprehension—which is where the title of this chapter comes from.

In so doing, I put my view literally alongside yours, as shown in Figure 6, for mutual enrichment of views and possibly for perception in depth. As Figure 5 shows, this transforms the two of us from yourself and myself in possibly competitive debate, into yourself and myself in potentially collaborative discussion.

In my view, this means that when two people use the IALC together, each does exactly what the other needs—that is, they do not get into a competition for dominance. So I see its use as a sufficient condition for collaborative discussion.

Equally, if I go backwards around the diagram in Figure 6, then once a conversation has got started:

- I cannot listen attentively to you unless I hear your comprehending acknowledgment of what I have already said. Otherwise whatever you are saying will be for me a *non sequitur*.
- I will not have said anything in the first place (i.e., I will not have offered my own thinking self-expression) unless I thought that you were listening attentively to me—which I do not think that you will have been doing...
- unless *you* felt comprehendingly acknowledged by me for what *you* already had said.

And so on.

In my view, this means that once a conversation has got started, use of the IALC is a necessary condition for collaborative discussion. Indeed, communication research has shown that the odds of understanding someone correctly without taking the IALC step of offering one’s comprehension for confirmation or correction are only 25% (Nolan, 1987).

So I conclude that use of the IALC is both necessary and sufficient, in order to have a collaborative discussion about any topic.

Implementation

If as a teacher I take responsibility for managing my use of the IALC, then it starts and ends with myself offering my attentive listening—as shown in Figure 6 by the start-finish arrows. This leaves you always free to continue the conversation by offering thinking self-expression of your own views, or to leave—whichever you choose.

This means that in using the IALC, I always go at least one and a third times around it:

- I offer my attentiveness to invite your own thinking
- I offer my comprehension to invite your attentiveness
- I offer my own thinking to invite your comprehension
- I again offer my attentiveness to invite your own thinking

A special case of this invitational process is the e-moderating skill known as ‘weaving’ (Feenberg, 1989), in which the second step of the cycle—offering my comprehension—is used to gather together the ideas and concerns of several participants, and the third step—offering my own thinking—then is used to ‘weave’ these together to raise new questions for discussion.

In general, I start by inviting your thinking, because I believe that learning is a sense-making activity—that is, that we cannot learn by having knowledge poured into us, but need to make sense of things for ourselves. This is the central tenet of constructivism (von Glasersfeld, 1995; Riegler, 2007)—not to be confused with social constructivism (Kukla, 2000). So starting in this way lets me invite not just your attentive comprehension, but your *thinking*, attentive comprehension. I believe that my teaching then will be more successful.

Equally, ending in this way lets me invite not just your attentive comprehension, but your attentive, comprehending, *own thinking*. This is where I get the benefit of your relevant creative thinking, if the course that I am offering is meant to encourage you in that.

This is not, however, necessarily easy to do. The next section describes ordinary behaviors that can stop the IALC in its tracks.

ISSUES: WHAT ROUTINELY DISRUPTS THE IALC

Offering attentive, comprehending thinking to invite thinking, attentive comprehension might seem like common sense. In my experience, however, it is anything but.

Dogma

In order to work, what the IALC needs most from the teacher is careful listening for the learner’s view, explicit presentation of the teacher’s view, and consistent awareness of the difference between the two. I find that this in turn requires a somewhat unusual use of language—namely, always speaking in such a way as to leave room for differing views.

I find that speaking in this way in the English language can require great skill. The English language at its simplest, presents any view as an objective report, which automatically casts any other view as fallacious. The preceding sentence is an example. I find that this phenomenon results easily in competition, among people claiming the rightness of their own view and the wrongness of all others. Soon they judge one another inferior, and then they start trying to dominate one another. I see the resulting competitive melee as the exact opposite of the thinking, attentive comprehension that the IALC invites.

For example, suppose that I say to you, ‘The cat sat on the mat.’ In so doing, I am claiming a

tremendous amount of authority. I am saying that I know what a cat is, I know what a mat is, and that there is no doubt whatsoever about what is what and what happened. I am leaving you no room whatsoever to have a different view—a view that could be equally valid. In particular, it might appear from where you are that the ‘mat’ is not a mat but a shadow on the ground. Who is to say?

A language like Aymara answers the question of, ‘Who says?’ within its very structure (Miracle & Yapita, 1981)—i.e. it is not possible to make a statement of ‘fact’ without also saying, in the very syntax of the statement, whose view that statement represents. But this is not so in English.

Even worse, in a noun-based language like English, I see no way in which a statement can be made about anything at all, without prior agreement between speaker and listener about what things are—for example, about what a cat is and what a mat is.

This problem is not inevitable. In Hopi, for example, there is a syntactic difference between the ‘unmanifest’ and the ‘manifest’ (Whorf, 1936; Todd, 2002; David, 2004), which makes it possible to build up a complete picture *before* projecting it onto the world ‘out there’ (Hussey, 1980). In my view, this kind of linguistic structure makes it much easier to put different views alongside each other, so as to have discussions rather than debates.

In other words, so far as I can see, the very structure of the English language encourages dogma—that is, telling other people what is what and thereby inviting approval or attack, instead of expressing one’s own views and inviting comprehension. If I were to engage in dogma, it would appear in Figure 7 in the lower half of the white box on the left.

Dogmatic Judgmentalism

It gets worse. Out of dogma can arise dogmatic judgmentalism—that is, praise or blame. This comes from the belief that since I am right about everything and therefore can tell you what is

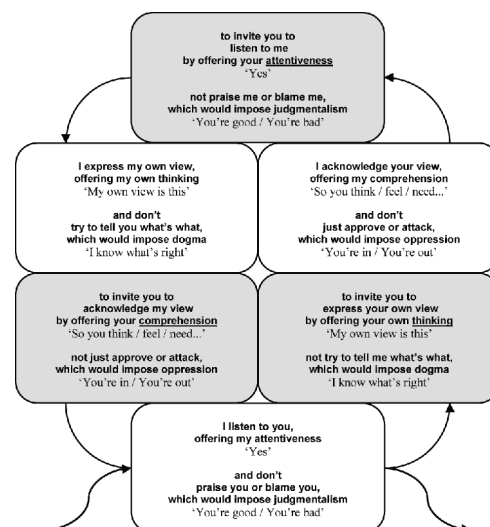
what, if you do not agree with me then I am the victim of your disrespect, and I can blame you for that. Equally, if you do agree with me, then I am the beneficiary of your respect, and I can praise you for that.

The problem that I see with this, is that both praise and blame are ways of passing judgment on you, thereby gaining an upper hand and putting you down.

For example, suppose that I am a scientist conducting an experiment, that my observations tell me that two events occurred at the same time, and that I declare this as fact. On the other hand, you—conducting a similar experiment—find that the same two events occurred at different times. As it happens, this is perfectly possible if you were in motion relative to me—it is an experimentally corroborated prediction from Einstein’s theory of relativity.

But suppose that neither you nor I know about this theory and that you attack my results—as shown in Figure 7 in the lower half of the grey box on the left. If I were to react by indulging in dogmatic judgmentalism—praise or blame—then I could end up blaming you as incompetent. After all, you would be contradicting what I ‘know’ to

Figure 7. What I try to avoid doing



be ‘true.’ Such behavior on my part is shown in the lower half of the white box at the bottom of the diagram.

Equally, suppose that either your experiment or mine is sufficiently sloppy so that our results appear to agree, and you then approve of my results—as shown in Figure 7 in the lower half of the grey box on the left. ‘Knowing’ that my results are ‘true,’ I then could end up praising you for your work—‘You are good at that’—a very ordinary occurrence. Such behavior on my part also is shown in Figure 7, in the lower half of the white box at the bottom of the diagram.

The trouble is, neither my praise nor my blame lets us explore what has been observed by each of us so that we can arrive at a shared understanding. Both my praise and my blame are opposites to my inviting your possibly differing view. Yet the noun-based structure of English makes it all too easy for me to indulge in them—that is, to depersonalize you and label you as something other than yourself, for example, ‘You are bad’ or ‘You are good’.

Dogmatic, Judgmental Oppression

Worse still, out of dogmatic judgmentalism can grow dogmatic, judgmental oppression. This comes from the belief—because of my presumed ‘knowledge’ of what is what and my consequent propensity to talk down to you with praise or blame—that I have the right to subject you to approval or attack. These are like praise and blame—except that rather than being for what you do, which is bad enough, they are for what I define you to be, which I consider worse. As Maturana has said, ‘If we believe that we have privileged access to knowledge of objective reality, then sooner or later our relationships become demands’ (Maturana, 1997).

For example, in the situation described, suppose that instead of you attacking my results, I attack yours—as shown in Figure 7 in the lower half of the white box on the right. There are

several ways in which I might do this, but the most common ways that I have seen, amount to inquisitorial accusation.

I find the inquisitorial part commonplace. It involves probing you, looking for weaknesses, demanding answers about all aspects of your work, and possibly of your character. The messages that I would be sending you are essentially, ‘Where did you get that idea?’ and, ‘What is wrong with you, anyway?’

I find the accusatory part even more commonplace. It involves reading negligence or malice into you for your disagreement with me—and perhaps even trying to punish you for what I myself have read into you. The essential messages that I would be sending you, answering my own bullying questions from the paragraph above, are, ‘You are careless. You are evil.’—followed by, ‘You are out.’ If done online, this amounts to ‘flaming’ (Kiesler & Sproull, 1992; Shea, 1994).

Equally, in the situation mentioned, suppose that instead of you approving of my results, it is I who approves of yours—again as shown in Figure 7 in the lower half of the white box on the right. Although approval might seem desirable, I see it as oppressive—that is, if I engage in it, then for me it amounts to my putting my imprimatur on a view of your own, that is, my taking possession of something that you have created, saying that it is valid only because I approve of it.

In other words, it is still oppression. The essential messages—representing full dogmatic, judgmental oppression—become, ‘I know what is right. You are good—well done. You are in.’ Yet I will wager that this sounds like a perfectly normal use of English.

As with judgmental praise and blame, and as with dogma before them, I see these oppressive behaviors—approval and attack—as being made possible by the noun-based structure of English, and its consequent ability to depersonalize you and to label you as something other than yourself, for example, ‘You are out’ or ‘You are in’.

In summary, I see dogmatic, judgmental oppression as the diametric opposite of a collaborative exchange of thinking, attentive comprehension. I also see it as the unfortunate norm rather than the exception. I attribute this phenomenon to the noun-based structure of many languages including English—and in my view, it can hide from people the very possibility of non-competitive communication as represented by the IALC.

In particular, I sometimes hear people claim that interpersonal learning takes place during competitive exchanges. From the analysis in the preceding section, in which I found use of the IALC to be not only sufficient but also necessary for collaborative discussion, it is clear to me that whenever interpersonal learning takes place it is entirely due to whatever vestiges of the IALC are present. That is, interpersonal learning takes place not because of any competition but in spite of it.

In other words, I see competition for dominance as wholly inhibitory toward the collaborative exchanges that make up interpersonal learning, as shown in Figure 6 and in the upper halves of the boxes in Figure 7.

As a result, I see development of techniques for restoring and stabilizing the IALC as being of paramount importance. The next section describes the techniques that I have found.

SOLUTIONS: HOW IN PRACTICE THE IALC CAN BE SUSTAINED

In finding ways to restore and stabilize the IALC, the constraint with which I have found it most difficult to work, is that use of the IALC never can be imposed. In my view, to attempt to impose it would amount to judgmental oppression and would violate the very principles on which it is based. I believe that any such attempt would lead, as with most impositions, to a competition for dominance—thereby destroying any chance of collaborative learning.

Therefore, so far as I can see, use of the IALC cannot even be initiated by appeals to ‘netiquette’ (Shea, 1994) or to an institutionally enforced code of conduct. Its use can only be modeled and invited.

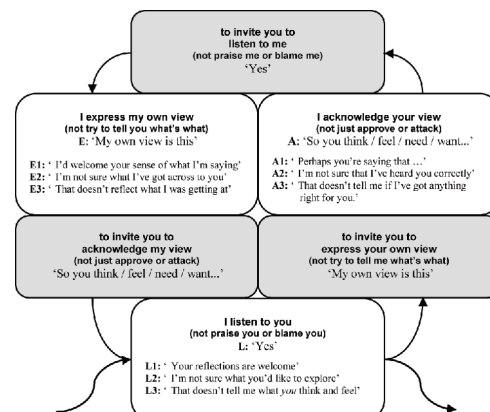
Within this constraint, however, I have found a number of techniques to be effective. This section describes them and gives examples.

Figure 8 shows the essential responses that these techniques embody. For each stage of the IALC—abbreviated as listening (L), acknowledging (A) and expressing (E)—four responses are offered. The first is the basic response of the stage, which can be used for stabilizing conversation. The remaining three are for responding, respectively, to:

- Silence (first-degree restoration)
- Ambiguity (second-degree restoration)
- Contradiction (third-degree restoration)

I would emphasize that, as the essential messages sent at each stage, these restoration responses also are only schematics. The wording shown for each is just one way of conveying its meaning. The specific wording used in any particular situation is likely to vary—or it might be conveyed by body language alone.

Figure 8. My actions to stabilize and restore my conversation with you



I also would emphasize that, especially for restoration responses, I do not always follow the steps of the cycle in strict order—sometimes iteration seems appropriate.

For the listening stage, the four responses are labeled in Figure 8 as L, L1, L2, and L3. For the acknowledging stage, they are labeled as A, A1, A2, and A3. For the expressing stage, they are labeled as E, E1, E2, and E3. All of the second-degree responses (L2, A2, E2) start schematically with, 'I'm not sure ...'. All of the third-degree responses (L3, A3, E3) start schematically with, 'That doesn't ...' and continue with an explicit description of the response being invited.

Following is more detail about each of these responses.

The Listening Responses

All of the listening responses invite the other person's thinking self-expression, which can be summarized as, 'My own view is this'.

Response L: 'Yes'

I use this response for ongoing stabilization of a conversation. As a starting point, it gives attention to the other person. As an ending point, it confirms the accuracy of the other person's comprehension—where the art of using it depends on finding things in the other person's comprehension that actually can be confirmed.

Response L1: 'Your reflections are welcome'

I use this restoration response when I hear simple silence in place of self-expression. It makes no demands, leaving the other person free to respond or not, as he or she chooses. In asynchronous communication, I use it as a standard ending/starting point for inviting further contributions.

Response L2: 'I'm not sure what you'd like to explore'

I use this restoration response when I hear apparent ambiguity about what the other person's purpose is. Given that the context is that of learning through discussion, a presumption is built into

this response that the other person's purpose is positive and has something to do with exploration.

Response L3: 'That doesn't tell me what you think and feel'

I use this restoration response when I hear outright dogmatism from the other person. It contains an explicit description of the kind of response that is being invited—that is, the other person's expression of his/her own view.

The Acknowledging Responses

All of the acknowledgment responses invite the other person's confirmation and attentive listening, which can be summarized as, 'Yes.'

Response A: 'So you think / feel / need / want ...'

I use this response for ongoing stabilization of a conversation. In my view, it is the most important response of all—the one that allows the other person to say, 'Yes,' whether or not his/her view and mine happen to differ. This is the response that allows me to put the other person's view alongside my own, so that collaborative discussion can take place.

Response A1: 'Perhaps you are saying that ...'

I use this restoration response when I have heard the other person as a bit cryptic but I think that I have got the gist. This response normally needs to be completed with some version of Response A.

Response A2: 'I'm not sure that I've heard you correctly'

I use this restoration response when I am not sure what the other person wants to do and why. It can be followed with Response A1.

Response A3: 'That doesn't tell me if I've got anything right for you.'

I use this restoration response when I hear outright judgmentalism from the other person. It contains, as with Response L3, an explicit description of the kind of response that is being invited. It embodies explicitly the philosophy that only the

speaker, not the listener, is in a position to judge whether he/she is being accurately understood.

I would make a note of caution here—I have found that the commonly used wording, ‘I hear you saying ...’ can be heard as patronizing, that is, as not leaving enough room for confirmation or correction. Instead, I use, ‘I hear you as saying ...’—or else I dispense with the ‘I’ altogether, as suggested in Response A.

The Expressing Responses

All of the expressing responses invite the other person’s comprehending acknowledgment, which can be summarized as, ‘So you think / feel / need / want ...’.

Response E: ‘My own view is this’

I use this response for ongoing stabilization of a conversation. This is the response that allows me to put my own view alongside the other person’s, so that both views can be combined for possible perception in depth.

Response E1: ‘I’d welcome your sense of what I’m saying’

I use this restoration response when I have said something that I care about, and have not received any response at all. In asynchronous communication—for example, in online conferencing—I sometimes also use it before inviting further reflections by means of L1, in order to try to ensure that the reflections will be about what I am actually trying to convey.

Response E2: ‘I’m not sure what I’ve got across to you’

I use this restoration response when I have said something that I care about, and the response that I receive does not sound to me like comprehension. If the other person has changed the subject to him/herself, then this response changes it back. If the other person has changed the topic of discussion, then this response changes it back. Yet it does not blame or otherwise judge the other person. It simply refuses to accept absence of acknowledgment.

Response E3: ‘That doesn’t reflect what I was getting at’

I use this restoration response when I hear outright oppression as coming from the other person. As with Response 2, if the other person has changed the subject to him/herself, then this response changes it back; if the other person has changed the topic of discussion, then this response changes it back; yet it does not blame or otherwise judge the other person—it simply refuses to accept absence of acknowledgment.

It also goes further. In describing the kind of response that is being invited, it treats apparent oppression as no worse than a failed but honest attempt at comprehension, and simply refuses any other possibility—on the grounds that it might well be an honest attempt, and that dialogue otherwise is impossible anyway.

Examples

I would emphasize again that these responses are only schematic forms—in actual use, many different wordings are possible. The following six example messages show this effect. Together they display all of the responses defined. They also show how several responses can be used in one message.

These examples are adapted from conference exchanges in which I have participated, within a course on systems practice—a kind of practice for which the ability to handle multiple perspectives is a key skill.

The six example messages are divided into four sections, as shown in Table 1. The first section contains Message 1, which demonstrates standard stabilization (the shaded columns in the table). This is an example in which I simply listen (L), acknowledge (A), express (E) to add my own view, and then listen again. Since the conferences are asynchronous and I cannot hear anyone’s responses immediately, the second listening is the kind that I use in response to silence—that is, first-degree (L1).

Table 1. Stabilization and restoration responses displayed by each message

		Stabilization / restoration responses											
		L	L1	L2	L3	A	A1	A2	A3	E	E1	E2	E3
Message number													
		Standard stabilization											
	1	x	x			x				x			
		Strong listening to invite thinking self-expression											
	2	x		x	x								
		Strong acknowledgment to invite attentive listening											
	3	x	x			x	x	x		x			
	4	x	x					x	x	x			
		Strong self-expression to invite comprehending acknowledgment											
	5	x	x			x					x	x	
	6	x	x			x				x	x		x

The second section contains Message 2, which embodies second- and third-degree attentive listening (L2, L3), in order to invite thinking self-expression very strongly.

The third section contains Messages 3-4, which embody first-, second-, and third-degree comprehending acknowledgment (A1, A2, A3), in order to invite attentive listening very strongly.

Finally, the fourth section contains Messages 5-6, which embody first-, second-, and third-degree thinking self-expression (E1, E2, E3), in order to invite comprehending acknowledgment very strongly.

Standard Stabilization

Message 1

L: *A participant is quoted as noting that ultimately he can see only from his own perspective, and another is quoted as wondering in response how people then can be expected to handle multiple perspectives.*

Hi S and S,

A: I hear you both as feeling stuck at an apparent contradiction.

E: I find a reconciliation of these two views in a simple but careful use of language:

A report of my own perspective can start with:
I see/hear...

A report of my grasp of *your* perspective can start with:

I see/hear *you* as saying...

In other words, my grasp of your perspective is nested within my own perspective.

Example:

I see the tree as moss-covered.

I hear *you* as seeing the tree as clear. (I am looking at the north side, you are looking at the south side...)

Example:

I perceive this animal as snake-like.

I hear *you* as perceiving this animal as tree-like. (I am perceiving the trunk of the elephant, you are perceiving a leg...)

L1: I hope this helps. Comments welcome.

Strong Listening to Invite Thinking Self-Expression

Message 2

L: *After I have used a Stephen Covey principle (1989) to suggest that all fights are about who gets to feel understood first, a participant is quoted as asking me what I think of this statement in view of Abraham Maslow's (1943) hierarchy of needs. This sets me up to teach rather than to help him learn, so I change the subject back to himself:*

Hi S,

L2: I can't tell from that, what it is that you'd like to explore.

L3: If you tell me what YOU think about those things, and where any puzzle about them arises for you, then perhaps I can tune in.

Strong Acknowledgment to Invite Attentive Listening

Message 3

L: *When criticism (not to be confused with critique) emerges in the conferencing, and I remind people that the conferences are for learning through discussion, a participant is quoted as dogmatizing that the conferences should be for learning through debate.*

Hi S,

A2: I'm not sure if you are agreeing with me here, or disagreeing.

A1: Perhaps you are saying that you see debate as essential for learning.

A: If so, ...

E: I would say the following.

I take care, as does the course, to distinguish between discussion and debate. In my lexicon, debate is something that is won or lost. It is in there with fights and games (Rapoport, 1960). It is for persuading people to agree. It is based on the idea that someone will be proved right about 'what is going on' or about 'what to do', and someone else will be proved wrong. Therefore I

see debate as antithetical to handling of multiple perspectives and therefore as antithetical to learning from other people.

In contrast, I see discussion as putting different views side by side and seeing how they might be combined—that is, as being for shared learning, not for persuading. This means that I see discussion as wholly compatible with handling of multiple perspectives.

So when I said that the conferences are for learning through discussion, I was being precise. I did not mean debate. I did mean discussion.

L1: I hope that this clarification is of help.

Message 4

L: *In the same context, a participant then is quoted as dogmatizing that feedback must be expected. This confuses feedback with criticism—a distinction that the course makes at length (Zimmer, 2004c).*

Hi S,

A2: I'm not sure what it is that you're countering here—I don't hear disagreement with what I was saying.

E: Reports of people's experiences of the course are very welcome. This means reports of what they've noticed, what they imagine about it, and how they feel about that because of what they need—and perhaps what they'd like to do about it and would like help to do.

That is feedback, as defined in the course—in short, what they liked, what they did not like, and what they would change. I find that feedback, unlike criticism, can be learned from and makes improvement possible.

A3: What I was referring to did not sound to me like feedback. I could find no information in it that could guide improvement—which involves saying what's been got right.

L1: I hope that you find this clarification of use.

Strong Self-Expression to Invite Comprehending Acknowledgment

Message 5

L: *A participant is quoted as owning to a personal hatred of consultants—and then is quoted suggesting in a later message that a reply from me to someone else sounded like a consultant speaking.*

Hi S,

A: From those responses,

E2: I can't tell what I've got across to you.

E1: I'd welcome your sense of what I was seeking to convey in each case—in particular, any way of putting it ...

L1: ... that you think you might have found easier to take in.

Message 6

L: *The same participant is quoted as saying that he believes that he understands—then shows that he does not. He characterizes the IALC as 'being civil' and 'touchy-feely' and suggests that it cannot be used when something really needs to be done.*

Hi S,

A: I have great sympathy with that position. I think that it often can seem that the more urgent things are, then the more control must be imposed and the more that people must be told what to do.

E: At the same time, it is my own experience that people's resistance tends to dissolve when they feel understood. This is certainly the case with myself. I also find that their resulting increased co-operation can save a lot of time.

So more and more, I try to remember to start if at all possible by offering my comprehension of their concerns.

E3: This strategy to me is not 'touchy-feely'.

E: It's a recognition of my own and other people's informational needs.

I think that people listen a lot more easily when they hear comprehension of their concerns. I also think that they understand more easily when they hear a personal perspective rather than something

purporting to be 'what is'. In addition, I think that they are more likely to give a personal perspective themselves than to try to tell people 'what is', when they feel safe because of good listening. And that is the whole IALC right there.

E3: So it's not really about being 'civil', as you suggest—

E: it's an information-processing thing.

E1: As usual, I'd welcome your sense of what I'm saying,

L1: and any reflections that you might have on it.

The last two lines above have come to represent for me what is most important about use of the IALC. It invites not just thought, but further thought—so that a learning dialogue can grow.

FUTURE TRENDS: IMPLICATIONS OF THE IALC FOR COURSE DESIGN AND ASSESSMENT

I believe that routine use of the IALC can have profound implications for teaching and instruction, collaborative learning, assessment, course evaluation, and professional development.

Teaching and Instruction

Most traditional teaching and instruction that I have seen consists of dogmatizing—that is, teachers apparently believing that they possess objective knowledge and believing that teaching consists of imparting this knowledge to course participants. From my point of view, this amounts to telling participants what to think.

I see this even in professional conferences. These often begin with 'keynote addresses' that effectively tell paying participants what to think about, instead of polling the participants to find out what they would most like to learn about in the context of the conference title.

Worse, as paying participants increasingly come to see themselves as consumers, it appears

to me that they expect to have knowledge delivered to them in this way. That is, they expect to be taught rather than helped to learn—an expectation reinforced by prevailing practice.

I believe that use of the IALC can reverse this trend. It begins with listening for desires instead of talking. And it ends with listening for feedback or further reflections. In so doing, it engenders collaborative learning.

For example, this chapter has been designed to do exactly that. It begins with listening, where the six questions that are asked invite the same thinking reflection that the chapter itself describes:

- What you notice and what you imagine about it
- How you feel about that because of what you need
- What you would like to do about it and to ask others to do

The chapter then describes what I think that your answers will have centered on, and only in that context does it then express what I myself think. Finally, in the Conclusion section, it will end by listening again—it will invite your reflections on what I have said and how I have said it.

Collaborative Learning

The IALC invites itself in return, so its use facilitates collaborative learning between teacher and course participants. In my experience, this engenders a sense of safety for participants.

I have found that when such a sense of safety has been established, mutually supportive learning can emerge (Zimmer & Alexander, 2000), and collaborative discussions then can take off in a very learningful way.

Such discussions often include challenge of ideas. Because the IALC puts support in before challenge (i.e., comprehending acknowledgment before thinking self-expression), personal safety is maintained.

All that I have ever known to stop this process is the tradition of competitive debate—that is, a win-lose situation develops in which people get dismissed along with their ideas. But I have also seen an antidote arise to this loss of collaboration, when course participants themselves understand the IALC well enough to use it consciously themselves. At this point, I find that a learning community can begin to emerge (Zimmer, Harris, & Muirhead, 2000).

If and when knowledge of the IALC—by whatever name—becomes widespread amongst course participants, then I predict that collaborative learning through discussion will become the norm.

Assessment

I know of two main kinds of assessment. The first is teacher-centered, in which the teacher wants to get something about a topic across. The assessment score then measures how well the teacher feels understood. Multiple-choice questions generally are suitable.

The second kind is participant-centered, in which the participant is given space to explore a topic and to put together a case about it. The assessment score then measures how well the participant presents his/her own thinking. Multiple-choice questions generally are *not* suitable.

In my experience, much of traditional assessment confuses these two. It is teacher-centered, in that the teacher wants to get something about a topic across and to be accurately understood about it. So whatever the topic might be, the teacher is the subject. But then the teacher acts as if the course participant were the subject, and turns the assessment score into a performance rating that bestows praise (or blame) on the participant, for the participant's acquisition (or not) of the teacher's knowledge.

So far as I can see, this is simply dogmatic judgmentalism and does not help either the teacher or the participant to learn.

Use of the IALC undoes this confusion, by always making clear who the subject is—teacher or participant—whatever the topic of conversation. In Figures 6-8, this distinction is represented in each diagram by the difference between the right-hand and left-hand sides.

This puts participant-centered and teacher-centered assessment alongside each other, showing that they are not in conflict with each other. If this realization spreads, I predict that participant-centered and teacher-centered assessment will be used increasingly to complement each other.

I see another benefit as well, in use of the IALC for assessment. It suggests low-maintenance versions of participant-centered assessment.

In particular, since participant-centered assessment is about how well the participant can present his/her own thinking, then in each participant's responses there always will be a personal aspect that is uniquely identifiable to a teacher who knows him/her—meaning that the assessment questions need not be changed from year to year.

So if and when knowledge of the IALC becomes widespread amongst teachers, I predict that the workload involved in assessment will decrease.

Course Evaluation

Traditional course evaluation, so far as I can see, suffers from the same confusion as does traditional assessment. The course participant is invited to lay judgments of praise or blame onto the course or the teacher—that is, 'Rate this course/teacher for...'.

I have never known such judgmentalism to provide information that a teacher can use to improve what he/she does.

In contrast, by maintaining clearly the distinction between what is about the teacher and what is about the participant, the IALC invites a report of the participant's experience of the course and its teaching—that is, what the participant liked, did not like, and would change.

In my experience, such feedback does provide information that the teacher can use to improve what he/she does.

So if and when knowledge of the IALC becomes widespread amongst teachers, I predict that the rate of improvement of course material and of teaching will increase.

Professional Development

My own experience of professional development for teachers has included being presented with vast quantities of material that amounted, metaphorically, to a lot of trees but no forest—that is, a lot of detail with no overall pattern.

I have found that to look at such mountains of material in terms of the IALC can be a great aid for making rapid sense of it all. It enables me to see rapidly what supports development of the learning dialogue and what does not.

So I predict that if and when knowledge of the IALC becomes widespread amongst teachers, professional development material will become considerably simplified.

CONCLUSION

I find that cultural and linguistic traditions often favor competition for dominance over mutual support. That is, they substitute dogmatic, judgmental oppression for thinking, attentive comprehension. In so doing, they can play havoc with collaborative learning, both online and face-to-face.

I also find that conscious use of the interpersonal action-learning cycle (IALC) offers a solution. This chapter shows how.

Further ideas about use of the IALC—including its use in this chapter itself—are invited.

FUTURE RESEARCH DIRECTIONS

Figure 9 summarizes the five areas of application of the IALC to instructional design that are discussed in the ‘Future Trends’ section. The areas of application are on the left and the effects are on the right. The arrows show the main directions of influence, as I see them.

Figure 10 shows five wider areas of application for future research that I also see. As in Figure 9, the areas of application are on the left, the effects

as I see them are on the right, and the arrows show the main directions of influence that I see.

General references for these wider areas of application appear in the ‘Additional Reading’ section.

In addition to these five wider areas of potential application, I see six main areas of systemic thinking in which the IALC itself has its roots. These are shown in Figure 11. As in Figures 9 and 10, the arrows show the main directions of influence that I see.

Figure 9. Instructional applications of the IALC, discussed in this chapter

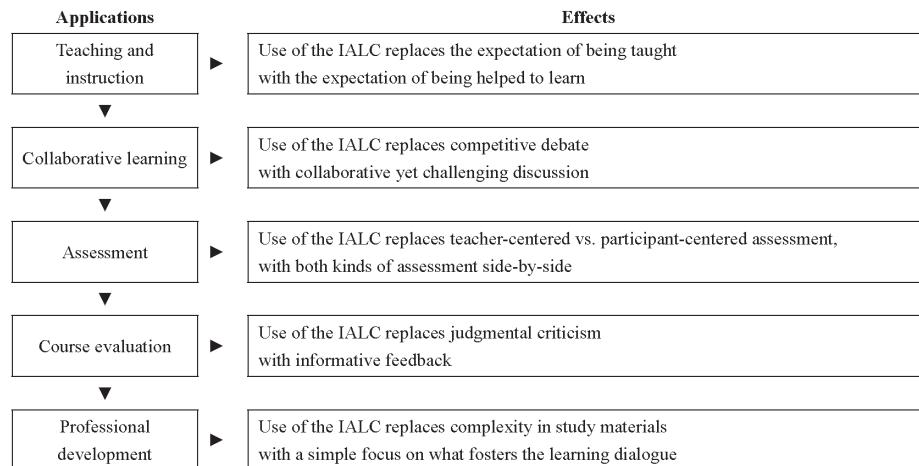


Figure 10. Wider areas of potential application of the IALC, for future research

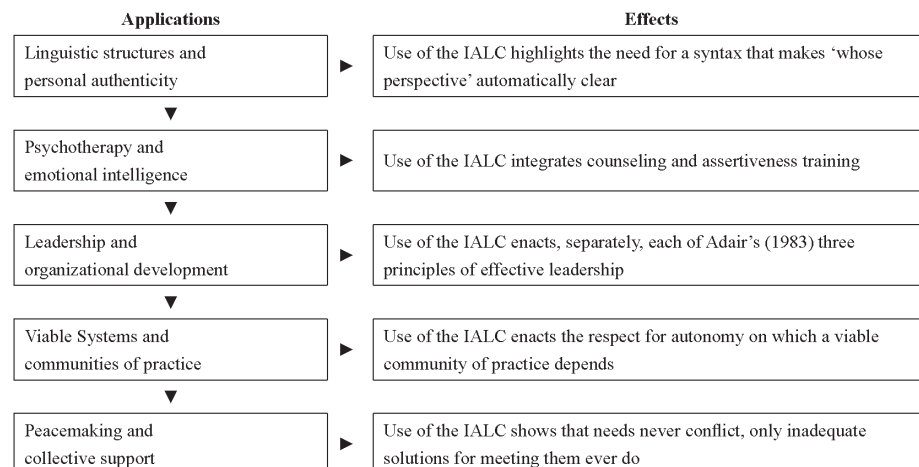
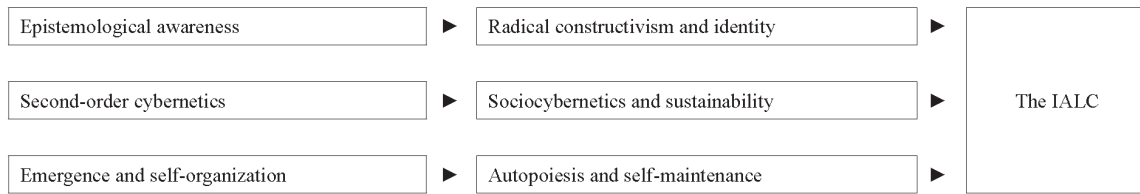


Figure 11. Areas of systemic thinking in which the IALC has its roots



Investigation of these roots can lead in principle to deeper versions of the IALC, with correspondingly wider domains of application.

General references for these roots also appear in the ‘Additional Reading’ section.

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Chapter 6.6

Synergy: Service Learning in Undergraduate Instructional Technology Courses

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ABSTRACT

Synergy describes a situation where the combined efforts are greater than individual parts. Service learning ties together academic content, in this case instructional technology, while providing service. This chapter offers an orientation to an exceptionally rewarding service learning activity in an instructional technology course. Based upon a case study and extensive literature review, this chapter provides best practices for fostering the synergy between service learning and instructional technology courses. This approach increased teacher candidates' exposure to diversity, served community needs, and facilitated candidate practice of skills from instructional technology class.

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INTRODUCTION

In instructional technology courses, teacher candidates are taught to use a variety of tools for instruction. Some instructional technology courses require field experience where pre-service teacher candidates observe and interact with in-service teachers and students in schools. A service learning model provides candidates with an opportunity to put the theory they are learning in the classroom into practice while serving the community. Service learning sites provide unique field opportunities for teacher candidates to work with diverse student populations. The resulting experience can be both rich and rewarding.

Service learning is an activity that meets identified community needs and connects course content with real life experiences. By exposing

instructional technology undergraduate teacher candidates to service learning, significant benefits are possible. Howard (1998) also indicated that academic service learning is a synergistic model where the students' experiences in community settings are just as valuable to the students' learning experience as any other element within the course. Citing a reciprocal relationship between service and learning, he posited that the service experiences of his students both "inform and transform the academic learning and the academic learning informs and transforms the service experience" (p.22). This chapter will explore the benefits of this approach to instructional technology courses through literature review and a case study.

This chapter will:

- Explain the synergistic relationship between instructional technology and service learning in undergraduate teacher preparation.
- Define service learning through both a historical and teacher preparation lens.
- Investigate stakeholder responsibilities and benefits of service learning.
- Detail a case study from a small, private, Midwestern university.
- Discuss best practices, documentation, and integration of experiences.
- Provide recommended readings.
- Establish an agenda for future research.

THE NECESSITY AND COMPLEXITY OF FIELD EXPERIENCES

The National Council for Accreditation of Teacher Education (NCATE) defines field experience as "A variety of early ongoing field-based opportunities in which candidates may observe, assist, tutor, instruct, and/or conduct research. Field experiences may occur in off-campus settings such as schools, community centers, or homeless shelters" (2008, p. 86). Field experiences are considered critical to

teacher preparation programs (McIntyre, Byrd, & Foxx, 1997). This experiential work provides an opportunity for teacher candidates to interact in an authentic instructional setting. Candidates teach, facilitate learning, and connect theory from classes to actual practice in their field placements. Such field experiences promote increased emotional involvement and intrinsic motivation for candidate success (Casey & Howson, 1993). By integrating field experience partnerships between K-12 schools and universities, positive results have been reported (Clark, Foster & Mantle-Bromley, 2005).

Although field experience has been a long-standing hallmark of teacher education, integrating field experience into educational technology was a relatively new concept just a decade ago. Many reports surfaced in the late 1990s indicating that a restructuring of technology preparation toward integrative models (theory and practice) was necessary in order to prepare teachers for the digital age (Larson & Clift, 1996). According to one report from Willis and Mehlinger, 1996:

Most pre-service teachers know very little about effective use of technology in education and leaders believe there is a pressing need to increase substantially the amount and quality of instruction teachers receive about technology... [T]he virtual universal conclusion is that teacher education, particularly pre-service, is not preparing educators to work in a technology-enriched classroom. (p. 978).

Field experiences integrating technology were recognized as solutions to the deficits in teacher technology skills (Brush, Igoe, Glazewski, Ku, & Smith, 2001). In a 1999 paper, Strudler and Wetzel detailed programs that provided pre-service teachers with technology experiences in the field prior to student teaching. In reaction to the reports and recommended solutions, models were developed that provided teacher candidates with authentic experiences focusing on effective use of instructional media (Dexter & Reidel, 2003;

National Council for the Accreditation of Teacher Education [NCATE], 2008).

More recently, teacher preparation programs began confronting another issue: preparing teacher candidates to teach in diverse settings. Public schools are becoming more diverse, while the teachers remain predominantly White, female, and middle-class (Swartz, 2003). There is a certain “cultural discontinuity” (Irvine, 2003) that may produce negative interactions and reinforce teacher candidate stereotypes. This cultural discontinuity creates a divide between the teachers and the students they are teaching. The literature indicates that teachers need to have more field experiences with diverse student populations in order to understand students and offer better instructional experiences (Graybill, 1997; Pransky & Bailey, 2002/2003). Research indicates that field experiences in culturally diverse urban settings encourage teacher candidates to teach in culturally responsive ways (Barnes, 2006; Gay, 2000).

MAKING THE CASE: A CASE STUDY ON INTEGRATING SERVICE LEARNING

In an effort to address the technology deficit, as well as the need for diverse experiences, a program was developed and implemented in the undergraduate teacher preparation program at a small, private, Midwestern university. Service learning is a general education requirement for all undergraduate students at this institution. Instructional Technology is a required core course for all teacher candidates.

Since fall 2006, every teacher candidate in Instructional Technology has been required to complete a minimum of ten hours of structured service learning field experience. This service learning field experience for instructional technology was piloted in three phases. In every phase, teacher candidates completed structured pre-service reflections, kept reflective logs, and

participated in service share sessions in class. Service shares will be discussed further in the case study narrative. These experiences tied the theory of instructional technology and pedagogy to the practice of working in a diverse setting with students via service learning.

There was a distinct lack of substantive research and literature on integrating service learning with instructional technology courses. In the literature review process, no research on this specific connection with undergraduate students was located. However, significant information on service learning was available. With a goal of investigating the synergy of service learning and instructional technology, the guiding question for this process was: “How can service learning be integrated effectively into undergraduate teacher preparation through instructional technology coursework?”

SERVICE LEARNING FUNDAMENTALS: A REVIEW OF THE LITERATURE

Prior to implementing the case study, a thorough investigation into service learning was completed. This included reviewing the history, definitions, concepts, models, and best practices of service learning. It was essential to have a clear understanding of this method in order to design an integrated service learning experience in educational technology. The following section highlights critical aspects of service learning pedagogy.

Establishing a Working Definition of Service Learning

The term service learning has infiltrated the vocabulary of most college campuses today. As a result of the desire to improve the scholarship of teaching and learning and to produce educated citizens who can think critically and solve problems, service learning programs and courses have developed and expanded over the last few

decades. But just what does the term service learning mean and how is it different from other forms of experiential education and service?

Many definitions and methods of service learning exist in the literature base from the field, but commonalities exist amongst them. For the purpose of this chapter, the NCATE definition will be used. Service learning is defined as:

A teaching/learning method that integrates community service into academic courses, using structured reflective thinking to enhance learning of course content. Through meaningful service, candidates are engaged in problem solving to create improved schools and communities while developing their academic skills, their sense of civic responsibility, and their understanding of social problems affecting children and families. When used as a pedagogical strategy, service learning can help candidates understand the culture, community, and families of students, as well as the connections between the school and the community (2008, p.91).

Service Learning Foundations

The term service learning first surfaced in the 1960s. During that time period, Robert Sigmon emerged as a leader within service learning and coined three principles that would serve as the foundation for future service learning work (Mintz & Hesser, 1996). Sigmon's (1979) principles were:

1. Those being served control the service(s) provided.
2. Those being served become better able to serve and be served by their own actions.
3. Those who serve also are learners and have significant control over what is expected to be learned (p. 10).

Sigmon's principles highlight the centrality of reciprocity, capacity building, and community-

defined need. Reciprocity exists due to the symbiotic relationship between the server and the served. As the expert on the community needs, the community should be the ones to define the 'what' and 'how' of the service. Additionally, the service is not meant to perpetuate the dependency on the servers, rather the service should help build capacity for the served to better help themselves (Council for the Advancement of Standards in Higher Education, 2006).

The 1980s were marked with increased growth in the national service movement as the Campus Outreach Opportunity League (1984) and Campus Compact (1985) were formed (National Service Learning Clearinghouse, n.d., History). With a desire to create high quality service programs and to aid in institutionalization of service learning, the National Society for Experiential Education (NSEE) collaborated with seventy organizations and the Johnson Foundation to convene a group at Wingspread (Mintz & Hesser, 1996). The result of this group was the *Principles of Good Practice for Combining Service and Learning*, or otherwise called the Wingspread Principles (Porter Honnet & Poulsen, 1989).

The group outlined the following principles for combining service and learning:

1. Engages people in responsible and challenging action for the common good.
2. Provides structured opportunities for people to reflect critically on their service experience.
3. Articulates clear service and learning goals for everyone involved.
4. Allows for those with needs to define those needs.
5. Clarifies the responsibilities of each person and organization involved.
6. Matches service providers and service needs through a process that recognizes changing circumstances.
7. Expects genuine, active, and sustained organizational commitment.

8. Includes training, supervision, monitoring, support, recognition, and evaluation to meet service and learning goals.
 9. Insures that the time commitment for service and learning is flexible, appropriate, and in the best interest of all involved.
 10. Is committed to program participation by and with diverse populations. (8)
9. Be prepared for variation in, and some loss of control with, student learning outcomes.
 10. Maximize the community responsibility orientation of the course (pp. 16-19).

Service Learning Stakeholders

When deciding to integrate service learning, faculty must consider whether service learning will enhance the course learning outcomes. Service learning, as a pedagogical tool, engages students in active learning and allows them to put theory into practice while serving others. The benefits, however, are not exclusive to the students or the community partner. Although there is additional work associated with creating service learning courses, faculty members can also benefit tremendously from the experience. Synthesizing the work of the Morgridge Center for Public Service at the University of Wisconsin – Madison (2008), Table 1 outlines the benefit of service learning for stakeholders: faculty, students, and community partner.

One of the most important components of making good service learning partnerships is effective communication amongst stakeholders. Each entity needs to understand the other stakeholders' needs, expectations, responsibilities, and roles. Faculty members have the pressure of teaching, scholarship, and service within the time context of a semester or quarter. Community partners have the focus of serving clients, staffing,

More than a decade after the Wingspread Principles were drafted, the rapid progression of service learning led to new pedagogical principles that built on the Wingspread Principles. Jeff Howard (2001), Editor of the Michigan Journal of Community Service Learning, outlined ten principles for service learning pedagogy. They are:

1. Academic credit is for learning, not for service.
2. Do not compromise academic rigor.
3. Establish learning objectives.
4. Establish criteria for the selection of service placements.
5. Provide educationally-sound learning strategies to harvest community learning and realize course learning objectives.
6. Prepare students for learning from the community.
7. Minimize the distinction between the students' community learning role and classroom learning role.
8. Rethink the faculty instructional role.

Table 1. Service learning stakeholder benefits

Faculty Benefits	Student Benefits	Community Benefits
Enhances teaching through organization's service learning experience	Provides an opportunity to apply course content	Supplements the human resources to meet the community needs
Strengthens relationships with students	Improves critical thinking	Raises awareness about the organization's mission needs, and population served
Broadens topics for research and publication	Gain valuable work experience	Provides the organization a connection to the community
Demonstrates commitment to university	Explore career interests	Identifies prospective employees and volunteers

funding needs, etc. within the unique timeline specific to the services they provide. Having a conversation prior to entering into a partnership will make the service learning more effective, smooth, and successful. Building off the work of the Council for the Advancement of Standards in Higher Education (2006), Cress, Collier, Reitenauer, and Associates (2005), and Howard (2001), Table 2 outlines each stakeholder's responsibilities.

While considering stakeholder responsibilities, addressing student rights is crucial for higher education institutions. Service learning takes place via the sphere of academics, but the classroom extends beyond the college campus, thus acquiring unique features. As a result, it is important to note that students have "rights" when it comes to service learning courses. Cress, Collier, Reitenauer, & Associates (2005) and Heffernan (2001) note that students have a right to:

- Know what is expected for the service learning and how it will be graded.
- Work with a community partner in a safe environment.
- Have the opportunity to apply knowledge for the benefit of others.

In order to have the most beneficial and educational service learning, it is important not to overlook safety; if the students don't feel safe, they won't be able to learn. Everything from

travel associated with the service to the actual physical environment of the service site needs to be discussed with students to aid in preparation. Some students arrive to college having experienced little exposure to diverse settings or economically depressed communities. While not all service learning takes place in these types of communities, environments in which students work with homeless, tutoring programs, and other social services do frequently have similar characteristics. Discussing what to expect; helping students reflect on their fears, expectations, and prejudices; as well as outlining safety procedures, will help prepare students to gain more from the experience.

PRINCIPLES OF GOOD PRACTICE

There are many aspects to consider when designing a service learning course. Fortunately, abundant resources and research are available to inform practice. To implement service learning into instructional technology courses, components like reflection, learning outcomes, and syllabi require attention.

Reflection

When incorporating service learning within a course, reflection is a critical component. Students will have new, eye-opening, and challenging ex-

Table 2. Service learning stakeholder responsibilities

Faculty Responsibility	Student Responsibility	Community Responsibility
Listen to community partner needs	Understand their role and function within the organization	Create an environment conducive to learning
Develop clear, strong, and course-specific learning objectives	Manage time effectively as to accomplish the goals and/or work	Orientate and train the students
Create meaningful reflection opportunities	Learn by engaging, discussing and reflecting	Serve as partner and co teacher
Know the skill level of the students and inform the community partner	"Do no harm"	Provide honest communication to the faculty member
Ensure academic rigor	Represent the college/university well	Understand the university timeline

periences via service learning; thus, it is important to help them process the experience as it relates to academics, career pursuits, and life. Through their service, students may be confronted with circumstances, behaviors, and human experiences that force them to re-examine previously held ideas or theories. Old frameworks for analyzing experiences may not suffice.

Eyler and Giles found that “the centrality of reflection to the academic enterprise had a significant impact on problem solving and critical thinking and on the complexity of students’ problem analysis and issue understanding” (1999, p.174). In a survey of 22,236 undergraduate students, Astin, Vogelgesang, Ikeda, and Yee (2000) found that class discussion, encouraged by the professor, was “the second most significant factor in a positive service learning experience” (p.iii). Similarly, Mabry found that while there was no difference between groups in her study with different frequency of out of class reflection, there was greater academic benefit for students who reflected at least weekly in class (1998). Some modes of reflection are: writing (journals, reflective papers, directed writings, case studies); activities (role playing, skits, interviewing peers); multimedia (photo or video essay, on-line discussions, wikis or blogs, poster boards); and telling (presentations, class discussions, meetings with faculty). Each of these modes offers a different way for the students to process and learn from their service learning experience.

Syllabus and Learning Outcomes

It is important not to overlook the power of the syllabus and learning outcomes when creating a service learning course. The syllabus is seen as the contract between the students and faculty member and serves to prepare students for the experience that will unfold over the semester. Additionally, students need to see the connection between the service learning and the academic course content or learning outcomes. Faculty can demonstrate

that connection via the course learning objectives and description of the service learning project.

The Council for the Advancement of Standards, in describing the role of the service learning syllabus, recommends that the following components be included in the syllabus:

- Needs that the service will address.
- Desired outcomes of the service and learning for all participants.
- Assignments that link service and academic content.
- Opportunities to reflect on one’s personal reactions to the service and learning experiences.
- Logistics (e.g., time required, transportation, materials required).
- Nature of the service work.
- Roles and responsibilities of students and community members.
- Risk management procedures.
- Evaluation of the service and learning experiences and assessment of the degree to which desired outcomes were achieved (2006, p. 305).

A CASE STUDY ON SPARKING SYNERGY: THE ROAD TO BEST PRACTICES

Based on the benefits of the service learning practices outlined above, three class sections of an initial teacher preparation course were selected to incorporate service learning. The average class size was 17; with two-thirds of the candidates being female and one-third male. Instructional Technology is generally the second course in education for the majority of students; the first course being a survey of school and society that requires several observation hours. None of the students had formal service learning experience at the university prior to taking this course.

The guiding research question was how to incorporate service learning effectively into

undergraduate instructional technology courses. Spanning four semesters, this case study illustrates three separate phases of implementation for all instructional technology students, detailing successes and challenges. The study takes place at a small, private Midwestern university. It is important to note that teacher candidates in this NCATE accredited program may pursue licensure in five different bands including Early Childhood (Pre-K through Grade 3), Middle Childhood (Grades 4-9), Adolescent to Young Adult (Grades 7-12), Multi-Age Physical Education, and Intervention Specialist (special education).

Phase One: Hi-Tech Environment

In fall 2007, undergraduate candidates in the teacher preparation program began their course with an innovative component—ten required hours of service learning. Prior to the semester, arrangements had been made with a local school district to place these candidates in classrooms and labs where they could tie the theory of instructional technology to practice. Placements were also aligned with their intended licensure bands.

According to the Ohio Department of Education (ODE) District Report Card for 2007-2008, the local school district selected for this phase consisted of 4,100 students (ODE, 2008). This school district's enrollment was 1,347 students at the high school, 1,025 students at the middle school, and 1,547 students at the seven elementary schools. The ratio of students to teachers was 17:1. Demographically, the district was 94% Caucasian, 2% Multiracial, 2% Asian, and 2% Black. The district reported 13% of the students had disabilities, and the overall attendance rate was 96%. Only 14% of the students in the district were economically disadvantaged. The district had recently received the second-highest recognition from the state, a designation of "Excellent." The expenditure per pupil was \$7,424. The school district was rich in technology, and all classrooms had at least one networked computer. Most classrooms had a data

projector, and each school had at least one Smart Board™ interactive whiteboard. There were multiple brand-new computing labs in each location.

Prior to the start of classes, the instructor met with the cooperating schools. The instructor and cooperating teachers discussed expectations, curriculum, learning goals/outcomes, and needs. Upon completion of that discussion, the course syllabus was created. Because service learning was integral to the course and a general education requirement at the university, teacher candidates would not be able to pass the course if the service component was not successfully completed. A service learning contract between the teacher candidates, site, and faculty member was implemented. Please note that in subsequent semesters, an additional liability waiver for travel was added, based on administrative policy.

Scheduling teacher candidates for service learning times was challenging. With several different schools comprising this district and each school having its own unique schedule, teacher candidates were challenged to balance service learning hours and their academic schedules. The university schedule for course times as well as academic calendar did not match any schedules at the partner schools. A system of creating sign-up sheets displaying time options was created to address schedule issues, although many candidates expressed stress and frustration because some schools were on block scheduling that conflicted with candidate coursework on campus.

Qualitative data was gathered to analyze candidate expectations and growth. Since service learning literature discussed the emphasis on reflections prior to their first site visit, candidates were asked to do a pre-service reflection. These reflections were brief open-ended essays covering candidate feelings, perceptions, and attitudes regarding service and technology. This first pre-service reflection format was unstructured. Due to the broad scope of responses, in subsequent semesters a more structured format of the pre-service reflection activity was implemented. The

goal was to improve focus and ensure that all teacher candidates addressed specific questions.

Pre-service reflection essays offered insight to inform class discussions, reading materials, and instructor intervention. The themes that emerged were that the candidates:

1. Did not see themselves as technology experts.
2. Had high comfort levels with certain technology applications (Facebook®, MySpace®, Microsoft Word®, PowerPoint®, Internet searches, music, etc.).
3. Felt their high school experiences did not include teachers modeling effective technology.
4. Expressed apprehension regarding interaction with students at the partner site.
5. Believed effective teachers made school fun, and technology was the answer.

As the semester unfolded, the emphasis on reflection continued. Teacher candidates completed a log of activities, accomplishments, epiphanies, or other notable occurrences throughout the service learning experience. The cooperating teacher verified participation and completed an evaluation of each candidate's work. Two of the teacher candidates did not complete their service hours which resulted in a failing grade.

At the conclusion of this service learning experience, teacher candidates wrote extensive reflections based on a departmental service rubric. For assessment of learning outcomes, a rubric was created by a task-force within the Division of Education to evaluate candidate reflections. The five criteria for the teacher candidate final reflection essays included:

1. What happened? (Objective statements without interpretation describing population, setting, demographics, and activities)
2. What was learned about the candidate's licensure area?

3. What are the candidate's reactions, feelings, impressions, and ideas? (An analysis of the experience)
4. What about the future? (Theoretical issues, content knowledge, dispositions that could apply to future teaching)
5. What two Specialized Professional Association (SPA) or State Teacher Standards could be applied to strengthen the service learning experience?

All candidates in the undergraduate instructional technology course were required to create a Microsoft PowerPoint® electronic portfolio that showcased their semester of coursework. A significant portion of this presentation required candidates to detail their experiences, growth, and learning as a result of this service component. This course generated interest from the broader campus community. Administrators and other faculty members attended student presentations to learn more about the synergy.

When the semester concluded, the instructor analyzed student reflections and comments. Each electronic portfolio presentation was reviewed, as well as any notes taken on verbal comments from the candidates' presentations. Five themes emerged. Participants in this service learning course:

1. Developed a sense of efficacy regarding the use of technology.
2. Observed effective use of technology.
3. Benefitted from working with students and technology in an authentic environment.
4. Appreciated exposure to new high-tech equipment (SMART Board™ interactive whiteboards, audience response systems, and specialized software).
5. Established bonds with the students they were tutoring.

In spring 2008, given the same placement, results were parallel. The instructor this time

handed out periodic service share worksheets to candidates for completion in class. Service share sessions were discussion/activity times set aside in specific class sessions where teacher candidates shared information on their experiences in service learning. Candidates completed forms consisting of open-ended questions about what was happening in their service work, how they were connecting class content to their service experience, and any challenges or successes. These worksheets were reviewed by the instructor. Closer attention was paid to each candidate's experience and follow-up calls or instructor visits were made to service sites to facilitate better cooperation and improve experiences. However, at the close of spring 2008, it was apparent that the challenges from fall 2007 remained.

Teacher candidate comments confirmed that appropriate placements were critical to success. Candidates who were matched with cooperating teachers excited and skilled with instructional technology had very positive experiences. The candidates assigned to cooperating teachers who were not confident in their ability to use technology were either given menial tasks (photocopying, lunchroom supervision/tutoring) or given too much responsibility (primary instructor for technology lessons). Additionally, many students jokingly remarked that the service site (school) had better technology than their own university campus. The instructor reviewed data. It was clear that the experience had benefits, but the design of the service component was not the right fit. Two questions arose:

1. How can negative experiences be avoided?
2. Are candidates providing true service in an environment already rich in resources?

After thorough discussion at the university, it was decided that a greater focus on service and diversity would be beneficial to the teacher candidates. Investigation for alternative placements began.

Phase Two: Shifting Focus - Service and Diversity

In fall 2008, the instructional technology course sections partnered with an after-school urban outreach enrichment program sponsored by the university and an urban church for K-4 youth. Candidates with licensure bands addressing early childhood, middle childhood, and intervention specialist participated in that program. Candidates with adolescent to young adult licensure bands assisted with an alternative high school program in the same building. This combination of service learning field placements made it possible for all licensure areas to be accommodated.

According to the Urban Outreach Report (Smith, 2009), the urban outreach site consisted of 32 students in regular attendance. The student to teacher ratio was approximately 5:1. Demographically, data indicated that 47% of the students were White, 34% Hispanic, 16% Black, and 3% did not disclose. Approximately 75% of the students served were economically disadvantaged. Although some students had disabilities, no data was gathered that semester on that topic. Over 90% of the students were at the early childhood licensure band level at this site (grades one through three). Regarding technology, this site offered seven older non-networked computers and 2 non-networked printers.

The adolescent to young adult licensure band service option was at a "last chance" high school in the same building. The mission of this school was to serve at-risk youth including drop-outs, near drop-outs, adjudicated youth or others with low achievement. This charter school did not meet any of the state requirements and was listed at the lowest designation, "academic emergency," on the state report card (ODE, 2008). The high school had approximately 88 students (J. Cole, personal communication, August 27, 2008). The ratio of students to teachers was 10:1. Demographically, the district was 46% Black, 42% Caucasian, and 12% Unspecified. The school reported 46% of the

students had disabilities. The attendance rate was 65%. At least 56% of the students in the district were economically disadvantaged (ODE, 2008). Regarding technology, most classrooms had at least one networked computer, and 2 classrooms had data projection.

In addition to the instructional technology course, several other university courses participated in the after school urban outreach initiative. The location of these facilities was in an economically disadvantaged area, candidate safety was a concern. To prepare the candidates for working with a more diverse population, a mandatory evening orientation session was scheduled and delivered prior to beginning the service hours; an asynchronous version was also available to candidates.

A few schedule concerns arose from the design of this service learning partnership. The enrichment program was an after-school program offered only on Tuesdays, Wednesdays, and Thursdays between the hours of 4:00 and 6:00 PM. Several candidates had evening or afternoon classes at those times. Others candidates were athletes or had employment/activity conflicts. With the program running over a 12 week period, many candidates reported stress based on scheduling issues.

Candidates signed service learning contracts and wrote pre-service reflection essays; however, the reflections were modified to include questions on diversity and poverty. Most answers about technology were parallel to previous semesters. However, the incorporation of diversity and poverty questions into this exercise yielded interesting data. Candidates:

1. Enjoyed community service and helping others.
2. Expressed concern about interactions with poor people.
3. Worried about how low socio-economic status impacted teaching and learning.
4. Lacked prior experience with racially and economically diverse populations.

Throughout the semester, candidates completed a log of their experiences, as well as answered periodic service share worksheets to inform the instructor of their activities and progress. These worksheets helped the instructor adjust lessons to more closely tie the service experience to the theory and objectives of the course. Additionally, based on comments from candidates' reflections, several readings on the culture of poverty were introduced and discussed in class.

Upon analysis of student reflections and comments at the end of the semester, the instructor saw some substantive growth with regard to diversity, empathy, and volunteerism. Seven core candidate observations emerged. The participants:

1. Reported that they felt they had made a difference in students' lives at the service sites.
2. Expressed interest in volunteering more.
3. Witnessed the effects of poverty.
4. Realized trust and respect had to be earned from the students.
5. Adapted activities to meet the needs of their diverse students.
6. Experienced a great deal about different cultures, economic status, and values.
7. Developed bonds with the students they served.

Some shortcomings did appear regarding the limited technology available. Although the initial project at the enrichment site was to set up and install a non-networked computer lab, some candidates raised concerns that there was not much connection to instructional technology thereafter. Additionally, some reported that they felt there were too many university service students for the number of youth participants. Candidates felt that they could not tie classroom theory to practice since there was a lack of opportunity for personal interaction with the partner students.

Upon analysis, the course instructor found the experience extremely rich and positive with respect to diversity, but the candidates' experi-

ences lacked a focus on instructional technology. Experiences under the previous structure (Phase 1) afforded candidates observation of cooperating teachers modeling effective technology use but lacked a true sense of service. Phase 2 offered candidates the opportunity to truly serve others in need, but lacked sufficient technology exposure. It was decided that an alternative site (Phase 3) would be sought to address both concerns.

Phase Three: Merging Service Learning, Diversity, and Instructional Technology

In spring 2009, the instructor and Director of Service Learning contacted a local non-profit organization that worked closely with an urban school district to implement after-school programs. At this location, 95% of the students attending the partner schools were below the poverty level. Further, 100% of the students participating in the non-profit organization's programs were below the poverty level (T. Bigler, personal communication, January 8, 2009). The non-profit also offered several support services (food, clothing, counseling, etc.).

The urban school district directly served by this non-profit consists of almost 11,000 students. Regarding enrollment, there were seventeen elementary schools with a total of 5,090 students, six middle schools totaling 2,528 students, and four high schools totaling 3,361 students. Nine of the schools in the district are listed as charter, alternative, or collaborative locations. The non-profit partner was specifically affiliated with a neighborhood area serving approximately 400 students. The student to teacher ratio was 19:1. Demographically, 54% of the students were Black, 24% White, 20% Multiracial, and 2% did not specify. The combined district reported 19% of the students had disabilities. The attendance rate was 95%. The district expenditure per pupil was \$9,916. The school received a mid-level designation of "Continuous Improvement" from

the state (ODE, 2008). Regarding technology in the non-profit center, there were multiple computers and printers in a networked lab, a digital music lab, library, large art/media classroom, and access to additional resources in the adjacent school building.

Collaboration between the non-profit Education Director and course instructor outlined expectations, needs, schedule options, and responsibilities for participants. Candidates were offered a sign-up sheet of various service times throughout the week between 10am and 5pm. This schedule addressed earlier concerns regarding candidate schedule conflicts mentioned in Phases 1 and 2. The Education Director delivered an orientation that prepared candidates for their work in an impoverished ethnically diverse neighborhood. The orientation included safety, rules, regulations, best practices, and other administrative issues.

Once again, candidates signed a service learning contract and liability waiver. They completed pre-service reflections, kept time logs, and participated in structured in-class service share sessions. Additionally, the final presentation and e-portfolio requirements were continued. Communication between the service partner and instructor was open and regular.

In spring 2009, candidates completed their service learning instructional technology experiences at the third site. Although some candidates felt that they had signed up for dates and times where there was not as much interaction with students, the overall response was very positive. Candidates reported that the activities they completed addressed both traditional and electronic media including:

1. Organizing and evaluating media (books, software, etc.).
2. Developing a cataloging system for media.
3. Tutoring on computers.
4. Working one-on-one with students to create mixed media projects.

5. Creating instructional and tutoring materials (bulletin boards, flashcards, PowerPoint® presentations).
6. Developing thematic units incorporating technology.
7. Supporting instruction with technology.

In previous semesters, service share activities were primarily written and insular. In this phase, four structured service share sessions were conducted verbally in class. Candidates began to build off of each other's experiences and openly discuss theory and practice connections collaboratively. The instructor used a variety of active learning methods to facilitate the reflections.. Active learning is defined by Bonwell and Eison as: "instructional activities involving students in doing things and thinking about what they are doing." (2001, p.2).

One example of active learning was an asynchronous discussion on SAKAI, an Internet-based open-source learning management system. An online discussion was conducted, focusing on "repurposing" equipment/materials as well as critically evaluating such materials. The instructor posted a question asking students to consider their service site and how they could "repurpose" or "re-use" existing equipment in innovative ways to bring media rich experiences to impoverished schools. Several candidates were able to locate and share that they could create a low-cost interactive whiteboard—much like the SMART Board™ interactive whiteboard used in the course, by using an infrared pen (\$8) and a Nintendo Wii™ remote (aka "WiiMote") (\$40). Candidates downloaded free software and tested their idea. Although instructional technology candidates commented that it was not as good as the classroom SMART Board™, they used research from the *WiiMote Project* (<http://www.wiimoteproject.org>) to successfully build and evaluate their own low-cost interactive whiteboard (Chung Lee, 2009).

The service opportunity in Phase 3 demonstrated the synergy between providing true service

and applying instructional technology content. Candidates openly discussed how to work with limited budgets but still bring rich technology options to their students. The candidates connected with the idea of technology being a tool, but recognized that not all schools would have the 'latest and greatest' equipment. Instead, they had learned to find innovative solutions to increase student learning with somewhat non-traditional technology tools.

In final presentations and reflections, candidates expressed high levels of satisfaction and growth as a result of this experience. Several commented that they had found projects that they planned to implement in their own classrooms. They also indicated that they had new appreciation for serving diverse learners. The majority of candidates felt they would continue to volunteer for the facility in the future.

At the conclusion of the semester, candidates' reflections and final presentations offered an interesting combination of the positive outcomes from previous semesters, as well as shed light on some new affordances. Overall, eight specific themes emerged. Candidates reported that they:

1. Saw great benefit from working with students and technology.
2. Developed bonds with the students they were tutoring.
3. Made a difference in students' lives at the service partner sites.
4. Expressed interest in volunteering more.
5. Witnessed the effects of poverty and expressed an increased understanding of the importance of education all children and creative ways of introducing technology.
6. Adapted activities with technology (traditional and electronic) to meet the needs of their diverse students.
7. Learned a great deal about different cultures, economic status, and values.
8. Developed bonds with students.

Beyond Phase Three

The instructor found the format of Phase Three to be the most effective. Plans are to continue to nurture the partnership with the local non-profit organization in order to improve services to all stakeholders. Course activities are being added in order to further strengthen the connections between service learning and instructional technology. Experience from the three phases has led to the continuation of best practices for this course--including pre-service reflections, verbal service shares, clearly stating expectations/outcomes, schedule flexibility, student diversity, and adequate technology. In the spirit of continuous improvement, evaluation will be ongoing.

Recent research offers a great deal of information on the implication of social justice as it ties into this service learning and instructional technology study. Currently social justice is not an explicit part of service learning at the university, though it is part of the underlying foundation. Unfortunately, it was not one of the specific main goals of the experience during the case study period. In the next phase, the instructor will focus more on social justice and its implications by incorporating additional readings and discussion points.

SOLUTIONS AND RECOMMENDATIONS

Based on the literature review and established best practices noted earlier, it is critical for the instructor to focus on the 'how' and 'why' of integrating service learning into instructional technology. At the same time, it is critical to ensure that the design of the service learning course will meet all stakeholder needs. Recommendations for those who wish to pursue service learning in instructional technology are:

- Incorporate meaningful pre-service reflections.

- Prepare students through orientations on the service site as well as safety.
- Select an appropriate site based on course learning objectives.
- Provide an opportunity and environment for meaningful direct service.
- Incorporate frequent and varied reflections with peers and faculty member.
- Maintain flexibility as service learning is not controlled by the instructor but discovered through the journey.
- State requirements and outcomes/objectives for service on the syllabus.
- Require all stakeholders to sign service contracts.
- Communicate effectively with all stakeholders and maintain a dialog.
- Evaluate and revise throughout the process.

FUTURE RESEARCH DIRECTIONS

This initial case study has yielded several agendas for future research topics addressing different stakeholder impacts. A series of potential research questions surfaced, spanning three domains: University Students, Community Partner Site, and Faculty. Although the entire list is not exhaustive, the researcher will work with the Director of Service Learning, community partner(s), and faculty to formulate additional research projects. The following list offers some emergent questions relating to each of the domains.

University Students

- What is the impact of service learning on university students regarding skills, knowledge, and implementation of instructional technology (quantitative and qualitative approaches)?
- How can candidates better understand poverty and its effects?

- Does the synthesis of service learning and instructional technology impact teacher candidates in their first year of practice?
- Does the service learning experience make candidates more comfortable in selecting diverse schools for their first year of practice?
- How does in-class discussion of service learning affect the experience for the service learning students?
- How many hours are optimal to achieve enhancement of course learning objectives via service learning?
- How do educators better prepare students to work in diverse educational environments?

Community Partner Site

- What are the academic, emotional, and social impacts of service learning on the constituents (students) from the community site through which the university students served?
- Are service projects able to meet a need identified by the community partner?
- How can the partnership be improved?
- What time commitment is sufficient to meet service partner needs?

Faculty

- What are the benefits for the faculty member teaching the service learning course?
- Is teaching and learning improved based on the service learning experience?
- Does the faculty member have a stronger relationship with the students?
- What are the incentives for teaching a service learning course?
- How can institutions of higher education better support service learning faculty?
- How can social justice be effectively integrated into an instructional technology course in a service learning format?

CONCLUSION

In conclusion, combining service learning with an undergraduate technology course requires a great deal of preparation and planning but yielded rich results. This chapter provided an overview of critical service learning information, review of current literature, and discussion of best practices. Combining service learning with instructional technology offers teacher candidates valuable experiences while tying the theory from the classroom to practical experience serving others. Effectively implementing service learning can meet the deficit previously found in field experience for instructional technology courses while preparing teacher candidates for diverse educational settings.

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Chapter 6.7

Knowledge Transfer in G2G Endeavors

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INTRODUCTION

Since the beginning of the 1980s, a movement was fomented by academics and executives to use information and communication technology (ICT) not only as a tool for processing data more rapidly, but also as a powerful strategic weapon. The need to use ICT as an enabler for reformulating old processes, rather than simply automating existing practices, was perceived by these academics and executives (see, for instance, Davenport & Short, 1990; Venkatraman, 1994).

As Internet technology became more readily available, the reformulation of productive processes in the public arena became a reality, leading all levels of government to strive for greater efficiency, efficacy and accountability in their relationship with their stakeholders, in what is named e-government.

Besides, the understanding of knowledge as a strategic weapon for a corporation is all but recent. In 1945, Frederick Hayek presented research about the use of knowledge in society. In 1962, in a seminal work, Fritz Machlup from Princeton University produced an eight-volume work under the general title, *Knowledge: Its Creation, Distribution, and Economic Significance*. In this work, it was concluded using 1958 data that 34.5 percent of the gross national product of the United States could be allocated to the information sector. In 1993, Peter Drucker analyzed a new knowledge economy and its consequences. Therefore, increasingly the importance of the intangible assets of a corporation, and even those of both countries and any other organizations—including non-profit entities—has been highlighted by academics, researchers and practitioners.

This article draws on the juncture of these two former main streams, namely e-government and the strategic role of knowledge for corpora-

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tions. It was elaborated in order to present the critical success factors that are able to explain the dynamics of knowledge transfer processes in government-to-government endeavors. In doing that, the article aims to explain how public administration can streamline their workflows, create more transparency between their agencies and deliver knowledge to civil servants more effectively and at reduced cost.

BACKGROUND

E-Government: An Idea Lacking a Clear Definition

E-government is still an exploratory knowledge field and it is consequently difficult to define it precisely. Moreover, it encompasses such a broad spectrum that it is difficult to find one expression that encapsulates accurately what e-government really represents.

According to Zweers and Planqué (2001, p. 92), one can say that:

E-government concerns providing or attainment of information, services or products through electronic means, by and from governmental agencies, at any given moment and place, offering an extra value for all participant parties.

On the other hand, Lenk and Traunmüller (2001, p. 64) choose to see e-government as a collection of four perspectives:

- **Citizen perspective:** Striving to offer public services to citizens;
- **Process perspective:** Seeking to rethink and redesign the *modus operandi* of current productive processes within public administration at its various levels, such as the bidding process to purchase products and services, namely e-procurement.

- **Cooperation perspective:** Aiming to integrate the many public agencies among themselves as well as with business and non-business organisations (NGOs), in order to streamline the decision process without prejudicing quality, as well as avoiding fragmentation, redundancies, and so forth, currently established in the relationships among these various players.
- **Knowledge management perspective:** Enabling the government, at all levels, to create, manage and make available the knowledge both developed and accumulated by its organisations in adequate databases.

Knowledge Transfer in Government-to-Government Initiatives

In the traditional governmental processes between two or more public agencies, it has recently been observed that efficiency, efficacy and effectiveness are substandard and costs are high (Joia, 2004). Faced with this situation one question arises: if private companies have discovered the enormous benefits that the Internet can generate for them through linkages among themselves, why don't public agencies use this technology and the integration it provides in order to become more responsive and at reduced cost? As public budgets have been challenged in many countries around the globe and society is increasingly calling for more accountable public administration, integrated electronic processes between public agencies via the Internet, known as government-to-government (G2G), can be the answer to this dilemma (Joia, 2004).

Government as a collection of public agencies, each of them having their own information and knowledge, needs to ensure that these agencies are linked such that they can share their knowledge. It can be said that government is (or should be) similar to a metabusiness—a quasi-firm, or virtual firm, created via digital links between several

companies—in such a way that it is almost impossible to define its precise boundaries (Keen, 1991).

THE KNOWLEDGE TRANSFER PROCESS IN G2G PROJECTS

In a G2G knowledge transfer process some critical success factors are involved. They are duly listed below.

Technological Infrastructure

In order to deploy a knowledge transfer undertaking, a solid technological infrastructure is needed. This endeavour is based on online linkage of knowledge repositories built on databases through inter-organisational systems (IOS). This linkage is built upon an extranet using either a private leased line or a VPN (virtual private network).

Inter-organisational systems (IOS) are typically defined as automated information systems shared by two or more organisations. The use of IOS thus involves networks that transcend organisation boundaries.

In the knowledge repositories, data, documents, videos, and so forth are all stored together. This poses a great challenge to public agencies, namely that of establishing compatible common technical interfaces to permit interoperability among the agencies. Several e-government interoperability frameworks have been developed, however no *de facto* standard framework has yet been developed. It can be claimed that XML (and its variants) has arisen as a standard for document exchange among public organisations, and the metadata concept has also begun to be applied to link different public agency databases (Augsten et al., 2004). By the same token, where knowledge is stored by the civil servants in their systems, standards like UDDI and SOAP have been used to deploy Web services among public organisations (Klischewski, 2004).

Furthermore, security features need to be adopted in order to grant restricted access to the system by the civil servants. Although risk is not the same as trust (Nissenbaum, 2001), trust building in a digital environment depends heavily on the perception of risk by the users (Jarvenpaa, 1997), in this case the civil servants. Hence, digital certificates in addition to access controlled by password need to be installed by the public agency, in order to reflect the privileged access designated for each user.

Installing an excess of security features usually results in a lack of flexibility in the IOS and user resistance to its use (see, for instance, Joia, 2004). So, there is a trade-off to be negotiated, that is, the inter-organisational system must be perceived as being both safe and flexible by its users.

Organisational Setting

According to Davenport and Prusak (1998), an adequate organisational setting is necessary to enable the transfer of knowledge. In this respect, Pinchot and Pinchot (1993) point out that the Weberian model adopted for use in public administration can hinder the transfer of knowledge. Facets of bureaucratic organisations that hamper the knowledge transfer process include: a hierarchical chain of command, specialisation by function, uniform policies covering rights and duties, standardised procedures for each job, and so forth. Further, wariness, a lack of trust and a non-flexible organisational structure and reward system are at odds with knowledge transfer in an organisation, leading civil servants to hoard their knowledge.

Therefore, the following measures need to be adopted in public organisations in order to promote the knowledge transfer process:

- Creation of set times and places for knowledge transfer
- Creation of a common ground based on mutual trust

- Development of evaluation performance on the basis of transfer and sharing of knowledge
- Encouragement of a non-hierarchical approach to knowledge, where the quality of ideas are considered more important than the status of the owner

An organisational culture oriented to knowledge transfer must therefore be instilled in public administration. As stated by Joia (2004), purely taking the technological facets of the specific enterprise into account in a G2G knowledge transfer project, that is, disregarding the internal culture of the public agency involved, can lead G2G project managers to fail to grasp the specifics of a given endeavour. Although the public realm is governed by the same set of laws, as it has to comply with the same administrative procedures, each public agency has its own identity and specific culture, with its own values, codes, symbols, and so forth. Consequently, preliminary painstaking analysis of the different cultures of the organisations involved in a G2G project is of paramount importance.

Training

Davenport and Prusak (1998, p. 97) stress the fact that knowledge transfer can only be achieved if there is similar common ground between the sender and the receiver. Moreover, the authors point out that lack of absorptive capacity in recipients can hamper the knowledge transfer process. By the same token, Szulanski (1996) points to ignorance, lack of absorptive capacity and lack of interaction as the major hurdles to knowledge transfer.

Glazer (1998) stresses the pressing need to establish a theory of knowledge equity, so as to manage the knowledge transfer process adequately.

Although a G2G knowledge transfer system is usually developed with a user-friendly interface and based on well-known technology, G2G processes demand a new *modus operandi* that most of the staff in public agencies are not acquainted

with. Therefore, training strategies related to the use of the system are also necessary, in order to communicate the benefits of this new workflow. Moreover, specific training events that allow greater interaction among public agencies lead to a better understanding of the system, not to mention the possibility of upgrading it with feedback from the trainees. These training sessions are also important for disseminating and sharing the knowledge associated with processes involving public agencies, so as to make it possible to develop and implement better practices.

FUTURE TRENDS

Naturally, the potential benefits accrued from the implementation and use of G2G knowledge transfer initiatives hinge on the basic presupposition that qualified and skilled public administration personnel are on hand to deal with this new *modus operandi*.

According to Araya Dujisin (2004, p. 28), it is not so much the challenge of having external specialists hired by government, but the need to envisage permanent training policies addressing the different knowledge fields embedded in e-government, as well as ensuring the integration between them.

On the other hand, it is necessary to understand that e-government is far more than mere technology (Lau, 2004, p. 243). According to Biasiotti and Nannucci (2004), a mix of several disciplines must be created, encompassing not only information and communication technology and administrative science, but also social, human and legal sciences, among others.

Several endeavors are underway to train civil servants in e-government (Biasiotti & Nannucci, 2004). However, the training models are very much centered on the content and duration of the courses (Lau, 2004), avoiding classification of the civil servants into specific training groups, according to the current hierarchy, so as to deliver

different skills to different actors within the public administration arena.

Consequently, it becomes clear that there is a pressing need to link all the aspects involved in e-government training efforts into a single integrated framework, so as to allow capacity-building endeavors to achieve the outcomes sought by policy-makers.

Fountain (2001) highlights the importance of training public managers in e-government. Joia (2005), for his part, emphasises the need to train not only the public managers but also the civil servants and the ICT personnel in public administration on e-government issues, so as to avoid failures in e-government endeavours.

CONCLUSION

Responsiveness to G2G knowledge transfer processes can be far greater than that obtained in traditional processes and such agility is, in itself, of paramount importance in deploying more effective and efficient public policies. Clearly these processes represent a valid new tool for public administration, which in many countries is facing the dilemma of cutting back its operational budget to ease control of governmental fiscal deficit and comply with citizen expectations with respect to public agencies.

As demonstrated above, G2G knowledge transfer processes are a form of inter-organisational network. According to Fountain (2001), despite the rationales and determinants of networks it has been seen that relatively few organisational networks have succeeded in the business realm. Assuming this to be the case, one can imagine the hurdles that need to be overcome to deploy an inter-organisational system within the public arena, where the structures of incentives, rewards and risks operate in accordance with the Weberian model.

Undoubtedly, the implementation of a G2G knowledge transfer endeavour must be conducted

by taking the possible sources of user resistance into consideration. Therefore, it is important to survey the precise context in which the system will be implemented, in order to comprehend fully how the system can be perceived as being valid by the users. Powell et al. (1996) state that the perceived usefulness of the network can foster a strong and fundamental interest in access to knowledge rather than simply resource sharing, or transaction cost reduction.

In line with this rationale, users must be given both instrumental and conceptual training in e-government and the inter-organisational system in order to take full advantage of the new workflow.

The security issue in a G2G knowledge transfer process is a critical factor, since any breach of security can be highly prejudicial not only to public agencies but also to society as a whole. Therefore, a healthy balance must be found, as excessive security and preoccupations with redundancy can cause the system to become too inflexible to harmonise with the processes and culture of a public agency.

Furthermore, to fail to take the organisational culture of a public agency into account by concentrating efforts solely on a technological facet of a G2G knowledge transfer project may cause the undertaking to fail. Despite the fact that public administration is ruled by the same legal agenda and must comply with similar procedures and rules, each public agency has its own identity, values and culture, leading it to develop different workflows, sometimes totally at odds with workflows addressing a similar process in another public agency. Analysis of the culture and values of a public agency is of paramount importance to ensure the success of a G2G knowledge transfer undertaking. It is also important to understand the division of labour as well as establish what the main characteristics of power and politics within a public agency are. If this is not comprehended and factored in, a clash between the IOS and the organisation might arise, leading the IOS to be swiftly abandoned by the users.

Finally, in order to take advantage of knowledge repositories in their organisations, public administration will have to tackle the challenge of creating a technical common ground among its public agencies. Most of the problems that have occurred in G2G projects to date arise from a lack of interoperability among the public agencies. If this is already a problem in the business realm, one can imagine the huge obstacles public administration will need to overcome in order to create this common ground, due to several different legacy systems deployed over the course of time in its organisations.

All in all, this is a very recent knowledge field, which is why a great deal more research is needed. This chapter attempts to make a contribution in this very challenging area, in the hope that the results achieved may be of benefit to society worldwide.

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KEY TERMS AND DEFINITIONS

E-Government: The various ways government uses information and communication

technologies to remain relevant in the knowledge society.

Government-to-Government (G2G): The digital-enabled collaboration and cooperation perspective among distinct government agencies.

Inter-Organisational Systems (IOS): Automated information systems shared by two or more organisations.

Knowledge Management: Techniques and tools for collecting, managing and disseminating knowledge within an organisation.

Metabusiness: A *quasi*-firm created through digital links among several companies, in such a way that it is almost impossible to know exactly its boundaries.

Metadata: Structured, encoded data that describe characteristics of information-bearing entities to aid in the identification, discovery, assessment, and management of the described entities.

SOAP: A protocol for exchanging XML-based messages over a computer network.

UDDI: An open industry initiative enabling businesses to publish service listings and discover each other and define how the services or software applications interact over the Internet.

Virtual Private Network (VPN): A private communications network usually used within a company, or by several different companies or organizations, to communicate over a public network.

XML: A recommended general-purpose markup language for creating special-purpose markup languages, capable of describing many different kinds of data.

Chapter 6.8

Policy Issues Regarding the Instructional and Educational Use of Videoconferencing

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ABSTRACT

The purpose of this chapter is to identify policy issues for videoconferencing at the elementary through college levels. As videoconferencing becomes a part of our educational landscape in schools across the country, it is important to understand what policy implications need to be addressed in regards to this educational resource. Issues such as ownership, content, and access are some of the areas that suggest policy discussion. Federal, state, and international policies that guide the use of videoconferencing will be discussed. In sum, this chapter attempts to investigate policy issues and trends related to videoconferencing that informs the educational (PreK-12), business (training), and academic (higher education) communities that use this resource.

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INTRODUCTION

The use of the Web/Internet in classrooms has quickly evolved from an occasional resource to a mainstay in education. The trend is clearly evident in New York State's mandate that all public schools be equipped with Internet access. It also can be argued that all major universities in the United States now use and rely on Web resources for many of their educational needs (Bruce, Dowd, Eastburn, & D'Arcy, 2005). Web and Internet resources have revitalized interest in distance education in that they provide a cost-effective and rapid way in which to deliver quality education to a broad spectrum of students. In this respect, online education is quickly becoming a central component of higher education; more colleges and universities are now offering courses using this resource (Lewis, Snow, Farris, & Levin, 1999).

The recent explosion of distance learning technologies clearly demands greater attention from educational researchers and policy-makers if we are to develop a complete understanding of the limitations and possibilities of this innovation. If distance learning is to be viewed as a new venue for learning, rather than as a technology or tool, it is important to examine the new and exciting possibilities made available by new communications and computing technologies.

These possibilities include advancements in videoconferencing that allow classrooms to obtain real-time answers to their questions, to have close-up views of marine life hundreds of miles away, to interview authors of their favorite books, and to exchange ideas for a project with students from another country. Unlike other distance learning tools that have been known to lack interpersonal instructional support crucial for reflective learning (Nobel, 1998), videoconferencing allows for face-to-face interactive experiences that are not possible with e-mail, chats, or threaded discussions. Furthermore, current Internet-based connections have given schools a much more cost-efficient method for establishing videoconferencing, while expanding the possibilities for intellectual growth. Schools are able to take advantage of their pre-existing Internet connections, rather than having to purchase and maintain an ISDN telephone line, which can be prohibitively expensive for schools.

As videoconferencing becomes a part of our educational landscape in schools across the country, it is important to understand what policy implications need to be addressed in the implementation of this educational resource. Issues of ownership, content, presentation, and access are some of the areas that suggest policy discussion. Questions arise such as: Are there federal and international policies that guide the use of videoconferencing? Are there state regulations and policies that focus on videoconferencing? What do school district administrators, board members, and teachers need to be aware of when they create videoconferencing environments? This chapter proposes to identify

policy issues of videoconferencing instruction at the Pre-K through college levels.

BACKGROUND

Before our discussion of policy implications, in regards to videoconferencing, it is important to describe what we mean by videoconferencing, what the origins of videoconferencing are, and the history of videoconferencing. The term “videoconferencing” can be traced back to two Latin words, “videre” which means “I see” and “confere” which means to “bring together.”

Videoconferencing, which is a collection of technologies that form the foundation for a wide variety of applications, can be defined as being an exchange of digitized video images and sounds between conference participants at two or more separate sites (Wilcox, 2000). Videoconferencing allows people at two or more locations to see and hear each other at the same time, using a compressed video system to transmit information from one location to another (Packard Bell, 1995).

In the 1930's, Bell Laboratories gave the first public demonstration of two-way videoconferencing, which involved picture and sound between locations in New York City (Montagna & Carlton, 1998; Wilcox, 2000). In the 1930's as well, Europe began experimenting with the technology, but due to World War II, the technology was not further developed for almost two decades. In 1964, Bell Laboratories introduced the first picture phone at the World's Fair in New York City. The first videoconferencing systems developed by Bell Laboratories failed in part because of poor picture quality and the lack of efficient video compression techniques. In 1970, videoconferencing capabilities were offered to consumers for the cost of \$160.00 a month, but the new innovation proved to be too costly for most consumers. Improvement of the technology needed to take place, along with affordability. This led other companies to improve upon the technology in the

1970's (Wilkerson, 2004). After many setbacks of videoconferencing, mainly due to the lack of quality in the technology, the medium finally arrived in the 1980's as a learning tool, particularly in medicine in the form of tele-lectures (Cannavina, Stokes, & Cannavina, 2004).

In general, videoconferencing has three distinct characteristics that separate it from other types of instruction: its capacity to reach large numbers of distant and dispersed learners, the ability for learners and presenters to interact, and its emphasis on the visual components of learning. In common practice, participants on either end need only a camera, a monitor, a microphone, and speakers, equipment to which most schools already have access. Additional requirements may include access to an information technology specialist to troubleshoot any problems that may occur. In addition to the organizational concerns of a normal classroom (such as the topic to be covered, instructional goals, and assessment), videoconferencing requires a specific amount of planning. For example, although it may seem obvious, it is important to schedule when and for how long the videoconference will be, a process that must be confirmed at both ends. If at all possible, test runs should be performed prior to use to ensure a connection, thereby limiting frustration and difficulties during the videoconference.

Overall, videoconferences can have a broad range of benefits. First of all, it is the closest thing to actually being there without leaving the classroom. Videoconferencing allows interaction to occur between students and instructors, and this enhances understanding not capable through e-mail, telephone, or online chats. Other noted benefits include heightened motivation, improved communication and presentation skills, increased connections to the outside world, and an increase in the depth of content knowledge. Clearly, videoconferencing provides a novel approach to instruction that excites students, thereby allowing them to form meaningful relationships with

others, while encouraging them to ask questions and demonstrate more depth of understanding.

Policy-Makers

As policy-makers define issues for videoconferencing and distance learning, it is essential that they understand the elements that are involved in this environment. A key element is the role of the teacher and the impact that they play on policy decisions. Policy-makers must understand the process, pedagogy, and classroom management expectations of teachers (in videoconferencing environments) to insure that they have the breadth of knowledge to make an informed policy decision. Board members will be asked to make decisions about technology, distance learning, or video distance learning, and base their conclusions on old and outdated concepts of instruction, teaching, learning, and integration of technology. Policy-makers must be reeducated to the new standards of teaching and learning in the technological classroom. Our goal in this discussion is to raise the concern and offer suggestions to policy-makers as they prepare to meet the challenge of policy determination for videoconferencing.

Teachers' Roles in Videoconferencing

Teachers also need to understand the person, the spirit of every child, and find a way to nurture that spirit. And they need the skills to construct and manage classroom activities effectively, communicate well, use technology, and reflect on their practice to learn from and improve it continually. The importance of powerful teaching is increasingly important in contemporary society. Standards for learning are now higher than they have ever been before, as citizens and workers need greater knowledge and skill to survive and succeed. Teachers need not only to be able to keep order and provide useful information to students, but also to be increasingly effective in enabling

a diverse group of students to learn ever more complex material (Darling-Hammond, 2006).

For teachers to reach these goals, we need to insure that policies are in place to support the appropriate deployment of videoconferencing in our schools, while recognizing that these policies are shaped at the local, state, national, and global level. The use of this rich media in classrooms is on the edge of a broad-based discussion of who creates, controls, and distributes the content. Educators would be mistaken not to understand the political forces and why it is important to participate in the dialogue on the policies that are being framed as this process evolves.

Policy Trends Facing Videoconferencing

Videoconferencing has been used in the educational arena since the mid 1980's (Smith, 2003). Because of the capabilities of this ever-expanding technology, some educational institutions have implemented policies that govern its use. Most K-12 schools, as well as colleges and universities, have developed policies that are not stand-alone policies, but have been included in computer technology use regulations or guidelines. The policies that most schools have adopted are generic. They usually include information such as: services offered; acceptable/unacceptable use; the person to contact for scheduling; hours of operation; available equipment; set up and technical support for the equipment; rates; terms of use; ramifications for violating the use of the technology; and responsibility of the user.

Specific information regarding videoconferencing policies can be garnered from policies such as the Child Internet Protection Act (CIPA), which was signed into law in 2000. This law required schools and libraries to operate "a technology protection measure with respect to any of its computers with Internet access that protects against access through such computers, visual depictions that are obscene, child pornography,

or any material that is harmful to minors," and that such a technology protection measure be employed "during any use of such computers by minors" (Wikipedia, 2006). CIPA requires filtering on computers that are used by minors. Because some videoconferencing systems use a broadband connection, it is important to make sure that videoconferencing systems are used for connectivity only and are not used for accessing the Internet (North Dakota State Government, 2005).

Whereas some policies specify use and tacit agreements among and between users, most regarding videoconferencing are merely informal agreements regarding the responsibility of those who use the technology (DeFord & Dimock, 2002). Policies are needed in many states and institutions that address the variety of legal and other responsibilities borne by states, regions, districts, and schools when offering videoconferencing opportunities to students. Because most educational institutions have generic and often limited information regarding the use of videoconferencing in the school setting, a national policy or template that schools can follow will be needed, which governs the use of videoconferencing in the educational setting. Additionally, most institutional policies were developed many years ago and need to be revised to reflect the changing conditions (United States Senate, 1999). Whereas videoconferencing is a technology, its uses are much more complex; hence, it requires stand-alone policies. Because this technology is being used in K-12 schools, and colleges and universities at an increasing rate, it is important to develop separate policies that will help to define how the technology is and should be used in the classroom setting.

In an attempt to facilitate this process, we have identified a group of current policy issues that must be addressed by developers, end users, teachers, college faculty, researchers, and content creators. These issues range from very personal concerns to international implications that will impact Internet visions and usage in the future.

In this section, we will move from the personal to the global issues that face videoconferencing.

Intellectual Property: Personal

The World Intellectual Property Organization (WIPO) defines intellectual property as the creations of the mind: inventions, literary and artistic works, and symbols, names, images, and designs used in commerce.

Intellectual property is divided into two categories: industrial property, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and copyrights, which includes literary and artistic works such as novels, poems, and plays, films, musical works, artistic works such as drawings, paintings, photographs, and sculptures, and architectural designs. Rights related to copyrights include those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programs (World Intellectual Property Organization, 2006)

Intellectual property and ownership of content material concerns are probably the main issues that must be addressed in developing content for videoconferencing. Issues of intellectual property and ownership will grow in importance, as teachers and educators create more content material with videoconferencing and other resources (Web sites, books, novels, video production, pod-casting, and lesson plans). When teachers create curricula, lesson plans, and content material for videoconferencing courses, workshops, or seminars, intellectual property and ownership have to be taken into consideration. Does a content developer have exclusive rights or ownership over the teacher's material? Does ownership have to be shared with the district, company, or other entities that owns, leases, or represents ownership of the videoconferencing equipment or network that the content is sent or delivered over? What type of contract has to be developed, and how long should it last? Can the developer take their content and use it

with another videoconference network, school, or business situation?

Many educational institutions have developed policies that were designed to recognize a faculty member's intellectual property rights in the courses that they develop and teach. But these institutions have not kept pace with the changing technologies or laws that govern their use. General terms of these agreements typically specify whether or not the university may continue to offer the course if the faculty member who wrote it no longer wishes to teach it, retires, or resigns; the agreement specifies how the net income resulting from sale or license of the course materials will be divided among the owners (United States Senate, 1999).

Copyright ownership is a very complex issue when it comes to videoconferencing and because of this, the educational community believes that a change in the law is required to optimize the quality and forms of distance education that take full advantage of today's technological capabilities (United States Senate, 1999). Discussions with videoconference service providers, schools, businesses, and colleges should be established to identify their policy on these issues. A written agreement that is satisfactory to all parties involved should be developed and signed. Individual knowledge of intellectual property and ownership protects an individual, an individual's work, and the time spent developing content material for videoconferencing.

Accountability: Building/Local Level

The teacher's role in the classroom, as technology is integrated into the classroom setting, is changing from the "sage on the stage" to a "guide on the side." This constructivist notion follows in the development of the "student-centered learning classroom environment" where the focus is on student learning. As the teacher in a videoconferencing classroom or environment starts to plan their instruction, there are many aspects

that have to be considered before actual course implementation can begin.

Teachers are expected to be “content-knowledgeable” and ready to provide information resources that support classroom instruction in their content area. But what content-level knowledge is needed to integrate videoconferencing? Is an information technology specialist degree required? It is suggested that teachers and/or instructors who teach in videoconferencing environments must be knowledgeable and comfortable with their subject area (English, math, science, history, and other content areas). A strong case can be made that teachers should be certified in the subject area that they are videoconferencing. Content material, lesson plans, Web sites, and resource material all exist on the Internet that can supplement and support classroom instruction. Many times, students can locate electronic or digital content quickly, but they do not have the skills to determine if the information is authentic. The teacher provides that support and instructs the student on how to evaluate the information that they gather from the Internet. The teacher must become a “facilitator of information” that can recommend, evaluate, and create content resources for students and other teachers.

Once content issues are defined, accountability concerns on the part of the instructors can be addressed. How do we address accountability concerns when implementing videoconferencing in the classroom? Numerous state education departments have established educational standards, by content areas, for their K-12 students and mandate that teachers incorporate these standards into their curriculum materials and lesson plans. As such, the performance indicators that are associated with each standard should also be integrated with videoconferencing activities to insure that the content supports student learning and achievement.

Educators also should consider student diversity, including ethnicity and gender, when developing curriculum or lesson plans for a

course. In an electronic videoconference environment, it can be a real challenge to get to know the history and culture of the students who may be in your courses. When using constructivist learning techniques, knowledge of your students is an important factor in the developmental process of supporting instruction of all students in your course. Requesting biographic information about students can assist in learning about the background of each student. Learning about a student’s culture also may provide information that will help in adapting course material.

E-Rate: National

The Telecommunications Act of 1996 required that elementary and secondary schools and libraries be offered discounted access to telecommunications for educational purposes (Federal Communications Commission, 1996).

The Schools and Libraries Program of the Universal Service Fund, commonly known as “E-Rate,” is administered by the Universal Service Administrative Company (USAC) under the direction of the Federal Communications Commission (FCC), and provides discounts to assist most schools and libraries in the United States to obtain affordable telecommunications and Internet access. It is one of four support programs funded through a universal service fee charged to companies that provide interstate and/or international telecommunications services (Federal Communications Commission, 2004).

The Schools and Libraries Program supports connectivity, the conduit or pipeline for communications using telecommunications services and/or the Internet. Funding is requested under four categories of service: telecommunications services, Internet access, internal connections, and basic maintenance of internal connections. Discounts for support depend on the level of poverty and the urban/rural status of the population which is served, and range from 20% to 90% of the costs of eligible services. Eligible schools, school

districts, and libraries may apply individually or as part of a consortium. Each year funding is capped at \$2.25 billion and unused fund balances can be rolled over to the following years. Annual requests for E-rate funding far exceed the monies available (Federal Communications Commission, 2004; Federal Legislation and Education in New York State, 2006).

The FCC, in 2004, determined that the E-rate program should be subject to the Anti-Deficiency Act. The Anti-Deficiency Act prohibits committing funds not actually accrued, so E-rate could not make funding commitments to school districts and libraries for the upcoming fiscal year. Late in 2005, Congress temporarily exempted E-rate from the Anti-Deficiency Act until December 31, 2007. Without continued, uninterrupted E-rate funding, schools and libraries, especially in rural and low-income areas, would not be able to install the technology that students, educators, and library users need to access critical information. Without this exemption, the program could once again be unnecessarily disrupted, causing schools and libraries to delay or eliminate education technology needs (The New York State Education Department, 2006). As educators who utilize these funds to support our work in videoconferencing, we must contact district and legislative officials and share our concerns about E-rate.

Universal Service: National

In the Communications Act of 1934, Congress established a national policy of universal service that went beyond merely laying the wires and infrastructure to connect each to all. It included a commitment to making service economically accessible to all Americans.

The Federal Communications Commission (FCC) was created at this time for the purpose of regulating interstate and foreign commerce in communication by wire and radio, so as to make available, so far as possible, to all of the people of the United States, a rapid, efficient, nationwide,

and worldwide wire and radio communications service with adequate facilities at reasonable charges (Thomson/West, 1997). Today, Congress has not only reaffirmed the central importance of universal service in telecommunications, but it has vastly expanded the concept.

Section 254 of the Telecommunications Act of 1996 significantly expands the concept of universal service (Federal Communications Commission, 1996):

1. The FCC is charged with assuring that all rates for universal service are just, reasonable, and affordable, not just the rates for interstate services.
2. The word “affordable” had not been used before this legislation, but the 1996 Act introduces the concept of affordability directly and explicitly into national policy.
3. The 1996 Act expands the services to which the universal service concept applies and institutes a formal process for expanding the definition of universal service over time.
4. Although access to the network for high-cost areas and low-income consumers has been supported for years, the 1996 Act explicitly requires this policy and requires that it be implemented with specific and predictable mechanisms, in the form of contributions from all providers of telecommunications services, to support universal service.
5. A whole new range of institutions has been identified as having a role in universal service policy.
6. Section 255 also adds a commitment to consumers with disabilities.

Cooper (1996) and Mueller (1993) provided the resources for this section, and their work supports the importance of this area. This is important because of the focus on the “last mile” of connectivity, where the homes of the users are reached. We are requesting a move from telephone access and service to the provision of broadband

services to the communities that need services. Regular telephone service that is supported by universal service at this time does not support the new forms of information (digital text, digital audio, digital images, videoconferencing, and interactive video) that is being passed across the present networks and telecommunications infrastructure. Universal service must keep pace with the information resources that are provided to all people presently in the United States and around the world. Currently, universal service continues the digital divide by not providing broadband capability to all users.

Cyber Security: International

We must determine how videoconferencing will impact national issues of cyber security. Are our networks secure, and do we provide information that may put our nation and end users (students and teachers) at risk? How do we protect our K-12 population and teachers from growing concerns about child pornography, identity theft, and plagiarism? The potential uses of videoconferencing can offer other opportunities where cyber security issues become equally important. These issues include: the use of e-mail and instant messaging to communicate off-line when courses or seminars are not in session, and using Web resources (e.g., Web sites, Web quests, wikis, and blogs) to support instruction. The point here is that as content developers use videoconferencing resources, we have to address cyber security issues because we are using one of the most powerful education media tools: interactive television.

Two legislative acts, the Deleting Online Predators Act (DOPA) and the SAFER NET Act have been introduced in the U.S. House of Representatives in 2007.

Deleting the Online Predators Act of 2/16/07 amends the Communications Act of 1934 to require schools and libraries that receive universal service support to enforce a policy that:

- Prohibits access to a commercial social networking website or chat room unless used for an educational purpose with adult supervision
- Protects against access to visual depictions that are obscene, child pornography, or harmful to minors
- Allows an administrator, supervisor, or other authorized person to disable such a technology protection measure during use by an adult, or by minors with adult supervision, to enable access for educational purposes
- Directs the Federal Communications Commission (FCC) to issue a consumer alert regarding the use of the Internet by child predators and potential dangers to children because of such use, including the potential dangers of commercial social networking websites and chat rooms
- Establishes a website resource of information for parents, teachers, school administrators, and others regarding potential dangers posed by the use of the Internet by children.

There is no companion Senate bill at the present time. (Representative Kirk Mark Stevens, [IL-10] 2007).

The Safeguarding America's Families by Enhancing and Reorganizing New and Efficient Technologies Act of 2/13/07 (SAFER NET) requires the Federal Trade Commission (FTC) to establish an office of Internet safety and public awareness, headed by a director. The office will carry out a nationwide program to increase public awareness and education regarding Internet safety, that utilizes existing resources and efforts of all levels of government and other appropriate entities and that includes:

- Evaluating and improving the efficiency of Internet safety efforts provided by such entities

- Identifying and promoting best practices
- Establishing and carrying out a national outreach and education campaign
- Serving as the primary contact in the federal government and as a national clearing-house for Internet safety information
- Facilitating access to, and the exchange of, such information
- Providing expert advice to the FTC
- Providing technical, financial, and other appropriate assistance to such entities

There is no companion bill in the Senate (Representative Melissa L. Bean, [IL-8] 2007).

Reauthorization of the Telecommunications Act of 1996

Our greatest concern at this point is net neutrality. Ben Worthen's (2006) article, *The Net Neutrality Debate: You Pay, You Play?*, provides an excellent backdrop for this discussion. Worthen (2006) provides a scenario and definition that informs the reader about this situation:

Last April, Cisco Systems published a white paper explaining how the companies that own the phone lines and cables that connect homes and businesses to the Internet, the proverbial last mile, could use new routing technology to boost revenue. The technology would allow telephone and cable companies to establish priority lanes for high-bandwidth traffic like video, games, or voice-over-IP (VoIP) calls and then charge the Googles, Yahoos, and Amazons of the world for access to these highway toll roads. Cisco's paper predicted that this new strategy would allow broadband service providers to create new revenue-sharing business models with any company that sells content online. The plan had only one problem: It was illegal.

Worthen continues the discussion by providing background and definition about net neutrality. He

states that the telecommunications laws that have governed the Internet since its inception require network owners to treat all traffic the same. The laws date back to the 1930's, and were put in place to force telephone companies to prevent a scenario where one company could refuse to carry calls placed by a rival's customer. The Internet was designed with the same principle in mind. Routers are programmed to direct each packet of data on a best-effort basis, regardless of file type, video, voice, e-mail, or who the sender and recipient are. The bill was not finalized in the summer of 2006 and is still under review and discussion in both houses of the United States Congress.

Since then, a Supreme Court ruling and a series of Federal Communications Commission (FCC) decisions have eliminated this barrier, prompting Congress to rewrite the nation's telecommunications laws. The result is that the entire Internet is now essentially outside the law. The new bill, which could be finalized as early as the summer of 2006, will in all likelihood officially eliminate net neutrality as the legal principle that governs the Internet. "If net neutrality goes away, it will fundamentally change everything about the Internet," says James Hilton, associate provost for Academic IT Works of the University of Michigan. More bluntly, Steve Effros, former president of the Cable Television Association, says, "This is about who pays." Worthen (2006) observes, "the competition that emerged in the telecommunications industry is between cable and telephone companies, and the service they are vying to provide is not just phone, but high-speed Internet access and television as well—the so-called triple play." This is the most serious event and challenge that we as educators, content providers, and end users are facing today, and will have a direct impact on how our educational information will be used in the future. In the past, our videoconference information was available to everyone who had access to the equipment and enough bandwidth to receive the conference. The potential exists that the telephone and cable companies will regulate

the freedom of access that we currently have and the amount that we will pay to use their networks.

REAUTHORIZATION OF THE NO CHILD LEFT BEHIND ACT OF 2001 (NCLB)

The No Child Left Behind Act of 2001 is being reauthorized and the Achievement through Technology and Innovation (ATTAIN) Act was introduced by a group of bipartisan legislators in the U.S. House of Representatives on May 23, 2007. The ATTAIN Act is designed to make improvements to the Enhancing Education through Technology (EETT) (Title II-D) program. The ATTAIN Act focuses on priority funding for schools in need of improvement, state assessment of technology literacy of students by eighth grade, systemic reform programs with strong technology components, and professional development (Roybal-Allard, 2007). The Act has the support of several education organizations including: Consortium for School Networking (CoSN), International Society for Technology in Education (ITE), State Educational Technology Directors Association (SETDA), National Education Association (NEA), National School Boards Association, American Association of School Administrators, and the Nation Council of La Raza (Jones, 2007). There is hope that similar legislation will be sent to the Senate in the near future. Advocates for the ATTAIN Act are working diligently to have this Act included in the larger NCLB reauthorization bill the House Education and Labor Committee will present later. Overall reauthorization of NCLB is not clear at this time.

FUTURE TRENDS

Videoconferencing has recently gained much wider acceptance as an instructional tool in the academic community (Fels & Weiss, 2001).

Because of its increased use for instruction in the classroom setting, the ways in which to use this technology is increasing as well. The world of videoconferencing is continuously changing everyday to reflect the ever-changing educational landscape in the United States schools, colleges, and universities.

One reason for the change in educational institutions is the increase of students in classrooms, specifically in schools that serve students in grades 9-12. It is expected by 2009 that the United States will graduate its largest high school class, and college enrollment will increase by 16 percent over the next ten years as well (Howell et al., 2003). As the enrollment of students in high schools and colleges expands, the need for video conferencing will increase. As the size of enrollment changes in colleges and universities, the needs of students will change as well. Students today are seeking educational institutions that meet their needs in regards to schedules and circumstances. Videoconferencing and distance learning are helping to meet the needs of those students who need flexibility when it comes to receiving an education.

The future uses of videoconferencing in the educational setting are many. For example, videoconferencing today in the educational arena involves the educator delivering a lecture or presentation to an audience. Videoconferencing in the future will become a full interactive experience, where the audience can play a role in the discussion, be seen, heard, and even share their own documents (Good, 2003). As such, visual and audio cues will help the instructor and students with developing a rapport (Galloway, Boland, & Benesova, 2002).

Furthermore, educational organizations and institutions can, and commonly do, limit access of materials to students enrolled in a particular class or institution. Additional technology and software will be required to address the multitude of intellectual property, ownership, and copyright concerns. The most effective means now available are secure container/proprietary viewer technolo-

gies that allow copyright owners to set rules for the use of their works, which are then attached to all digital copies, and prevent anyone from making a copy that is not in accordance with the rules. For example, students could be allowed to view the work or print a single copy, but not save it to disk or distribute it to others electronically. Streaming formats also will be used because they do not facilitate the making of copies as does the use of low-resolution digital copies (United States Senate, 1999).

The tools for videoconferencing will change as well in the future. Videoconferencing will no longer be stand-alone tools. A person will be able to go to a computer, select who to invite to a meeting, and then start a meeting. There will not be a need to upload materials ahead of time or convert them. Loading the materials onto your screen and sharing them with one click will be all that is needed (Good, 2003).

Another way in which this technology will be used in the future is to support students who will not be able to attend school. For example, students who may be in the hospital for an extended period of time or home convalescing from an illness will be able to participate in a lesson at their school from the hospital or their home. This will enable the student to keep their schoolwork current and not fall behind in their studies (Arnold, Cayley, & Griffith, 2003).

Videoconferencing and other technologies help to enrich distance media and provide many benefits of face-to-face instruction. Technology fluency is becoming a graduation requirement. Many colleges and universities are requiring students to complete at least one online course before graduation. More and more colleges and universities are offering coursework through distance learning (Howell et. al., 2003).

The integration of videoconferencing with other technologies such as video streaming and chat will be used as more schools move to Internet protocol (IP) environment for videoconferencing. The use of IP-based conferencing will increase

the number of systems available in the school setting. Futuristically, every computer will have conferencing capability (Arnold et al., 2003). Videoconferencing also will have the capability to be integrated with content management tools, such as: presentation software, video and audio editing, and interactive white boards. The simultaneous use of these technologies will enable more people to take part in a conference by watching it live and feeding back responses via other media such as e-mail (Arnold et al., 2003; JKC, 2006). New ways in which to use videoconferencing for educational purposes are being developed. A recent development is to incorporate videoconferencing into Web-based systems. Web-based systems using streaming video multicasting are now reaching the educational arena. With these systems, educators can sit in their own office or other location and present a live lecture in front of a camera attached to a Web server. With the use of a simple switching device, the educator can provide remote participants with graphics, whiteboard, flipcharts, and other visual aids as well as alternative views of the classroom or lecture room. Video streaming in this manner also will be used to archive recordings of videoconferences and make these available via the Internet, possibly packaged with other teaching resources (Arnold et al., 2003; JKC, 2006; Plymouth, 2006).

Mobile videoconferencing, which is still in its infancy, will enable a user to conference while on the move using portable devices. Mobile videoconferencing also will help to increase the awareness of and interest in desktop-based videoconferencing. Mobile conferencing has the ability to change the entire landscape of the videoconferencing market, and the prospects for growth is tremendous (JKC, 2006; National Informatics Centre, 2006).

Lastly, technological advances will allow the user to manipulate video images, such as moving one image with another and overlapping different images to provide a continuous picture appearance. Frame-by-frame manipulation also will be avail-

able, and will enable the user to print still pictures, rewind to a particular frame, interleave frames, and synchronize frames. Because videoconferencing systems are becoming less expensive, multiple participants will be able to videoconference with other participants in the conference simultaneously (National Informatics Centre, 2006). The use of videoconferencing in the academic community will soon become a regular part of teaching. This technology will be useful for a variety of activities by teachers and students alike. Videoconferencing is changing the way in which we communicate with each other, much like the telephone did when it was first invented. Videoconferencing is continuously growing and changing the educational arena and, more importantly, videoconferencing is here to stay (JKC, 2006).

CONCLUSION

Our research on policy issues regarding videoconferencing has led us to several issues that we have identified and discussed. The conversation is not over, however; there is a need for more sharing of thoughts on the development and deployment of policy decisions about videoconferencing. The major limitation of the above discussion is the lack of informed data and research focusing specifically on videoconferencing. In most areas, policy research has focused on technology integration in general and is not specifically focused or targeted at videoconferencing. It is our hope that we have provided a strong case to document the importance of further research into videoconferencing-based learning policy issues. There is a need for research regarding policies for videoconferencing that can be shared to inform policy-makers about important issues around this topic. Should our research interest focus on higher education, cultural education (libraries and museums), and pre-K-12 uses of videoconferencing individually? And what collaborations may evolve that relate to policy issues?

The goal of our discussion was to provide policy guidance and leadership for users of videoconferencing. Our findings promote the use of videoconferencing across the Pre-K-16 spectrum to support program development and create a larger research base. This larger base expands the concerns about policy issues for videoconferencing and the discussion about new policies that need to be addressed in the future. Concerns such as cyber security issues, protection of access, and content are critical points that policy-makers must address. Is there a need to monitor, assess, and regulate content? These questions will certainly raise concerns about intellectual property issues for faculty and others that produce videoconferencing course material and teach classes. More importantly, could policy-makers develop policy that protects content development?

Videoconferencing provides great instructional opportunities to students and teachers in urban and rural communities, because it provides access to instructional material that may not be available. Many school districts use videoconferencing to enhance instruction and provide additional shared resources to classes, library, and administrative activities. Having an understanding of the policy issues and concerns associated with videoconferencing strengthens the opportunities and reduces the challenges to provide the best instruction possible in this environment. Whether there is a need for policy or just regulatory statutes to be in place for videoconferencing is an area for further research and discussion. We believe that both should be in place and that policy issues should be discussed, planned, and developed. State education boards, business council organizations, and state offices of technology should be working together at the state level. At the federal level, we should look for collaborative support from the Department of Education, Department of Commerce, and the Federal Communication Commission to manage and monitor videoconferencing policies. Furthermore, we support the call for a national

clearinghouse on videoconferencing that provides information, best practices, and policy decisions.

DEDICATION

The authors of this chapter would like to dedicate it to Mrs. Violetta Bowman, Mr. Joseph Bowman, and Mia Felice Fernandez.

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Chapter 6.9

Improving Teachers' Self-Confidence in Learning Technology Skills and Math Education through Professional Development

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ABSTRACT

Using technology tools in math instruction can help stimulate problem-solving skills and understanding of math concepts. However, teachers need to be confident in their abilities to use technology tools. This study investigated whether or not a four-week in-service professional development institute that addressed the use of technology in

math education helped improved the teachers' attitude and confidence in applying technology. Findings indicated that as the teachers explored and used the available technology tools relevant to math instruction during the institute, the more proactive and motivated they became to continue their professional development in using technology for classroom instruction. They realized that they were able to use technology and desired to continue their education in this area.

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INTRODUCTION

Technology is a tool that could be used in the mathematics classroom to enhance learning (NCTM, 2000). There are many forms of technology that can assist in teaching mathematics, supplement instruction, and remediate mathematical skills that require reinforcement. Tools such as spreadsheets, databases, educational software programs, drill-and-skills programs, scientific calculators, interactive whiteboards, and other applications are appropriate methods to teach mathematical concepts. The problem lies in that some teachers do not know how to use the technology tools or feel that they possess the ability to integrate technology effectively. Hence, teachers need to obtain the knowledge and skills that would help improve their self-confidence in using the technology at hand (ISTE, 2008). Mitchem, Wells, and Wells (2003) state that, "Research on schools and teaching has suggested for decades that student success and achievement are intricately associated with students' interactions with effective teachers" (p. 1). If this is true, then mathematics teachers are the key agents to bringing out reform toward technology integration (Garofalo, Drier, Harper, & Timmerman, 2000). But, the way to effectively prepare teachers to become change agents is another issue. Professional development is a primary factor toward helping teachers become self-adept in learning the knowledge and skills required of them when teaching math content. This study investigates whether professional development could promote math education teachers' self-confidence in using and applying the technology tools learned back to the classroom. In-service teachers participating in a Math Summer Institute are the participants in this particular study, and the researchers explore whether completing a four-week intensive professional development institute has improved the participants' knowledge, skill sets, attitude, and self-confidence in applying what they have learned.

Literature Review

The effective preparation of teachers to teach mathematics in K-12 education is recognized as a vital factor toward students' academic success. In conjunction with the curriculum, teachers are the key in assisting students to learn required information necessary to succeed in the mathematics curriculum (Schmidt et al., 2001). Several professional organizations note the importance of teacher preparation and professional development as a means toward improving the aptitudes of math education teachers, especially in regards to technology integration. The National Council of Teachers of Mathematics (2000) considers technology as being essential "in teaching and learning mathematics; it influences the way mathematics that is taught and enhances students' learning" (p. 2) as one of their six principles of school mathematics. Furthermore, the Association of Mathematics Teacher Educators (2006) goals includes one to promote the recognition of the ever-increasing impact of technology on mathematics teacher education and has made a position statement on the importance of preparing math teachers to meet the current standards of integrating technology. If one reviews the Association of Mathematics Teacher Educators newsletter called *Connections* (2008), the content solely concentrates around technology and why these tools should be utilized in the math classroom. If organizations such as these recognize the importance of technology, then teacher preparation and professional development need to include a demonstration that goes beyond just the "how to use technology," but how to integrate.

Reasons behind using technology in the mathematics curriculum are numerous. Heid (1997) cites that technology when used in conjunction to teaching math could (a) make learning more student-centered, (b) give students the experience of being mathematicians themselves, (c) provide an avenue for reflection, and (d) make available constant access to the instruction, meaning that the instruction is no longer restricted when the

teacher teaches. Contextual learning in constructive environments is critical when applying technology in math education. Students need to apply learning in novel and authentic situations so that they can practice skills, knowledge, and decision-making, while experiencing the implications or repercussions of certain decisions (Dyer, Reed, & Berry, 2006). Constructive or contextual learning environments actively engages the students as they (a) relate learning to one's life experience, (b) experience and learn by doing or through exploration and discovery, (c) applying the concepts to actual scenarios, (d) cooperate with others in terms of sharing, responding, and communicating with others, and (e) transfer the knowledge to a new context or novel situation that has not been covered in the classroom (Crawford, 2001). In short, technology in math education provides students with an opportunity to explore, reflect, and discover the consequences of learning math concepts.

The issue toward successful implementation of technology in math education is professional development. A large body of literature cites that the major obstacle toward teachers using technology in the classroom is the lack of proper teaching training (VanFossen, 1999; Veen, 1993; Whetstone & Carr-Chellman, 2001; Wild, 1996). Teachers today are often behind in meeting current challenges of the rapid expansion of technology in education. Many technology tools are available to teachers, but the application of these tools to teach content areas can be foreboding, especially when training is not present. Other studies on the effectiveness of teaching technology in pre-service and in-service courses reveal some positive results such as the participants improving their likelihood to use technology in the classroom and altering their perspectives toward technology as an obstacle (Lee & Hollebrands, 2008). Although some studies indicated that certain technology tools are more likely to be used than others, an introduction to technology in math education is important (Franz, Pope, & Fredrick, 2005). Thus, professional

development is critical when expecting teachers to use technology in the math classroom. With more practice, teachers' self-assurance increases.

Problem Overview

Educators in math education should integrate technology tools as a means to assist students to learn mathematical concepts and principles. Technology can become an interactive supplement to the standard form of math instruction through paper-and-pencil methods to stimulate higher order problem-solving skills in novel situations. In addition, technology is a tool that could be applied in classrooms to assist students with diverse needs and learning styles to approach math and problem-solving scenarios more effectively (Kurz, Middleton, & Yanik, 2005). Students are not a homogeneous group of individuals in which everyone learns at the same pace and in the same method. Hence, math instruction should be individualized to cater diverse learning styles. One classroom teacher cannot design and develop personalized math curricula for thirty-three distinct students. But, the teacher could use different instructional tools and strategies that could accommodate individual learning characteristics (Cohen, 2001). With the availability of technology in schools, homes, libraries, and other public spaces, using technology as instructional tools to teach mathematical concepts and problem-solving skills seems to be the logical approach. However, the teacher is the central cornerstone toward successful implementation and integration of technology. The teacher is the one who selects and evaluates which technology tool to use at specific times. Without access and knowledge concerning technology hardware and software, successful integration of technology will not occur. In addition, not only do classroom math teachers need constant instruction and assistance in using various hardware and software application tools, personal self-aptitude and esteem are also essential criteria toward effective integration.

The teacher has to know what he/she is doing in the classroom, along with embracing a positive outlook toward using technology as a means to instruct math. Thus, attitude and confidence are key criteria when trying to integrate technology into the mathematics curriculum.

For teachers who are currently in the classroom, in-service professional development conducted during the summer is a way in which they can obtain instruction concerning available technology tools. In addition, these in-service institutes can provide teachers with practice in using and adapting technology into their curriculum. The goal of these in-service institutes is to foster a positive reinforcement on part of the teacher's ability to take the knowledge back to the classroom. The researchers in this study were involved in such an in-service Summer Math Institute to help teachers in the surrounding area to learn, explore, utilize, and practice different technology tools that could be applied to math instruction. The researchers wanted the participating teachers to understand that alternative instructional tools were available that could be successfully utilized in the math curriculum. Improving the participating teachers' self-confidence was a primary objective of the in-service math institute.

This study tried to assess whether participating in a four-week Summer Math Institute concerning the integration of technology into the math curriculum helped improve teachers' skills, knowledge, ability, and willingness to apply what they learned. To examine this research problem, four research questions were investigated:

1. Does participating in an in-service training session concerning technology integration into math instruction help teachers learn how to apply and use their knowledge and skills in the classroom (RQ1)?
2. Does participating in an in-service training session concerning technology integration into math instruction help develop teachers' interest in using technology and self-confidence to apply what has been learned (RQ2)?
3. Do teachers who complete a technology-oriented in-service training session focus more on learning to use the technology during the professional development, as opposed to applying the technology in teaching (RQ3)?
4. Do teachers who complete a technology in-service training session have a more positive attitude and outlook toward technology after completing the professional development (RQ4)?

Methodology

Participants

Participants for the research study involved public school mathematics teachers in grades 5 – 8 from South Mississippi. A total of 75 teachers (24 in 2005, 24 in 2006, and 27 in 2008) participated in the Summer Math Institute. Between five to nine high-needs schools were represented each year (5 of 9 in 2005, 9 of 12 in 2006, and 5 of 12 in 2008). In this case, high-needs schools were those that served not less than 20 percent of the children from families with incomes below the poverty line. The vast majority (80%) of the teachers had more than 3 years of teaching experience; 12% had over 25 years. The Institute provided four-weeks of professional development on the integration of technology into math instruction including: strategies involving the scientific graphing calculator, Microsoft PowerPoint, Microsoft Excel, MS Paint, MathType Equation Editor, and the Internet. Instruction occurred in a computer lab equipped with an interactive whiteboard and enough computers for each teacher to work individually. Each teacher was provided a USB flash drive and TI graphing calculator to use during the institute and for classroom instruction.

Instrumentation

Methods of data collection for this study involved teachers completing a pre- and post-survey and completing a weekly reflection instrument. An instrument for the in-service institute derived from The Concerns-Based Adoption Model was developed by the researchers (Hall & Loucks, 1979). The model describes a hypothesized sequence of seven stages that individuals experience as they adopt a new practice. Professional development strategies may then be tailored for the predominant stage of a group. The Stages of Concern instrument, consisting of 35 items, was developed for assessing concerns of teachers as they adopt new practices (Hall, George, & Rutherford, 1979). Teachers respond using a scale of 0 – 7 with 0, indicating that the concern is irrelevant and 7 indicating that the concern is very true. Bailey and Palsha tested this version with a shorter, 15-item instrument (1992). Using multiple statistical tests, these researchers demonstrated enhanced psychometric properties with the shortened version and made the argument for a five-stage model. The correlation between total concerns on both the long and short versions of the questionnaire was .92. Along with a brief description of each level of concern, the Cronbach's Coefficient Alpha for each factor is provided below.

- Awareness. The individual has little concern or involvement with the innovation, but wants to learn more about it. Cronbach's α long version .74; short version .74.
- Personal. Individuals are concerned with how the innovation will affect them, with a specific focus on required changes in roles and tasks. Cronbach's α long version .76; short version .83.
- Management. Individuals are concerned with time management, organization, and prioritizing responsibilities. Cronbach's α long version .55; short version .60.
- Impact. Individuals focus on the innovation's effects. Cronbach's α long version .73; short version .81.
- Collaboration. Individuals are concerned about working with others to implement the innovation. Cronbach's α long version .78; short version .79.

The survey developed specifically for this institute consisted of 24 items based on a four-point Likert scale: 4=Strongly Agree, 3=Agree, 2=Disagree, and 1=Strongly Disagree (see Appendix). Modifications included changing the statements from generic to more specific terms. For example, the statement "I am concerned about not having enough time to organize each day using this innovation," was changed to "I am concerned about not having enough time to organize each day when it comes to combining math and technology." There were sixteen items (1-16) of this nature. In addition, 8 statements (items 17 – 24) required teachers to indicate their perceived level of proficiencies in specific technologies (e.g., Microsoft PowerPoint, Microsoft Excel, graphing calculators, MathType Equation Editor, the Internet). Following the initial orientation session, the survey was administered during the first day of the 2005, 2006, and 2008 institutes. The questionnaire was administered again four weeks later at the end of the last regularly scheduled working day.

The second method of data collection consisted of prompted responses. The instrument consisted of five prompts on a one-page reflection paper. Each prompt was positioned within a large circle with room provided for teachers to record their responses. Prompts included: (a) I expected, (b) I got, (c) A thing of value, (d) I wish, and (e) Next I will or Next I need. In this regard, Krathwohl's affective domain taxonomy (1964) helped frame the effectiveness of a professional development institute by taking into account prior expectations. If participants' expectations are incongruent with the goals of a professional development program as indicated by responses in the "I expected"

circle, then teachers may be dissatisfied with the experience despite the quality of the program. The prompts served as a means of formative assessment and enabled instructors to make modifications if needed. The prompts also facilitated the process of metacognition. Metacognition is the process of monitoring one's own learning progress and making changes to improve learning strategies (Winn & Snyder, 1998). Ways to facilitate metacognitive approaches to instruction, including the use of prompted responses, have been described in *How People Learn* (NRC, 2000). On the Friday of each week of the Institute, time was set aside at the end of the day for completing the prompted response instrument. Following the Institute, the researchers listed each teacher's responses to each prompt in an Excel document.

Findings

The presentation of findings is organized into one of the four categories developed for this study: (1) technology integration, (2) hardware, (3), software, and (4) confidence. These categories emerged as the researchers reviewed and analyzed the prompted reflections. Initially, the researchers began with six categories, but later immersed two categories into one of the four. The following discussion addresses the results from the survey, supported with responses given by the participants in the prompted reflections.

Survey Instrument

The survey consisted of 24 items (see Appendix). The researchers anticipated that scores for some items would *decrease* from pre to post, because it

was hypothesized that teachers would demonstrate greater concerns about using technology in teaching mathematics at the beginning of the institute than at the end of the institute. Thus, numbers 1, 2, 5, 6, 8, 9, 15, and 16 were coded as negative items. All the negative worded statements were recoded (reversal of responses) during analysis of the survey. The researchers anticipated that scores for other items would *increase* from pre- to post-test, because it was hypothesized that teachers would demonstrate less confidence about using various technology tools at the beginning of the institute and greater confidence at the end. Positive items included numbers 3, 4, 7, 10 - 14, and 17 - 24. Overall, the survey included 16 positive and eight negative statements. The eight negative items are italicized in the Appendix. Two of the positive items overlapped among categories. Item number 7 combined integration, hardware, and software; number 17 combined integration and confidence. All the hardware and software questions were positively worded. While analyzing the overall confidence, the researchers considered all 24 items, including those designated as confidence. As shown in table 1, six positive items (4, 7, 10, 13, 14, and 17) and four negative items (1, 5, 9, and 16) were categorized as *integration*; four positive items for *hardware* (3, 7, 21, and 23), six for *software* (7, 18, 19, 20, 22, and 24); three positive (11, 12, and 17) and four negative (2, 6, 8, and 15) for *confidence*.

Descriptive statistics (means and standard deviations) were used to describe the central tendency and dispersion on all measures. Table 2 provides the minimum and maximum scores for each category. The participant's responses over technology integration, hardware, software and

Table 1. Classification of survey items for data analysis according to category and coding

	Integration	Hardware	Software	Confidence
Positive	4,7,10,13,14,17	3,7,21,23	7,18,19,20,22,24	11,12,17
Negative	1,5,9,16			2,6,8,15

Table 2. Minimum and maximum scores in each category

	Total number of items	Scale	Minimum Score	Maximum Score
Positive integration	6	1-4	6	24
Negative integration	4	1-4	4	16
Hardware	4	1-4	4	16
Software	6	1-4	6	24
Total positive Confidence	16	1-4	16	64
Total Negative Confidence	8	1-4	8	32

confidence at the beginning and end of the program were compared by using two-tailed paired sample t-test. The 0.05 level of significance was set for the rejection of all null hypotheses.

Technology Integration

The first category to be discussed is technology integration. Participants were asked to rate their capabilities and knowledge for incorporating technology into math instruction. Results from this particular area helped answer the research questions RQ2 and RQ4. The analysis revealed that teachers' concerns decreased over the course of the institute each year. The analysis revealed significant changes in participants' attitudes toward the integration of technology in math instruction in 2005 and 2008, positive changes though not significant in 2006 (see Table 3). These results indicated teachers' confidence levels in using technology in their math instruction increased as well as their knowledge about the use of technology. They had more confidence in both their

capabilities and knowledge needed for integrating technology into math instruction.

Participants' improved attitude toward technology integration also emerged in the prompted reflections. The following statements demonstrate how the institutes altered teachers' attitudes toward the use of technology in teaching mathematics.

As a result of this workshop, I expect to become a more efficient user of technology and use calculators and computers in my classroom.

A thing of value from this experience is the benefit of being able to learn to use a variety of strategies for various technologies in mathematics instruction for the classroom.

Next I need to go observe a computer discovery class (7th grade) in my school to learn more about how technology can be used.

Next I will take back to my classroom all the information that I have learned in this workshop. I

Table 3. Attitude toward integration of technology in mathematics instruction

Year	Pre-Survey		Post-Survey		Change of Score		t	p ¹
	N	(Mean±SD)	N	(Mean±SD)	N	(Mean±SD)		
2005	18	27.50±2.12	17	30.35±3.52	15	2.20±3.53	2.41	0.0300
2006	16	28.69±2.85	17	30.71±2.93	10	0.40±3.03	0.42	0.6857
2008	22	30.23±2.14	24	32.04±3.91	20	2.30±4.08	2.52	0.0208

Note: ¹ by paired t survey.

want to carry all my skills back to the classroom to help instruct my students.

Hardware

In the hardware items, teachers were asked to rate their proficiency in the use of a graphic calculator (T1-83 or T1-84) and other technology materials. Results from this particular area helped answer the research questions RQ1 and RQ3. Paired t-tests revealed significant and positive changes in self-confidence in the knowledge and use of hardware across the three years (see Table 4). These findings show that participating in the summer mathematics institutes had a positive impact toward the attitudes of using hardware in math instruction. Researchers could also see that the participants obtained greater confidence in using hardware and became more aware of institutional support for hardware. This confidence not only made these teachers believe they were better able to use hardware, but also helped them become future leaders in their schools to advocate technology access and availability.

Participants' attitude toward the utilization of technology hardware to teach math concepts also changed for the better in the prompted reflections. The following statements demonstrate how the institutes improved teachers' attitudes toward the use of related technology hardware in teaching mathematics.

I got a lot of information on the calculator skills this week and how to graph the information in

tables. I am feeling reasonably safe and competent with calculator use.

Wish I can learn more ways of implementing all this into my classroom. I would like to use this and see how the Smart Board and the Smart View software (in conjunction with the graphing calculator) can be used in the classroom.

I wish our district would use the graphing calculator presentation as part of our staff development. This technology can really help us teach math skills.

I expect to continue learning about Excel and the graphing calculator. So far, I have learned many things such as creating graphs and random number generators in the calculator that I had no knowledge of prior to this workshop.

I wish we were reviewed more on using the Smart-Board. We do not know all of its features and what it can do in the classroom

I wish I had a SmartBoard in my classroom. But, now I know how to ask for it (from my principal) because of what it could do for the classroom.

Software

The third category is the application of various software programs in education. Results from this particular area helped answer the research questions RQ1 and RQ3. Teachers' attitudes toward

Table 4. Attitude toward hardware use in mathematics instruction

Year	Pre-Survey		Post-Survey		Change of Score		t	p ¹
	N	(Mean±SD)	N	(Mean±SD)	N	(Mean±SD)		
2005	18	9.50±1.58	21	12.52±1.50	16	3.00±2.22	5.40	<0.0001
2006	21	10.62±1.88	20	12.65±1.93	17	2.12±2.50	3.50	0.0030
2008	24	9.67±1.95	26	12.69±2.43	23	3.00±2.65	5.44	<0.0001

Note: ¹ by paired t test.

related software programs used in mathematics instruction are revealed in Table 5. Teachers were asked to rate their knowledge of software programs that included Excel, PowerPoint, Equation editor, and the Internet. Researchers found significant and positive differences between the pre- and post-surveys in all three years. From these results, researchers believe that teachers became more prepared for using the software programs available, and this increased confidence will have a positive impact on the usage of software programs in their teaching process.

Teachers also changed in their perspective toward using different software application programs to teach math concepts in the prompted reflections. The following statements demonstrate how the institute helped teachers positively perceive the use of software in teaching mathematics.

I want to continue learning various functions in Excel and use special features of PowerPoint so that I can use these programs when creating lesson plans.

A thing of value is learning how to make spreadsheets, creating charts and graphs, and using clipart. I also enjoyed creating PowerPoint for teaching math lessons and using animations.

A thing that I valued the most was using spreadsheets to create gradebooks. Learning how to create a gradebook from scratch and putting formulas into cells to get operations performed was useful. I know how to make the spreadsheet more for "my taste."

Confidence

The fourth category involves an increase in confidence, attitude, and a desire to continue using technology to teach math concepts in math classrooms. Results from this particular area helped answer the research questions RQ1, RQ2, and RQ4. The results revealed significant improvement in their concerns regarding the use of technology across all years (see Table 6). According to these results, the researchers believed that the participants acquired greater confidence regarding technology integration and their knowledge of hardware and software compared to before attending the institutes. The significant changes between the scores of pre- and post-survey also indicate that the teachers were more prepared to utilize the technology available in schools. The institutes not only gave teachers knowledge of hardware and software, but also helped them gain confidence to integrate technology into their curriculum. This confidence would help teachers utilize the available technology in schools and in math classrooms. In turn, the improved confidence would help teachers explore more concepts and applications in this area.

The responses in the prompted reflections also indicate an increase in self-confidence and willingness to learn more about technology integration. The following statements demonstrate how the in-service training led by the Institute's instructors assisted in improving teachers' confidence and continuing their desire to use technology. Most of these comments with reference to confidence emerged in the *Next I will* or *Next I need* prompt.

Table 5. Attitude toward software use in mathematics instruction

Year	Pre-Survey		Post-Survey		Change of Score		t	p ¹
	N	(Mean±SD)	N	(Mean±SD)	N	(Mean±SD)		
2005	20	13.25±3.34	21	19.57±3.33	18	6.50±3.43	8.03	<0.0001
2006	20	15.50±3.03	21	19.81±3.93	17	3.88±5.81	2.76	0.0141
2008	23	15.65±4.15	26	20.54±4.66	22	4.73±4.97	4.46	0.0002

Note: ¹ by paired *t* test.

Table 6. Overall confidence in incorporating technology in mathematics instruction

Year	Pre-Survey		Post-Survey		Change of Score		t	p ¹
	N	(Mean±SD)	N	(Mean±SD)	N	(Mean±SD)		
2005	11	56.27±3.00	17	70.76±6.72	10	15.10±5.17	9.23	<0.0001
2006	14	62.79±6.14	16	72.56±6.07	9	7.33±7.58	2.90	0.0199
2008	21	59.62±6.93	23	71.30±9.23	19	12.05±8.86	5.93	<0.0001

Note: ¹ by paired *t* test.

I will continue to learn all that I can in order to be an asset to my students and my school. I also want to pass this information to my fellow co-workers.

I will continue to practice experimenting and using what I have learned. I want to take these skills into my own classroom.

I will continue to work harder in understanding the various formulas in Excel and work on my own!

I am getting a SmartBoard this coming year. So, I need to go in and play with it. I also need to begin creating PowerPoint's for certain math skills taught this coming school year while this is still fresh on my mind. I would also love to set up a master Excel sheet with formulas already set in it for students to use.

I will try and take time to find places/topics in the curriculum standards to insert Excel and PowerPoint. I also need to continue building my confidence in what I am doing.

I want to take all this information back to my classroom to make it a more exciting and productive environment for learning.

I got 50000000 much more from all this. My brain was exercised greatly with the math concepts to go along with the technology skills.

An interesting finding from the prompted reflections was the issue of time, in addition to

technology access. The teachers wanted to keep learning and using these technology tools in the classrooms. But, time and access were a reoccurring concern as exemplified in these statements, "I wish I had more time with colleagues to develop in-depth math lessons for my class and have more computers in my class to implement the lessons," and "I wish I had more time and access to integrate all of this into my daily schedule."

CONCLUSION AND DISCUSSION

The research questions asked for this particular study have been answered. First, offering an in-service professional development institute concerning technology integration into math instruction can help teachers learn how their knowledge and skills could be used in the classroom. Teachers not only learned about the technology hardware and software per se, but also the practical skills that they could use in instruction. By modeling appropriate uses of technology in the institute, teachers could envision how instruction can be carried out. Second, participating in an in-service professional development institute concerning technology integration into math instruction helped develop teachers' self-confidence to apply what they learn. Many teachers who had never used a computer before voiced their aspirations to continue learning and using technology beyond the institute. Some expressed interest in becoming leaders in their schools to help others learn to use the technology tools. Third, the teachers who

completed this technology-oriented institute not only focused on learning to use the technology, but also on the application of technology in teaching. The questionnaire and prompted reflections indicate that although teachers valued the how-to-use-technology instruction they received, the teachers also began thinking about how they could use the technology in their math lessons and how to make it part of their school culture. This information reveals that the institute was successful in taking teachers from the initial "awareness" level all the way to the final "collaboration" level in Bailey and Palsha's five-stage model of concern (1992). Finally, the teachers who completed this institute developed a more positive attitude and outlook toward technology. Most were excited to continue their exploration of the possibilities that technology tools could provide in the classroom and how to obtain them.

This study does have its limitations. First, the sample population is not representative of teachers in South Mississippi. They were selectively chosen to participate in the Institute through an application process. Second, the administration of the prompted reflection instrument was not always consistent. In some years, the weekly reflections were administered on Thursday rather than Friday and the content schedule fluctuated that affected how the participants responded to the prompts (e.g., for one year the topic of grants was predominant, but not in another). Although this factor did not affect the data findings, not all the participants completed both the pre- and post-surveys. Nonetheless, the findings from this study address the effectiveness of conducting an intensive, four-week professional development institute focused on the integration of technology in teaching mathematics and how this could enhance teachers' attitude, confidence, and skills acquisition.

Teachers' perceptions, attitudes, and concerns should be addressed during any professional development workshop or institute. Simply administering a questionnaire before and after an event

bypasses the rationale for a concerns-based survey, and, other than providing institutional assessment, serves as a fruitless exercise. Feedback from the weekly reflections enabled instructors to address teachers' struggles with certain technologies or mathematical concepts immediately. Instructors provided personal attention and instruction was modified accordingly. As revealed by this study and others (Atkins & Vasu, 2000; Rakes & Casey, 2002), future studies should continue to be performed in the tradition of Hall and Loucks (1978) in order to examine the effectiveness of professional development in improving teachers' confidence and attitude. However, a survey is only useful if the professional development staff uses the initial analysis to design the professional development experiences. That said, however, a survey alone is not sufficient to determine all areas of concerns that teachers may have. Prompted reflections, administered daily during a workshop or weekly during an institute, provide a simple and effective way to obtain additional feedback and take immediate steps to address teachers' concerns. However, an even more thorough qualitative approach could be performed that includes interviews, observations, and document analyses. This type of examination would bring a further in-depth perspective of how professional development sessions can change the environmental culture and people's perspectives.

Professional development helps teachers become the key agents they need to be. If anyone expects change to occur in the classroom, teachers need to be well-informed, skilled, ready, and possess the correct tools for change to take place. Without this help and support, change in the mathematics classroom will not occur. The Summer Math Institute provided teachers with the professional development needed to integrate technology into the math classroom. However, this professional development model is just not limited to mathematics. Schools, colleges, and universities can adopt similar types of extended professional development to help facilitate the acquisition of not only content material (e.g.,

math, science, language arts), but technology skills and pedagogical applications as well. In addition, professional development requires to be delivered over a longer period of time in order to be effective in changing the confidence level of teachers. A one-time, daylong workshop is not sufficient enough to initiate change in terms of attitude and confidence. Participants in such shorter professional development sessions may acquire specific technology skills or content knowledge, but the application of such skills and knowledge may not be fully recognized. A long-term professional development model is required to help stimulate continuing interest among the participants and increase confidence. A final observation that emerged from this study is that time and access to technology must be provided to mathematics teachers. This access to technology needs to be ensured in order for change to occur in instruction. Comments made by the participants in this study emphasized the need for extra time to assimilate all the information and skills learned into their actual teaching. Furthermore, the participants were concerned that the technology used in the professional development workshop may not be available back at their schools. They believed that in order to fully integrate what had been learned from the Summer Math Institute, extra time to practice using the technology tools was required. This is an area in which educational institutions need to consider if change is to occur. In short, effective professional development is one way to stimulate interest that would extend beyond the constraints of the workshop itself and lead toward greater self-confidence in one's ability.

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APPENDIX

Survey for (SM)² I Summer Math Institute Participants

The purpose of this questionnaire is to determine your current concerns regarding the integration of mathematics and technology into your classes. The items were developed from typical responses of teachers who ranged from no knowledge at all about the ideas to many years experience in using them. **Therefore, a good part of the items on this questionnaire may appear of little relevance to you at this time.** For completely irrelevant items, please circle “NA” on the scale. Other items will represent those concerns that you *do* have, in varying degrees of intensity, and should be marked higher on the scale. Please respond to the items in terms of your present concerns about your involvement, or how do you feel about your involvement with **integrating mathematics and technology into your classes**. We do not hold to any one definition of this innovation, so please think of it in terms of your own perceptions of what it involves in your teaching situation.

1 = completely disagree 2 = somewhat disagree 3 = somewhat agree 4 = completely agree NA = Irrelevant

- 1 2 3 4 NA 1. *I am concerned about my ability to integrate mathematics with technology.*
- 1 2 3 4 NA 2. *I am concerned about not having enough time to organize each day when it comes to combining math and technology.*
- 1 2 3 4 NA 3. *I am concerned about availability of technology materials at my school.*
- 1 2 3 4 NA 4. *I would like to help other faculty in their attempts to blend technology into their subject areas.*
- 1 2 3 4 NA 5. *I have a very limited knowledge about integrating mathematics and technology.*
- 1 2 3 4 NA 6. *I am concerned about the students' abilities in technologies exceeding my own.*
- 1 2 3 4 NA 7. *I would like to know what resources are available if we decide to integrate mathematics and technology.*
- 1 2 3 4 NA 8. *I am concerned about my inability to manage all that integrating math with technology requires.*
- 1 2 3 4 NA 9. *I would like to know how my teaching or administration is supposed to change when integrating these subjects.*
- 1 2 3 4 NA 10. *I would like to revise the instructional approach for integrating technology into the mathematics classroom.*
- 1 2 3 4 NA 11. *I would like to have more information on time and energy commitments required for integrating these subjects.*
- 1 2 3 4 NA 12. *I would like to know what other faculty are doing in this area.*
- 1 2 3 4 NA 13. *I would like to determine how to supplement, enhance, or replace the mathematics teaching that I use to integrate technology.*
- 1 2 3 4 NA 14. *I would like to use feedback from students to change my integration of the two subjects.*
- 1 2 3 4 NA 15. *I would like to know how my role in the classroom will change when I am using this approach.*
- 1 2 3 4 NA 16. *Coordination of tasks, grading, and equipment is taking too much of my time with regards to integrating math and technology.*

- 1 2 3 4 NA 17. I would like to know how using this approach is better than what I have been doing in my classroom.
- 1 2 3 4 NA 18. I am proficient in the use of Powerpoint in my classroom.
- 1 2 3 4 NA 19. I am proficient in the use of Microsoft Excel in my classroom
- 1 2 3 4 NA 20. I am proficient in the use of integrating Microsoft Excel into Word documents.
- 1 2 3 4 NA 21. I am proficient in the use of graphing calculators (ex: TI-83) in my classroom
- 1 2 3 4 NA 22. I am proficient in using MathType Equation Editor to create documents.
- 1 2 3 4 NA 23. I am proficient in using the graphing calculator to perform spreadsheet applications.
- 1 2 3 4 NA 24. I consider my knowledge of the Internet to be very proficient.

Note: Items in italics were coded as negative statements for the purpose of item analyses (e.g, the researchers anticipated that scores for these items would go down from pre- to post-test).

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Section VII

Critical Issues

Section 7 details some of the most crucial developments in the critical issues surrounding instructional design. Importantly, this refers to critical thinking or critical theory surrounding the topic, rather than vital affairs or new trends that may be found in section 8. Instead, the section discusses some of the latest developments in cognitive load, social constructivist and pedagogy theories, as well as new approaches in faculty development, learning with visualizations, and implications of anonymity online. This section also asks unique questions about the role of business intelligence in developing countries and in linguistic confusion across cultures. Within the chapters, the reader is presented with an in-depth analysis of the most current and relevant issues within this growing field of study.

Chapter 7.1

Theories and Principles for E-Learning Practices with Instructional Design

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INTRODUCTION

E-learning has become an area of increasing interest for academics, consultants, and practitioners. Notwithstanding, it seems that in current experiences the instructional dimension is often overlooked. Many e-learning courses are content-oriented and the attention is often put on the technological dimension. We believe that a fruitful contribution in order to overcome the gap between technology and pedagogy and promote a more sensible instructional approach to e-learning, can be derived from *instructional design* (ID). ID is an ever growing field of research (Dijkstra, Seel, Schott, & Tennyson, 1997; Gagné & Briggs, 1990; Merrill, 2001; Reigeluth, 1989; Savery & Duffy, 1995; Wilson & Cole, 1991). Its results have a transversal value with respects to the specific delivery supports adopted in the learning

environment. Whether we are dealing with online or face-to-face education, useful criteria from ID can be outlined for designing effective, efficient, and appealing learning experiences.

Therefore, with the aim of suggesting useful criteria and guidelines for e-learning design, this paper focuses on ID and examines some main approaches that currently characterise this field.

HISTORICAL AND THEORETICAL BACKGROUND

The field of ID emerged more than 40 years ago as psychologists and educators searched for effective means of planning and implementing instructional systems. One of the most important work for the growth of this field was Robert Gagné's *The Conditions-of Learning* (Gagné, 1965). According to the American psychologist, there are

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different levels of learning, each of which requires different types of instruction. He distinguished eight types of learning (from signal learning to problem solving) arranged in hierarchical order and proposed nine instructional events as conditions for learning. See Table 1.

These events should provide the basis for designing instruction and selecting appropriate media.

ID from the very start, was configured as a field of research aimed at identifying criteria for the choice of the most appropriate learning methods, taking into consideration the conditions-of-learning and the different learning methodologies. And yet this sector was often confused with other fields, thus generating ambiguity and misunderstanding. Recently, Reigeluth (1999) elaborated a deep study on ID with the purpose to clarify its specific field and focus on the epistemological nature of ID theories. Broadly speaking, an ID theory provides more or less general indications on how to facilitate learning and cognitive, emotional, social and physical development of people. But how should the term “theory” be interpreted, and what does an ID theory consist of, compared to other theoretical fields?

First of all an ID theory is design-oriented, that is, it focuses on how to achieve learning results. It therefore has a prescriptive nature, and does not involve the description of cause-effect

relations between events, but indicates how to obtain specific results. An ID theory is not true or false, but involves a choice between possible preferable ways of intervening, and thus satisfies preferability criteria rather than that of validity.

There is a tendency to identify ID with the area of learning theories. Obviously the relationship between these fields is very close since the learning theories have the fundamental role of explaining why an ID theory works or not. However, an ID theory involves the defining of the methods that facilitate learning and indicates the situations in which their use is preferable.

The methods have a situational nature and not a universal one, meaning that they work in certain situations and not in others. The situation affects the choice of methods and influences their applicability.

An ID theory therefore defines not only the methods, but also the situations, while identifying the aspects of the context that influences the choice of the method. In any learning situation, the most important aspects can be put into two macrocategories which are the learning conditions and the desired results. Among the first to be considered are: the nature of that which must be learnt (e.g., understanding concepts is different from developing abilities), the characteristics of the students (e.g., their previous knowledge, their learning strategies, their motivations), the characteristics of the learning environment (e.g., the activities could be carried out at home, or in a class of 20 students, or in small groups at workplaces, etc.), and the organizational and economic constraints. All these conditions can affect the choice of the most favorable methods for achieving the desired results. They must not be confused, however, with the *conditions-of-learning* of Gagné, even when the internal conditions coincide with the category, “student characteristics”, while the external conditions are methods of learning and not conditions of learning. The desired results are the levels of effectiveness, efficiency (costs/time) and appeal (attraction for the student) with which one hopes to reach learning objectives.

Table 1.

Instructional events	Cognitive Process
Gaining attention	Reception
Informing learners of the objective	Expectancy
Stimulating recall of prior learning	Retrieval
Presenting the stimulus	Selective Perception
Providing learning guidance	Semantic Encoding
Eliciting performance	Responding
Providing feedback	Reinforcement
Assessing performance	Retrieval
Enhancing retention and transfer	Generalization

The situation is therefore defined in a rather complex way and the intervening factors are multiple. This entails another characteristic of the ID methods, that is, they always possess a probabilistic nature. It means that an ID method does not guarantee that the application of an appropriate method in a certain situation will deterministically lead to the desired results, but does indicate a good degree of probability in a given situation, that the method will work.

Briefly, an ID theory identifies the adequate methods, so that, given certain learning conditions, learning results to be effective, efficient and appealing (Figure 1).

Currently there are two main approaches occurring in this field. The first is more traditional and is usually indicated as “instructivist”. The second prefers alternative expressions like “learning communities” rather than “instruction” and leans towards constructivism.

In the second part of the chapter, we shall focus on these two different approaches, examining the ID principles developed in the traditional approach and the most recent evolutions of ID due to constructivism.

DO FIRST PRINCIPLES OF INSTRUCTION EXIST?

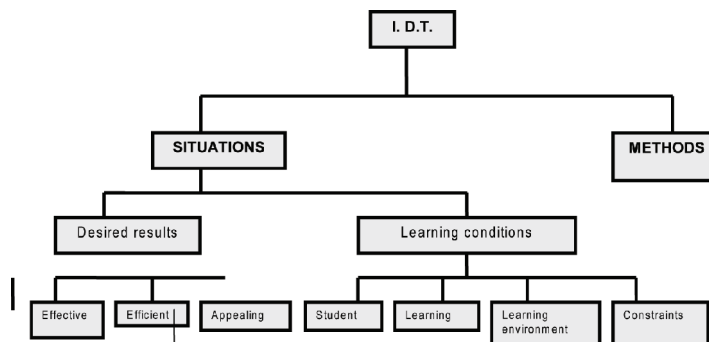
Merrill (2001), an advocate of the instructivist approach (Merrill, Drake, Lacy, Pratt, & ID2

Research Group, 1996), claims the right of ID to develop general principles in order to design instruction. According to Merrill, in comparing existing instructional models, it can be gathered that there are five instructional dimensions occurring in a transversal way: problems, activation, demonstration, application, and integration. What do such principles prescribe?

Problem. Learning is facilitated when the students concentrate on the solution of authentic problems. This principle is followed by resulting corollaries, that is, learning is facilitated: (1) when students are shown the task to achieve or the problem to resolve at the end of the course, rather than focusing on abstract learning objectives; (2) if the students are engaged in achieving a task or resolving a problem and not at the level of simple action or application of procedures; and (3) when the student solves more problems arranged in order of growing complexity for the gradual and progressive development of skills.

Activation. Learning is facilitated when pre-existing knowledge is activated as foundation for new knowledge. It is surprising, Merrill observes, how often we pass on immediately to presenting new information in very abstract forms, without first having prepared the ground for them to be understood. Activation implies much more than testing previous knowledge; it is rather the activation of those mental models that can be modified in order to allow students to integrate new knowledge with the existing one.

Figure 1. Elements of ID theory (Reigeluth, 1999)



The best example for activation is that of the advanced organizers of Ausubel (1960, 1963).

Demonstration. Learning is facilitated when, what must be learned is demonstrated instead of just receiving information about it. Knowledge is often represented at a too general level rather than through examples. It would be more opportune instead, if examples and counterexamples were furnished for concepts, demonstrations held for procedures, and visualization done for processes and modelling of behaviour. Demonstrations entail a guide that helps the student to select the relevant information, the offer of the multiple representations of knowledge and also the comparison among multiple examples.

Application. Learning is facilitated when the student is given the opportunity to practise and apply new knowledge or abilities in the solution of a variety of problems. It is necessary obviously to provide adequate support (coaching) and feedback during the performance.

Integration. Learning is facilitated when students are encouraged to apply the new knowledge/abilities in real life, are given the opportunity to demonstrate their own new knowledge/ability, and are able to reflect, discuss and defend their new knowledge. Integration has positive effects on motivation. If the students have the opportunity to demonstrate their own progress, their motivation increases.

INSTRUCTIONAL DESIGN AND CONSTRUCTIVISM

During the last 20 years, studies in cognitive science and psycho-pedagogy have led to a meaningful change in the definition of learning. Three main research paths have been developed which, though similar, emphasize different aspects (Striano, 1999). These main perspectives consist of: (1) a constructivist approach which recovers the piagetian work, and interprets learning as an adaptive process in which the learner plays an active

role of construction/de-construction of structure and knowledge strategies; (2) a historical-cultural approach referring to Vygotskij and interpreting learning as a mediated experience and as a socially shared and culturally constructed process; and (3) a contextual approach which emphasizes the ecological attitude of learning processes (Striano, 1999).

Therefore, new currents have emerged in the ID field as constructivist instructional design (Dick, 1991; Jonassen, 1994; Savery & Duffy, 1995; Wilson, 1996), which share the perspectives developed on the psycho-pedagogical level.

The instructional models which are oriented towards constructivism, put the emphasis on the concept of learning environment. This is defined as “*a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities*” (Wilson, 1996, p. 5). The idea is to set up around learners, multiple supports and resources available for their cognitive progress. This concept is derived from the Vygotskijian theory of zone of proximal development. The latter indicates a set of potentialities that the individual can develop, if adequately helped. In order to promote learning a varied environment consisting of learning resources, techniques, and interpersonal activities must be constructed around learners, so that each student can find the suitable atmosphere and the most appropriate “strongholds” to make progress.

Other authors provide further interpretations. According to Collins (1996), a learning environment should offer multiple representations of reality, avoid simplifications representing the natural complexity of the real world, focus attention on the building of knowledge and not of its transmission and reproduction, offer opportunities for learning based on real world situations rather than on predefined instructional units, nourish reflective practices, allow the building up of knowledge according to context and favor the cooperative construction of knowledge through social negotia-

tion. Briefly, a constructivist learning environment is characterized by the following aspects:

- Focus on knowledge construction rather than knowledge transmission;
- Focus on context rather than abstraction thus presenting authentic tasks based on real cases;
- Multiple and complex perspectives on reality which stimulate metacognitive attitudes;
- Emphasis on social meaning negotiation and cooperative learning.

We now focus on two models arising from the Vygotskian tradition, that is, the community of learners (Brown & Campione, 1990) and the Community of Practice (Lave & Wenger, 1991). What defines a learning community is the existence of a culture of learning in which each person is committed in a collective effort of meaning comprehension (Collins & Bielaczyc, 1999). The four specific factors that characterize such a culture are:

- The diversity of expertise among the community members
- The shared objective to contribute to the continuous growth of expertise and collective knowledge
- The emphasis on learning how to learn
- The setting-up of methods and tools for sharing what is learned.

A learning community can also be considered as a “social device” oriented towards favoring collaborative learning. It is characterised by members joining spontaneously and deep emotional relationships. A learning community cannot be designed in a strict sense, but is at most, “favored” or “cultivated”. More analytically, according to Collins and Bielaczyc (1999), the issues to be addressed in order to promote a learning community can be analysed within eight dimensions:

1. **The scope of the community:** It is that of promoting a culture of learning, in which both the individuals and the community considered as a whole, learn how to learn. The members of the community share their efforts to reach a deeper understanding of what they are learning. The students learn to consider multiple perspectives to solve problems, and to use each other’s knowledge and expertise as a resource to collaboratively solve problems.
2. **Learning activities:** The activities of a learning community aim at: (a) promoting individual development and collaborative construction of knowledge; (b) favoring the sharing of knowledge and abilities; and (c) making the process of learning visible and well structured.
A learning community is typically involved in learning activities, such as individual and group research, discussions, peer tutoring and learning, collaboration in artefacts production intended to make visible what students learn, and collaborative problem solving based on shared objectives. Brown and Campione (1996) suggest that learning community activities are distinguished by two aspects, that is, interdependent actions and interconnected objectives.
3. **The changing role of the teacher and transformation of the educational relationship:** In a learning community the teacher assumes the role of organiser and facilitator. The student becomes responsible for his/her own learning and that of the others.
4. **Centrality/peripheral and identity:** The member’s identity is defined by the central or peripheral role he plays in the community and by the respect he receives from the other members of the community (Lave & Wenger, 1991). In a learning community the central roles are those that contribute more directly to collective activities and to

community knowledge. There are, however, opportunities for all and the participants who assume peripheral roles are evaluated for their contributions. The centrality and peripheral aspects depend on the context. Individual identity is constructed through participation. Therefore the community identity emerges by working towards a common goal. It makes collective awareness grow, and favours the skipping of peripheral positions to favor centrality.

5. **Resources:** In a learning community the knowledge acquired and the learning processes enriched by external sources are shared between the members and become part of collective knowledge.
6. **Speech:** In learning communities language used to communicate ideas and practices emerge in the community through the interaction with the various sources of knowledge and the cobuilding and negotiation of meaning between the members. The learning communities construct a common language through which they express learning processes, plans, aims and assumptions. Speech assumes the function of a medium for the exchange of ideas; promoting moreover, the motivations of research and reflection, and arousing new questions and hypotheses that give rise to ulterior research. In this process the students help each other.
7. **Expertise:** In learning communities both individual and collective expertise are emphasized. Subjects that focus on principles and ideas that can generate wider and deeper comprehension of the themes themselves, are preferred. A growth in the community knowledge also occurs when the discussions on what the members have learned lead them to seek other knowledge to be shared within the community. Therefore there exists an inter-relationship between personal growth and that of the group.

8. **Products:** In a learning community the members collaborate to produce artefacts that can be used by the community to understand other themes or problems.

As regards communities of practice (CoP), they are defined by Lave and Wenger (1991) as groups of persons sharing an interest and regularly interacting to learn how to perform better. They are distinguished by three crucial features: identity that is defined on the strength of a shared interest, belonging to a community wherein the members help each other, and the sharing of practices. A CoP shares a program of resources, experiences, stories, tools, ways of problem resolutions, and in short, a program of practices.

INSTRUCTIONAL DESIGN AND E-LEARNING PRACTICE

We have just examined the two main current perspectives in ID field. How can they offer methodological insight for e-learning design?

As an example, let us consider the following case, that is, the methodological structure of a master on e-learning designing and managing delivered at the University of Florence since 2001. The master lasts one year (including a period of internship and one month reserved for the final dissertation) and provides blended learning, including f2f meetings and online activities supported by a virtual learning environment.

Briefly, the overall instructional model which characterises the master is based on the following principles inspired by both Merrill's Principles and learning community theory:

- Promoting problem based learning
- Favouring the activation of pre-existing knowledge
- Providing expert modelling through case studies and simulations

- Allowing students to apply knowledge and abilities in different contexts
- Facilitating knowledge integration through project based work
- Favouring the development of a community of practice
- Promoting students awareness on their own performances

How are these general principles concretely implemented? The master starts with a first phase of three months aiming at providing students with the conceptual handholds and expert examples concerning the various subject area. Each week is dedicated to a particular topic and is planned as described in Table 2.

During the following three months, a completely online phase is delivered, which is oriented towards collaborative project work. The purpose of this phase is to enable participants to apply their own knowledge and skills in real life contexts (application and integration). At the same time, the emphasis is put on the formation of collaborative groups and the growth of a community of practice.

The team building process is favored by the sharing of a common interest and supported by the e-tutor. Students can choose among various scenarios referring to different contexts, that is, university, private company, public corporation, and so on. The groups therefore emerge from the interest in a particular scenario and operate within the selected scenario. Participants start to search and exchange information in order to create a common knowledge base and language. Next step is to define the objective to be accomplished and identify the necessary resources. The project work activity engages the students in a continuous problem solving process, asking them to develop different views on the same topic and to evaluate different possible solutions.

In addition, two intensive face-to-face workshops are delivered with the aim of offering more opportunities for demonstration and application.

CONCLUSION

During the last 20 years, Instructional Design has gained its own autonomy as a specific field of research and has developed a theoretical reflection on its own epistemological statute. It is designated to elaborate instructional theories or models, able to indicate the adequate methods so that, given certain educational situations, learning can have greater probabilities of becoming effective, efficient and appealing. At the same time different approaches are emerging. One is more oriented towards the research of transversal fundamental principles applicable to a variety of contexts. The other, inspired by constructivism, is more intent on valorising the social and contextual dimension.

Even if the two approaches are different and in some way hardly reconcilable from a theoretical perspective, we believe that both the traditions provide methods and criteria that should be taken into consideration in e-learning design and practice. As noted, these criteria can be identified either in the Merrill's first principle of instruction or in the guidelines for cultivating learning communities.

In any case, professionals and practitioners in the e-learning field should not overlook the instructional dimension, while paying special attention to the research contribution from instructional design.

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Table 2.

PROBLEM	Monday	E-tutor		
		ONLINE WORK The e-tutor presents the subjects and the themes that will be examined and discussed during the week. He also introduces the subject matter experts (SME). At the same time, he provides documents and learning materials on the subject area, and focuses on the fundamental questions that will be addressed in face-to-face event.		
ACTIVATION	Monday		Students	SME
	Tuesday		ONLINE WORK Students achieve their tasks autonomously or in small groups supported by a Web forum. They must identify problems and issues emerging from the provided learning materials and documents. Eventually they realize a concept map or a final report on emerged issues.	ONLINE SUPPORT During this period the SME may interact if needed with students giving support and hints on the subject area. He therefore intervenes in the Web forum collaborating with the e-tutor.
	Wednesday			
	Thursday			
DEMONSTRATION	Fryday (afternoon) and Suterday (morning)	Before the face-to-face event, the e-tutor summarizes students reports and submits the final report to the SME so that he can arrange the face-to-face lecture on the emerged issues.		FACE-TO-FACE WORK* During the face-to-face event, the SME discusses the issues identified by the students giving feedback and adding new information and examples on the subject area.
DEMONSTRATION	Suterday (afternoon)	FACE-TO-FACE WORK * The e-tutor gives ulterior information on the discussed themes, and organises possible in-depth examinations if needed.	FACE-TO-FACE WORK* Students will realize personal works taking into consideration the information and the suggestions provided by the SME and supported by the e-tutor . The personal works will be inserted into the student portfolio.	
* Students who cannot be present to the face-to-face event, may participate and interact with the SME and other students through a videoconferencing system.				

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KEY TERMS AND DEFINITIONS

Constructivism: Epistemological theory according to which individuals construct knowledge through active experience. It emphasizes that knowledge is a social product, historically and culturally situated, and which is negotiated, constructed and learned by the members of a community.

E-Learning: A Neologism created at the start of the 2000s to indicate a set of methodologies aimed at using the ICTs in order to provide learners with learning resources and interactions free

from temporal and spatial constraints. Three main solutions can be distinguished: content + support, wrap around, and integrated model. These three structures are respectively based on content, teacher's support for activities between peers and the Internet, and the collaborative learning group.

Instructional Design: Is the sector which has to do, on international levels, with the study of criteria and instructional models applicable to diverse contexts, in such a way that learning has a greater possibility of becoming effective, efficient, and appealing.

Learning Community: It is a notion that received a great attention in last years by educational scholars. According to Bielaczyc and Collins (1999) the four essential characteristics to define a learning community are: (1) diversity of expertise among its members, who are valued for their contributions and are given support to develop; (2) a shared objective of continually advancing

collective knowledge and skills; (3) an emphasis on learning how to learn; and 4) mechanisms for sharing what is learned (p. 272).

Learning Environment: A definition currently accepted in literature is "*a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities*" (Wilson, 1996, p. 5).

Zone of Proximal Development (ZPD): The ZPD theory goes back to the work of social psychologist Vygotskij, according to which social interaction is critical to learning. He considers the learning process as continuously moving from an "actual development level" to a "potential development level". The movement between these two levels, where the ZPD lies, occurs through the interaction of an expert and a novice.

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Chapter 7.2

Humanistic Theories that Guide Online Course Design

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INTRODUCTION

Humanism comes from one of three schools of psychology in which theories are categorized. The other two schools are the schools of behaviorism and cognitivism. It is believed that one school of theory is not better than the other, and individuals are encouraged to apply the theory that is the most appropriate for the student. Theories from the school of humanism focus on students' affective needs which means that the theorists center their attention on feelings, emotions, values, and attitudes (Tomei, 2007). Colonel Parker, once deemed the Father of Progressivism of the nineteenth century by John Dewey, promoted creating curriculum with the child at its center. He wanted the school to be a replica of home, an inclusive community, and a budding democracy

for the students. Parker's work and thought on curriculum would eventually be an apparent part of John Dewey's progressive work (Pinar, Reynolds, Slattery, & Taubman, 1996).

Years later, G. Stanley Hall fervently criticized a report created by the Committee of Ten that promoted fitting children in a learning mold that consisted of canned subjects that were meant to be taught to all students in the same way without individualization of any kind. Hall rejected these ideas, because he believed that changes in society evolved slowly and that genetics not surroundings impacted students. Unlike Parker's push for individualization so that every child's needs could be met, Hall believed in individualization so that the gifted child would stand out. Eventually, Hall's critics who saw no need for social reform labeled his laissez-faire ideas as disastrous (Pinar et al., 1996).

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Then, during the 1950s, theorists such as Elliot W. Eisner, Ross Mooney, and Paul Klohr expressed their views concerning curriculum and the need of the educator to design curriculum that focused on self-value. Finally, during the 1960s, humanism began to be thought of as the third psychological orientation that followed theories of behaviorism and cognitivism. At this time, Carl Rogers and Abraham Maslow, respected humanistic psychologists, began to contribute papers on humanism which provided the field with an alternative educational view. The change that began to occur was considered to be a paradigm shift in which theorists moved from an interest in curriculum development to an interest in understanding curriculum. It was antiwar efforts and political unrest that helped drive the interest in a curriculum that focused on the self (Pinar et al., 1996).

Researchers noted that in 1975, McNeil presented four conceptions of curriculum: the humanistic, the social reconstructionist, the technological, and the academic curriculum conception (Pinar et al., 1996). The humanistic view brought back the facet of progressivism that looked to child-centered and individual-focused learning experiences. This came as the social reconstructionists tried to bring about societal reform through school reform.

HUMANISTIC THEORIES AND ONLINE DESIGN

When we look at the past, we see that theorists such as Elliot Eisner and Elizabeth Vallance thought of schooling as a way for individuals to gain personal fulfillment. They thought of it as a means to provide a way for people to discover and create their own identities. Curriculum, at that time, had the responsibility of fostering personal development in many different ways. Theorists began to present their theories through

models of teaching and learning (Pinar, et al., 1996). For example, the phenomenal field theory, self-actualization theory, theory on nondirective teaching, theory of moral development, theory of immediacy and social presence, and cooperative learning theory came about.

Phenomenal Field Theory

A humanistic theorist named Arthur Combs presented his phenomenal field theory with psychologist Donald Snygg. According to this theory, they postulated that to understand human behavior, the time must be taken to consider the point of view of another. They believed that if one wanted to change another person's behavior that he or she must first modify his or her beliefs or perception. One had to "walk in their shoes" if one wanted to understand and guide change. By taking this line of thinking, educators had to recognize that the learner needed to find meaning and understand the learning as opposed to learning and understanding the strategies (Boeree, 2007; Tomei, 2007).

Combs and Snygg felt that if they were to understand and foresee the behavior of another that they had to reach into the person's phenomenal field. Since it was impossible for them to physically look into another person's mind, they had to make inferences from what was observed. When educators utilize this theory, they cannot choose a topic of instruction and a strategy, implement the learning experience, and expect every child to be motivated by what has been placed before them, because the information does not connect to their own lives. Instead, the educators have to get to know the learner's phenomenal self and create learning experiences that have meaning to the learner. Once instructors take this path, the student that was not motivated to learn at one time will become connected to the learning experience (Boeree, 2007; Tomei, 2007).

Self-Actualization Theory

Nearly forty years ago, Abraham Maslow and Carl Rogers presented their ideas about personal growth and performance in connection with individual differences in how individuals respond to their physical and social environment. Other theorists who based their theory in the other schools of psychology focused on ability and development. Maslow and Rogers focused on an individual's view of his or her self. Maslow believed that strong beliefs about one's self was connected to the thought of self-actualization. According to his thinking, individuals with strong self-actualization interacted well with others, and they found ways to develop and contribute to the world around them fairly easily. Those who did not have strong self-actualization choose to live within their environment and accept what comes their way, instead of reaching into their environment and making new opportunities happen for themselves. People of this nature are less secure with themselves in their environment and their ability to succeed. Maslow believed that every individual had a force within that either sought or shunned growth (Joyce, Weil, & Calhoun, 2000; Pinar et al., 1996; Tomei, 2007).

For people to reach the level of self-actualization, they had to be fulfilled at each level of what Maslow referred to as the hierarchy of needs. The first level was the biological level. At this level, an individual's need for food and shelter had to be met before the individual could move to another level. At the next level, the individual would have to feel secure. Level three of the hierarchy of needs demanded that the individual felt as though the individual belonged and was loved. Needs for self-respect, achievement, attention, and recognition needed to be fulfilled if an individual was to move past the esteem level of the hierarchy. When an individual had past each of those levels, the individual had reached the final level, the level of self-actualization. At this point, the individual's ability to reach potential

could take place. While each level had to be fulfilled, they did not have to stand alone and one behavior could satisfy more than one level on the hierarchy. Instructors who utilize this theory when designing and conducting a course look to see if their students' needs have been met to help them understand student behavior (Joyce et al., 2000; Pinar et al., 1996; Tomei, 2007).

Nondirective Teaching Theory

Carl Rogers believed that in order for people to grow, they needed positive relationships with other people. Instructors who have utilized this theory nurtured their students instead of controlling the learning experience. The nondirective procedure required the teacher to guide students to explore new information and experience new occurrences in the world around them. According to this theory, students and their teachers are partners in learning (Joyce, et al., 2000). Rogers believed that all humans had an innate drive to learn. He felt that when a student viewed the learning as valuable that the experience would be valuable to the student. Educators were expected to create a threat free learning environment where students could initiate learning, and they could think metacognitively about their own learning needs. Teachers were seen as facilitators in the nondirective teaching approach (Joyce et al., 2000; Tomei, 2007).

Theory of Moral Development

Lawrence Kohlberg developed the theory of moral development. According to Kohlberg, individuals moved through different stages that defined their own perception of justice. He presented three levels from which he believed morals developed. The first level, the preconventional level, was divided into two stages. At this level, individuals responded to the cultural rules and labels of good and bad or right and wrong. During the first stage of this level, the individual's moral judgment was motivated by a need not to be punished. An individual's

moral judgment was impacted during the second stage by the need to satisfy personal desires. The second level of the moral development theory was the conventional level. At this level, honoring the expectations of one's family, friends, or others in society determined the individual's development. This phase also contained two separate stages. The first stage from the second level held that individual and moral judgment was impacted by the need to avoid rejection, disaffection, and disapproval. The second stage at this level showed moral judgment to be impacted by one's need to not be criticized by others. The third phase of this theory was the postconventional stage. During this stage, individuals tried to describe the morals and values that they felt were valuable. Individuals from this level of moral judgment tend to be influenced by community respect and a need for social order. Those at the second stage from the third level found that their moral judgment was motivated by their own conscience. Instructors who integrated this theory in the curriculum guided the learners to look at their own moral situation, and they lead them to recognize how they justified their moral position. Critics of this theory have indicated that it is difficult for a teacher to apply this theory during instruction because the students were all at different levels of moral development (Joyce et al., 2000; Pinar et al., 1996; Tomei, 2007).

Theory of Immediacy and Social Presence

A model of online learning which presented the significance of social presence during asynchronous computer mediated discussion was presented by Rourke, Anderson, Garison, and Archer (2001). They held that learning took place through the interaction of three core components: cognitive presence, teaching presence, and social presence. A more in-depth look was made by the researchers of the social presence response and was presented as affective responses, interactive responses,

and cohesive responses (Martyn, 2004). These responses were used as indicators by Rourke et al. (2001) when analyzing content during their exploration of computer mediated discussions and affective behaviors among participants. Learners' perceptions were an important factor that instructors kept in mind when designing online courses, because learners' perceptions influenced their behavior. Two behaviors that have had an impact on interaction are immediacy or quick response to an act or question and social presence referred to a learner's skill of visually and affectively interacting in the learning environment whether it be done synchronously or asynchronously.

After administering a questionnaire, researchers found that perceptions of interaction had an influential effect. In the case of this study, the teacher's perceptions of the interaction influenced how the students perceived the actual interaction which in turn influenced the teacher's perceptions of interaction. Based on the results of the study, self-assessment and self-reflection on the part of the teacher for the purpose of modifying the actual interaction was necessary if the teacher wanted to change the perceptions of interaction in the classroom. If perceptions were adjusted for the better then circular communication processes developed so that behaviors were influenced to be more interactive (Fisher, Richards, & Newby, 2001).

Predictors of learner satisfaction were explored by Gunawardena and Duphorne (2000) in a study that focused on the academic computer conference environment. Of the influential factors that they investigated in the study, comfort with participating in discussions, easiness with communicating with text, and assurance with presenting oneself into a computer mediated discussion were some of the variables that significantly impacted learners' perceptions. Results pointed to the understanding that learners' social presence was effected by students' perceptions of preparedness and that course design and immediacy on the part of the instructors attended to familiarize the

learners with online features, computer mediated discussion learning approaches, as well as the tools and abilities that they needed to feel ready to participate in a discussion.

Murphy (2004) presents sharing personal information, recognizing group presence, communication appreciation towards other participants, expressing feelings and emotions, and expressing motivation about a project or participation as indicators of social presence in a computer mediated discussion that promoted collaboration. Social presence existed as a lower level thinking ability on the online asynchronous discussion model that was designed and presented by the researcher. Social presence was a significant engagement that the researcher found to exist during a computer mediated discussion. It was a skill or behavior that learners needed to accomplish before they could move to the higher levels of Murphy's design model.

Cooperative Learning Theory

Five facets of the basic elements of cooperative learning were presented to help others understand how to design learning experiences that utilized cooperative learning theory. Positive interdependence took place when students worked together, and they perceived that they were moving toward the same goal. Direct interaction occurred when students discussed what they planned to do and how to go about it. Individual accountability brought individuals to master learning while sharing and working with others. Attaining collaborative skills involved individuals working together before they could cooperate and learn. Finally, group processing took place when the individuals in the group discussed and evaluated their work. Upon evaluation, the group members found that they worked well together. Instructors who have applied this theory would guide their students through each facet of the model. The more students developed, the better that worked in a cooperative learning situation (Joyce et al., 2000).

Teaching Tips

Instructors who utilized humanistic theory were advised to use developmental psychology as a guide for adjusting instruction so that the students were asked to perform at their own developmental level. Some instructors found that once they had identified their students' developmental level of ability that they should not expose the students to the higher levels of instruction. Other instructors believed in instructing just above the students developmental level because the students were not ready. Joyce et al. (2000) indicate that instructors should not underestimate an individual's mind. They felt instructors should remember that students need hands-on experience to help them understand the concepts.

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KEY TERMS AND DEFINITIONS

Behavioral Theory: Behavioral theory comes from one of three schools of psychology in which

theories are categorized. Theories from the school of behaviorism hold that the environment has an impact on learning and that all behavior is learned.

Cognitive Theory: Cognitive theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of cognitivism guide students to process information in ways that are meaningful to the student. These theories are based on declarative and procedural learning tasks that are authentic.

Humanistic Theory: Humanistic theory comes from one of three schools of psychology in which theories are categorized. Theories from the school of humanism focus on learner's affective needs that include their feelings, emotions, values, and attitudes.

Instructional Design Theory: Use of theory by professionals when designing, developing, managing, and evaluating a learning experience.

Online Instructors: Qualified individuals who have had the schooling or training to teach or guide learners to gain new knowledge and abilities in an online learning environment.

Online Learning: A form of learning in which learners interact with each other and the instructor through either asynchronous or synchronous modes of learning.

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Chapter 7.3

Commodity, Firmness, and Delight: *Four Modes of Instructional Design Practice*

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This chapter is interactive, with surveys and reflective examinations of the reader's own work in instructional design. It examines instructional design using four professional models: manufacturer, engineer, architect and artist to help develop a broader understanding of the process of design. The values of the instructional design are also challenged, with the chapter examining the balance between utility and aesthetics, function and form. It concludes with a call for the instructional designer to work more as an artist, and offers tactics to encourage that change.

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INTRODUCTION

How do *you* solve an instructional design problem? Do you attempt to craft a solution based on the unique demands of each problem and the application of well researched instructional strategies? Or do you build upon an existing model, one that has worked many times before, selecting from solutions developed for a range of previous projects?

Your work is directly connected to your conceptualization of your role within the field of instructional design. And that conception includes assumptions and biases about processes, theories, and products. In the course of this chapter we

will ask you to re-conceptualize your professional practice as an instructional designer and to recognize the roles of instructional manufacturer, instructional engineer, instructional architect, and instructional artist. We will describe how the working ethos of each shapes their practice.

What then, would happen if you were an *instructional artist*? As an instructional artist, you might be encouraged to create fundamentally different designs and work in a completely different manner. You might begin from an idea, engaging and desirable, but unconnected with learning, only later to apply it to instruction. It might work; it might not; but the application would be entirely different. We can see that the perspective through which we view ourselves biases how we understand and address problems.

Your Balance in Design

The following survey is intended to stimulate personal reflection and discussion of the ideas included in this chapter. Participating in the survey will help you to engage with the article, to stimulate understanding of the concepts presented, and to reflect on your personal practice as an instructional designer. The survey was built from the characteristics which will be explored in this chapter, and will focus on the Vitruvian values of *commodity*, *firmness* and *delight*. We will pose these questions twice in the course of this writing, the second time at the conclusion of the chapter.

To complete each question, select the point on the Likert scale most aligned with your *current* practice. Note that there is no middle point and there are no right or wrong answers. Questions are intended to create difficult choices, encouraging

personal reflection. After completing the survey, score each response according to the directions that follow.

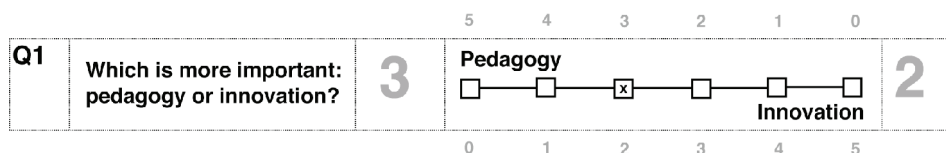
Scoring of Each Item in the Survey

Each question is given two scores which are entered in the boxes to the left and right of the Likert scale. To determine the score for the left box, count the number of blank spaces from the right margin to your entry (each margin is set at 0). For the right box, count the number of blank spaces from the left margin to your entry. In the illustration below (see Figure 1) the sample entry is three steps from the right margin, scoring 3 points for pedagogy. Likewise, the check is two steps from the left margin, scoring 2 points for Innovation. Together, the total points awarded for each question must sum to 5. There are 21 questions, with 105 points in total.

Calculating Your Score

After scoring each item, use the table below to assign points to the three categories (i.e., commodity, firmness, and delight). Each question will produce two scores. The short answers for each question are included in the table to help with proper scoring. For example, in the scoring example above, “pedagogically sound” will be in one box, and “Innovative” in another; the appropriate score should be written in each box. Shaded boxes designate comparisons not included for that question; do not write in scores in those places. Add the points when complete to achieve a total score for commodity, firmness, and delight.

Figure 1. How to calculate the survey score



Scores should be interpreted as follows:

- 0-14 points: low
- 20-50 points: medium
- 51 + points: high

We will help you to analyze and interpret your scores later in the chapter.

INSTRUCTIONAL DESIGN

Instructional design is guided by a range of theories and ideas, beliefs and assumptions, not the least of which is a perception of our own practice. Consequently, if we view the process of instruc-

tional design as one of production (that is, the manufacture of instructional materials) we will create work limited in conception and execution. Similarly, if we go beyond mere production to engage theories of learning and perception, the scientifically based outcomes are engineered, highly efficient, yet may lack the wholeness needed for the development of knowledge (Wilson, 2005). To be complete, we must extend our self-image and think beyond production or engineering. We must seek a balanced model of professional practice, one which expands our understanding of design itself.

Ultimately, in this chapter, we hope to improve educational practice through the design and development of technology based products and methods.

Table 2. Scoring the survey

Q	Commodity		Firmness		Delight	
01CD	Teacher				Artist	
02CF	Functionally useful		Stable			
03CF	Content providers		Tools			
04CD	Pedagogically sound					
05CF	Usability		Utility		Innovate	
06FD			Stability		Visual richness	
07CD	Easy to use				Motivating	
08FD			Functional capability		Motivation	
09CD	People				Design experiences	
10CF	Pedagogical soundness		Efficiency			
11FD			ID products		ID experiences	
12CD	Content				Experience	
13CD	Usability				Aesthetics	
14CF	Teacher		Technician			
15CD	Functionality				Visual richness	
16FD			Tools for learning		Tools for experience	
17FD			Efficiency		Innovation	
18FD			Utility		Aesthetics	
19CF	Ease of use		Functional capability			
20FD			Technician		Artist	
21CF	People		Products			
	Commodity Total		Firmness Total		Delight Total	

Achieving such a goal requires an understanding of the relationship between instructional design practice and product. To clarify this relationship, we examine instructional design through the architectural dictum of Vitruvius: commodity, firmness and delight. We will identify four modes of design practice; instructional manufacturer, instructional engineer, instructional architect, and instructional artist; and examine how the Vitruvian values are employed. Finally, we offer tactics to promote a balanced approach to instructional design.

Methods

Instructional design specifically addresses learning through products and contexts which facilitate the development of knowledge (Parrish, 2005). The traditional methodology of the instructional design field encompasses the analysis, design, development, implementation, and evaluation of instructional processes and products (Reiser, 2001). Other professional fields of design, such as interface design, systems engineering, information sciences, industrial design, technical communications, and new media design have similarly strong understandings in psychology, community context, implementation, and social value (Wilson, 2005).

To orient the field toward design work that engages learners more meaningfully and effectively, instructional designers must begin to focus on creating *experiences*, as opposed to simply developing products or processes. To engage and involve the learner, instructional designers must shift their practice. Substantial innovation in the field will occur only when designers surpass the technical and pedagogical issues in their work. (Innovation is messy and difficult in most situations, particularly including education). Beyond utility is the affective domain, the engagement of the learner, the beauty within the eye of the beholder; not the steak but the sizzle. This is the aesthetics of design.

For thousands of years, philosophers and designers have used the term aesthetics, often interchangeably with the word beauty, to illustrate the sensual relationship and dynamic perception of art to culture (Lavie & Tractinsky, 2004; Parrish, 2005). For example, Leone Battista Alberti, the Italian 15th century architect, painter, and philosopher, defined aesthetics as “a great and holy matter,” essentially the harmony of all design elements in proportional relationship to one another (Johnson, 1994, p. 402).

Formally established as a philosophical means to critique the visual arts, literature, music, performing arts, and even food (Ekuan, 1998), aesthetics is defined by the *American Heritage Dictionary of the English Language* as “an artistically beautiful or pleasing experience” (Tractinsky, 2004, p. 11). However, the influence of aesthetics and its significance to the instructional design community moves beyond illustrating the relationship of art to culture and simply critiquing the surface level elements (e.g., shape, color, texture, etc.) of objects and environments (Parrish, 2005). Parrish (2005) defines aesthetics as “a quality that exists equally in the experiences of everyday life as in the fine arts, and one that certainly applies to the learning experiences we design as instructional designers” (p. 16). Central to human thought and practice (Lavie & Tractinsky, 2004), aesthetic experiences provide a foundation for the intellectual activities associated with learning (Parrish, 2005). For the purposes of this chapter, we define aesthetics as those elements of interactive design which are focused primarily on enhancing and heightening the learner’s experience, as opposed to elements that merely satisfy the pedagogical or technological needs of the instructional objectives. In other words, aesthetics is *design beyond done*, the essence of the design process which continues after the completion of operational and technical requirements.

For the most part, aesthetics has been largely overlooked by instructional designers; only a handful of recent articles address the relationship

between aesthetics and usability (cf. Aspillagae, 1991; Kirschner, Strijbos, Kreijns, & Beers, 2004; Parizotto-Ribeiro & Hammond, 2004). The instructional design community at present is concerned primarily with performance improvement and systematic instructional design procedures (Reiser, 2001). The field's reluctance to acknowledge aesthetics as an integral facet of instructional design curriculum, practice, and research will suppress the development of engaging learning media and, ultimately, the effectiveness of instruction (Parrish, 2005; Wilson, 2005).

Parrish (2005) posits that instructional designers often view aesthetics as a superficial quality which encourages passivity by creating an illusion of learning, sidetracking the chief responsibilities of instruction. Yet others suggest aesthetics should exist at the core of design, intertwined with utility and usability, to provide pleasant experiences that enhance and extend the way people work and learn with technology (Kirschner et al., 2004). Frequently viewed as superficial, aesthetic design gets overlooked in lieu of utility and efficiency (Tractinsky, 2004) and is traditionally delegated to graphic designers late in the design process (Parrish, 2005).

Although instructional designers often neglect the potential impact of aesthetics on learning and view emotional design as a superficial task, many disciplines (e.g., architecture, automotive engineering, interior design, etc.) view aesthetics as a principal design element in the problem-solving process (Parrish, 2005). For example, automotive engineers often place the aesthetics of their vehicles at the core of the design process, playing a vital role alongside utility and usability in the development of the final design. Instructional designers, "beholden to the dry, yeastless qualities of their work" (p. 5) tend to focus on theoretical strategies and levels of efficiency, rather than discussing how their designs emotionally inspire or motivate learners.

Some in the field of instructional design have begun to address a balanced approach which

includes aesthetics in their work. For example, interaction design is a framework anchored in utility, usability, and aesthetics focused on creating pleasurable learning experiences that appeal to and benefit the user (Kirschner et al., 2004). While utility is defined as the array of functionalities and features incorporated by a system (i.e., the tools present in the software that satisfy the outlined pedagogical requirements), usability is concerned with the effectiveness, efficiency, and satisfaction with which learners can accomplish a set of tasks. Together, the utility and usability of a design represent the *usefulness* of the system. For a system to be perceived as useful by its audience, the design of a software environment must balance utility and usability. In addition, interaction design is concerned with aesthetics and emotion, more precisely, how the software may appeal to and benefit learners (Kirschner et al., 2004).

BALANCE

Some design fields have long recognized a value in the balance of the functional, technical, *and* aesthetic aspects of design. It is implicit that no one aspect should dominate, nor should any be neglected. From intercontinental bridges across the Bering strait to the elegant simplicity of an orange juicer (Norman, 2004), delight, beauty, and aesthetics are common in the fields of engineering and product design. Historically, architecture has codified this balance as *commodity, firmness, and delight*.

In the first century B.C., Marcus Vitruvius Pollio, a Roman writer, architect, and engineer, authored a book titled *De architectura*, later known as *The Ten Books of Architecture* (McEwen, 2004). Considered the forefather of systematic architecture theory, Vitruvius advocated that architecture design must satisfy three discrete requirements: *firmitas* (i.e., strength), *utilitas* (i.e., utility), and *venustas* (i.e., beauty) (Tractinsky, 2004). Whereas *firmitas*, or firmness, refers to the construction

and physical soundness of a building, *utilitas*, or commodity, deals with the functional use and appropriateness of a design. The phrase “commodity, firmness, and delight” is partially attributed to Henry Wotton, who translated Vitruvius’ text in 1624.

The third Vitruvian requirement, *venustas*, or delight, refers to the aesthetic or beauty of architecture. Vitruvius believed architecture was an imitation of nature (McEwen, 2004). Humans, mirroring techniques employed by birds and animals, construct their homes as shields against nature’s elements. However, in addition to building strong, durable, and useful homes, Vitruvius believed architects must focus on the aesthetic elements, or beauty, in their designs. Beauty (i.e., delight), is responsible for making design a uniquely human process: “Is it not strange that sheep’s guts should hale souls out of men’s bodies?” (Shakespeare, W., *Much Ado About Nothing*, Act 2)

Vitruvius’ architectural requirements present an illuminating framework for instructional designers to re-align their design methods. The elements of commodity, firmness, and delight can inspire instructional designers to greater innovation and higher quality, and the three aspects of architecture can be used to inform the work of instructional design.

Within instructional design, the Vitruvian ideal of firmness can be used to describe the technical issues of instructional design, specifically how media are used and how technology is applied in a solution. Technical skill is a requisite for success here. For example, software should not crash; it should run well and be delivered on time. This is the production aspect of instructional design.

Commodity refers to the functional use of a design product. Within the field of instructional design, commodity refers to the application of instructional methods, the use of sound instructional theory, and the structuring of the interface design. Scientifically researched and proven, this is the domain of the engineering aspect of instructional design.

Delight encompasses the affective aspects of the design, from the surface aesthetic to the complete experience of the learning adventure. This is the area that is most difficult in which to succeed, and which will prove most effective and rewarding. As a dominant feature, this would describe the realm of the instructional artist, possibly sacrificing utility for aesthetics and experience.

YOUR VALUES IN THE DESIGN PROCESS

We will now revisit the results of the survey completed at the beginning of the chapter. Your scores will reflect your perception of your own work, illuminating those areas most central to your current instructional designs. Any one aspect rating in the high range (i.e., 50 points and above) indicates a predilection for that area to the detriment of others. Each area scoring in the medium range (i.e., from 20 to 50 points) indicates a balanced approach to design.

Some designers focus on a single design aspect, others successfully integrate two in their work, and many have a goal to balance all three. For example, some architects are known to put buildings together well; others understand the social, functional and programmatic aspects of the field; and some, the rare few, concentrate on the aesthetic domain of the field. (From an old anecdote; Frank Lloyd Wright to a patron with a severely leaking roof: “Enjoy. You live in a Frank Lloyd Wright building.”)

Many of the professions that create the designed objects, environments, and experiences we interact with in society can be described through the Vitruvian descriptors of commodity, firmness, and delight. For example, one can imagine the results from various cooks and chefs to the survey. Some would view food as a utilitarian need, as all people need to eat. Sufficient food is provided in many settings. It is warm, it’s cooked, and it’s safe to eat. A better diet can be provided, however, ensuring

some variety and essential nutrients needed for a healthy lifestyle such as fiber, vitamins, and antioxidants. It might not taste great, but it's very good for you. Some meals reach the level, however, of *cuisine* where the taste, the smell, the nutrition, the visual sensation, and the experience of the meal combine to make something exceptional. In that case, the chef may have achieved the Vitruvian charges of commodity, firmness, and delight. And so should we in instructional design.

One way to apply the three Vitruvian aspects to instructional design is to use other design professions as models for our work. Although many definitions of instructional design exist, models for professional orientation can provide a means to advance the field.

INSTRUCTIONAL MODES OF PRACTICE

We have identified four modes representing distinct yet common approaches to instructional design practice: the instructional manufacturer, instructional engineer, instructional architect, and instructional artist. The modes were developed from our observations of design practice, and are used as a sorting mechanism, a 'hat' to help understand what is a continuum of practice with varied characteristics (see, for example, Rowling, 1996). Names were chosen to signify various processes in design. Each mode differs on several dimensions (see Table 1). Most importantly, practitioners in each mode differ in how they go about their work; the difference is reflected in the nature of their products. After reading the modes of practice, we ask the reader to identify their personal primary design approach from within the modes.

The *manufacturer* is a developer of instructional materials. The manufacturer is often a technician who applies a pre-defined design model or template to solve an educational problem and delivers a product as efficiently as possible. To a large extent, the solution to an educational

problem is presented to the manufacturer whose responsibility becomes one of developmental efficiency. Product consistency and stability are of primary importance, leading to results that are predictable and stable.

The *engineer* is an instructional problem solver. The engineer is generally a highly trained professional who ensures a product achieves its educational goal and is usable by the target audience. The engineer can apply contemporary research-based ideas to develop educational materials. Thus, interface design and pedagogical theory are important components of this mode of instructional design. The engineer's principal goal is the functional efficiency of the design.

The *architect* extends the engineer's functional and usable solution and attempts to incorporate aesthetics at the core of the design process. By doing so, the architect explores divergent solutions that extend and cultivate the affordances of a medium. The architect's approach to instructional design attempts to balance utility, usability, and aesthetics.

The *artist* is an instructional explorer. The artist uses instructional problems as stimuli to experiment with media and affordances. The instructional artist may work without client or audience, only later attempting to apply to instructional practice what has been learned through the artistic experience. The artist embraces failure and engages in continuous self-criticism while attempting to understand both the problem and self.

What then is your mode of instructional design practice? One's perception of role indicates one's general orientation; in other words, how you perceive your professional orientation will affect your processes and methods of working. Most designers have one principal orientation for work. In reality of course, most instructional designers operate in different modes at different times, but for our purposes here, understanding your principal mode of operation will provide a basis for understanding this chapter. The results of your survey can help you locate your own profes-

Table 1. Survey

Q1	Are you a teacher or an artist?		Teacher Artist
Q2	Which is more important: a functionally useful product or a stable product?		Functionally useful Stable
Q3	Should media be used as tools or content providers?		Content providers Tools
Q4	Which is more important: pedagogical soundness or innovation?		Pedagogically sound Innovative
Q5	Which is more important: software usability or utility?		Usability Utility
Q6	Which is more important: software stability or visual richness?		Stability Visual richness
Q7	Should designs be easy to use or motivating to the learner?		Easy to use Motivating
Q8	Which is more important: functional capability or learner motivation?		Functional capability Motivation
Q9	Should people or design experiences be more central in ID?		People Design Experiences
Q10	Which is more important: pedagogical soundness or efficiency?		Pedagogical soundness Efficiency
Q11	Should products or experiences be more central in ID?		ID Products ID Experiences
Q12	Which is more important in media use: content or experience?		Content Experience
Q13	Which is more important in media use: usability or aesthetics?		Usability Aesthetics
Q14	Are you a teacher or technician?		Teacher Technician
Q15	Which is more important: product functionality or visual richness?		Functionality Visual Richness
Q16	Do media provide tools for learning or tools to create experiences?		Tools for learning Tools for experience
Q17	Which is more important: efficiency or innovation?		Efficiency Innovation
Q18	Which is more important in media use: utility or aesthetics?		Utility Aesthetics
Q19	Which is more important: ease of use or functional capability?		Ease of use Functional capability
Q20	Are you a technician or an artist?		Technician Artist
Q21	Should products or people be more central in ID?		People Products

sional practice among these four modes. It is hoped by examining beliefs inherent in the survey questions we can stimulate reflection and encourage balance within the field.

We can examine each of the modes by using hypothetical results from our earlier survey (see Figures 1–4). Although we illustrate the performance of each of the four modes across a range

Table 3. Focus of the design process for the artist, architect, engineer, and manufacturer

Focus	Artist	Architect	Engineer	Manufacturer
Audience	Self	End users	End users	Irrelevant: Audience has been predetermined
Usability	Irrelevant beyond the artist	Important, but adaptable	Very important	Irrelevant: Usability has been predetermined
Technical robustness	Will vary according to the problem	Important, but adaptable	Very important	Irrelevant: Structure has been predetermined
Aesthetics	Critical	Important, but adaptable	Low	Irrelevant: Aesthetics has been predetermined
Profit	Irrelevant	Less important than for the engineer	Budget driven	Critical
Solution	Internally driven	Externally driven	Externally driven	Template driven

of factors, the illustrations are not presented as quantitatively precise graphs. Instead, they are intended to illustrate the changing values among different professional modes.

Manufacturers would have high scores in the firmness category, indicating a concentration on production, operation, and utility. Instructional engineers would have a high rating in commodity, with interests in usability, the scientific/research basis of education, and a focus on the human aspects of learning; they would also have a medium rating for firmness. Artists would have a high rating in the aesthetic area, possibly ignoring or viewing as less valuable other aspects of the design endeavor. Instructional architects would have a balance in the three areas with no one area

having dominance in the design process. Actual results would vary among modes and even within individuals on a day-to-day basis. We now ask you to return to your initial survey scores to compare and reflect on the illustrated modes in Figures 2–5.

We can compare how each of the four modes of instructional design is differentiated by the Vitruvian aspects (see Figure 6). We believe it is particularly important to understand how different design aspects vary across each mode. Once this pattern has been recognized, we anticipate readers will quickly understand other relationships presented herein and may generate additional relationships of their own.

Artists generally rank highest for aesthetic issues (i.e., delight), but produce correspond-

Figure 2. Commodity-firmness-delight: Instructional architect

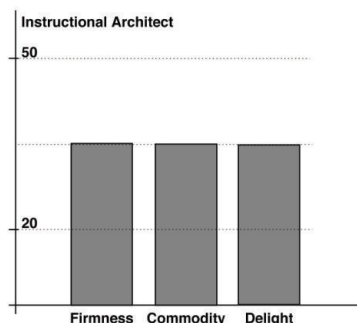


Figure 3. Commodity-firmness-delight: Instructional artist

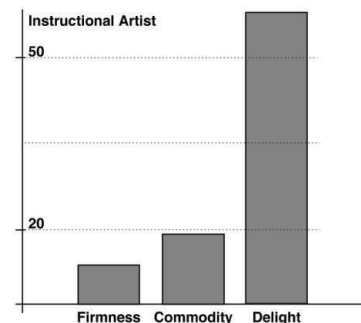


Figure 4. Commodity-firmness-delight: Instructional engineer

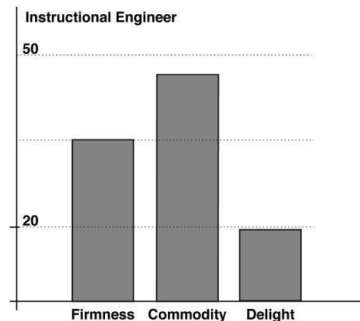
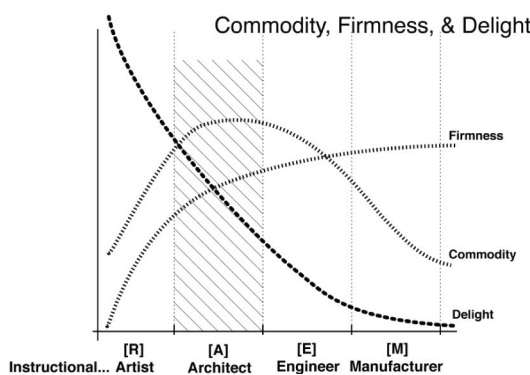
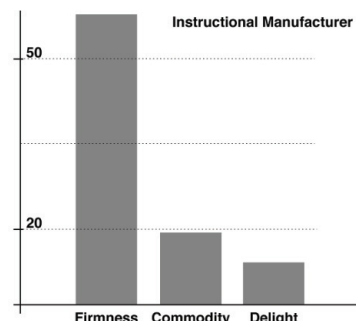


Figure 6. Differences in design approaches for the artist, architect, engineer, and manufacturer



ingly low ratings for firmness and commodity, reflecting the instructional artist's interest in the experimental, experiential, and visual as opposed to the utilitarian aspects of design. Instructional architects' scores generally reflect a balance across the three areas: no single dimension dominates the design process. Instructional engineers score high in commodity, reflecting interests in usability, the scientific/research basis of education, and a focus on the human aspects of learning. Engineers score medium for firmness. Manufacturers are concerned with the utilitarian aspects of design (i.e., efficiency, robustness, and completion) and score high in the firmness category, reflecting an emphasis on production, operation, and utility. However, they score low in commodity and have little interest in aesthetic design.

Figure 5. Commodity-firmness-delight: Instructional manufacturer



These classifications suggest one's attitudes and goals for instructional design. We contend that the field of instructional design emphasizes function and theory, neglecting affective and aesthetic issues to the detriment of education.

INSTRUCTIONAL DESIGN EDUCATION AND INNOVATION

While our observations of the field and subsequent description of modes of practice can shed light on the field of instructional design, comparisons with other aspects of professional practice can also be valuable. In this graph we illustrate two separate areas, innovation and instructional design education. Each is discussed separately, and in combination below.

Within instructional design education, the focus of learning is principally on the manufacturing and engineering modes. Indeed, we suspect many instructional designers would be happy to complete an instructional design program armed with the ability to select and apply one or more of the most frequently used design models and a foundation in using the most visible software applications in the field (Jonassen, 2006). For those most interested in manufacturing approaches, the focus on software tools becomes paramount. Many instructional design students learn how to use software to produce instructional materials,

which are often based on applying existing models of learning.

More advanced students may approach the engineering mode, employing educational and pedagogical theories in their design work. Few students of instructional design reach the level of instructional architect balancing aesthetic concerns with functional and theoretical concerns. Occasionally, students (and practitioners) assume the mantle of instructional artist, but given the radical and experimental nature of their products, their efforts tend not to be well supported.

Innovation, the ability of the field to develop and implement new methods of instructional design, varies greatly across instructional design modes. Innovation is least evident in manufacturing, where accepted production methods are maintained and applied to instructional design problems, but no new directions are used or sought. Change is incremental and craft based; improvements in efficiency are sought, but are generally modest. Instructional engineers are more likely to innovate through research-based concepts and directions, but change remains moderate. Instructional architects specifically seek new directions for their work, and hence, innovation is increased. Instructional artists, perhaps seeking the “shock of the new” (Hughes, 1991), rate highest in innovation and change.

A hypothetical comparison can be made between the educational system for instructional designers and the value placed on innovation in instructional design. While we often contend creativity and diversity are valuable, in our own students, in instructional design education, those qualities are “messy.” Quite often, our goals, like those in mainstream education, are the transmission of content and the development of proper students, graduates, and subsequently instructional designers. We are pleased to produce instructional engineers, and often fail to recognize the value of the instructional artist. A culture of innovation has not developed within instructional design education.

MEDIA FOCUS

Many instructional design students have an intense engagement with technology; many others develop skills in this area as they practice. Media can be the stepchildren of instructional design: a chore to some, but a pleasure to others. How we emphasize or avoid media is an interesting measure of our instructional design practice (see Figure 3).

Media is an important component of instructional design, and our emphasis or lack thereof is instructive in understanding our modes of instructional design practice. As practitioners vary across the landscape of instructional design, there is a close connection between the focus on the media and our component, delight.

As with practice as an artist, increased skill in media increases the potential for innovation and aesthetic reward. This connection follows with electronic media as well; high levels of skill are often more engaging and more enriching. The instructional architect, however, realizes both the value of a focus on the media and a balanced approach to function and utility. The artist may overstate the instructional experience, whereas the engineer or manufacturer may overemphasize production and function and undervalue aesthetics.

INSTRUCTIONAL MODES IN PRACTICE

We anticipate the design approaches for each mode could be examined across diverse instructional design problems. To illustrate, we will explore the use of distance learning and how it is addressed by practitioners of each of the four modes of instructional design. Afterwards, we will ask you, the reader to imagine your own hypothetical instructional design problem and to conceive how you could, as an instructional manufacturer, engineer, architect, and artist, address the problem.

Although each solution approach will embody the designer’s theoretical conjectures about how

people learn and interact with media (i.e. expectations about how designs should function in unique instructional settings) (Sandoval & Bell, 2004), the divergent characteristics of each mode ultimately guide the exploration and solution of the problem.

When asked to develop educational materials for use through distance education, the instructional manufacturer might employ traditional instructional design methods to develop instructional materials emphasizing content presentation and application. Such materials are commonly delivered to learners via the most efficient technologies (e.g., online quizzes, Blackboard/WebCT templates, PowerPoint presentations, etc.). Most of these technologies are stable and, at the core, are based on educational theories such as constructivism, collaboration, or cognitive science, but such theories are remote from the manufacturer. Models for the design process would focus on the functional (i.e. “form follows function”). As with the architecture in the 1960s, an aesthetic could develop based on making the technology work, on utility.

Following a more innovative and media-driven approach than the manufacturer, the instructional engineer could design materials that promote higher-level learning (i.e., both near- and far-transfer) of the content. For example, the engineer could use the linear interactive affordances of a development environment such as Adobe authorware to design animations to highlight key steps in worked examples, simulated models of complex phenomena, and develop interactive exercises adaptive to the prior history of each learner.

The instructional architect, fueled by a balanced approach that includes aesthetics and innovative design, would approach the problem by designing new solutions that promote high-level learning (i.e. generation and challenge), followed by a critical examination of the solution to improve user engagement, motivation, and interaction. By scrutinizing the design and questioning the solution, instructional architects are unique in

that they are not satisfied by simply solving the problem. The architect is motivated by extending the boundaries of the available media affordances to explore solutions that enhance the learner experience, moving beyond the pedagogical and technological specifications of the instructional problem (i.e. design beyond done).

The instructional artist, operating with a high expectation of failure, would approach the scenario with little concern for the problem specifications and simply experiment with the available design media and content. For example, the artist could use the graphical capabilities of Adobe Flash to create interactive visualizations or sonic interpretations. Most importantly, although the initial goal may have been pure experimentation with experience, an instructional artist might discover techniques that promote learning. (Note that the term “might” is critical to the nature of the artist; results that are unsuccessful in generating added learning remain valuable.)

We ask now that you, the reader, imagine an instructional design problem of your own. It might be one of your current practice or one that is imaginary. How would this problem be addressed as a manufacturer, as an architect, as an engineer, and as an artist? Which is closer to your own practice or learning? And from which can you draw further inspiration?

It is important to note that most instructional designers are not purists: They do not restrict themselves to a single design mode. Instead, they often shift between modes, borrowing from each mode’s approaches and processes. For example, an instructional architect may choose to shift responsibilities toward a manufacturer to construct rapid-prototypes for transient use and experimentation with learners early in the development process. Alternatively, an instructional engineer may shift towards an architectural or artistic practice mode to enhance the aesthetic design and user engagement of their solution, essentially working “beyond done.”

The modes are dynamic: any individual designer at times may work in each of the modes. The goal of a balanced approach to instructional design is paramount, encouraging activity across the modes as necessary.

RETAKING THE SURVEY

In reading any article or experiencing any lecture, one measure of success in communication is in changes affected on the reader or audience. We now invite you to revisit the survey from the beginning of the chapter, and this time, answer the questions as to how you would like to perform as an instructional designer. An additional copy is provided after the bibliography.

Reflection on possible changes and alternative directions is valuable for most professionals, including instructional designers. Have your ratings changed? How will this change your outlook on your current position? How should this change the nature of your future design work?

We hope to continue the research surrounding this survey which is available through <http://hokanson.cdes.umn.edu/CFD/>.

MOVING TO THE LEFT: TACTICS TO INFUSE AESTHETICS IN YOUR INSTRUCTIONAL DESIGN

So how should you solve an instructional design problem? We contend that to do it well, you need to step outside of your comfortable answers and ideas. To do it well you need to embrace failure through experimentation. And to do it well, you need to be more of the instructional artist.

How then *will* you become an instructional artist? You might begin by making semantic and conceptual steps, in other words, thinking of yourself *as* an instructional artist and describing your work to others in that way. Extend that to your work procedures: redefine not only your work,

but the next project you begin. Assume that the work has hidden meaning, and that you bring to it a completely new vision.

Much of the work in instructional design is done in modes displayed on the right of Table 1, or Figures 5-7 working as an instructional manufacturer or an instructional engineer. Moving to the left (i.e., becoming more balanced in one's approach to instructional design, and working more like an instructional architect or artist) is a philosophy contingent on how *you* value the aesthetic and effectual components of your designs. A number of tactics can be employed to engage and infuse *Delight* in your practice of instructional design; they follow below. Examples of tactics and strategies are described for individuals, professional firms, and schools of instructional design, each encouraging a "move to the left".

Each of these approaches attempts to develop skills of the architect and artist, to help create work that is more engaging, experiential, and delightful. These approaches may be contrary to many aspects of practice in instructional design, and of course, should not become dominating in one's practice. They are meant to re-orient one's practice. We have based this on a series of observations about those actions which would encourage more innovative and diverse work.

Figure 7. Differences in instructional design education and innovation for the artist, architect, engineer, and manufacturer

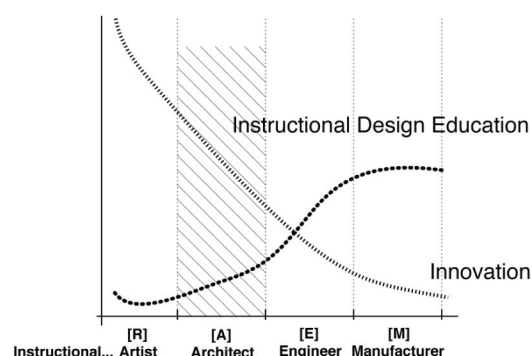
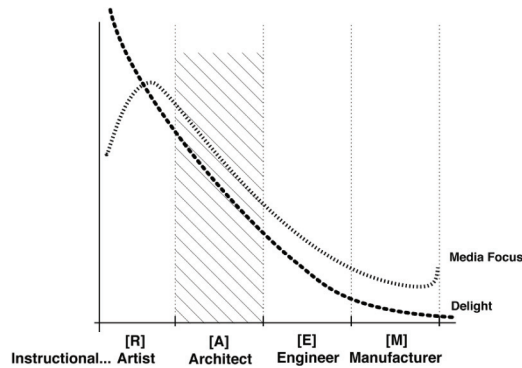


Figure 8. Differences in media focus and delight for the artist, architect, engineer, and manufacturer



- **Technological immersion leads to insight.** We believe that the instructional medium drives the selection of the method. Limiting design work to a single medium limits the ability to conceptualize those procedures possible with that medium. Similarly, having a range of different media for use allows for a cross-pollination of ideas; what you learn in Flash can help you understand audio software technology. “Intelligence is skill in multiple media” (Hokanson, 2001).
- **Diversity in background leads to innovative practice.** Expertise in a different field provides inspiration and metaphors for novel and innovative work. Pragmatically, alternative expertise stimulates divergent thought, provides varied examples of work, and attracts a wealth of contacts, discussants, and diverse experts to engage.
- **Understanding how to think, communicate, and behave as one’s audience, clients, and colleagues is valuable to any practice.** Good instructional design cannot be created in a vacuum; it needs engagement before, after, and during the design process. Understanding one’s audience is a constant in the field. We all pay lip service to the idea. However, actively engaging the audience in the design process and seeing their responses is less frequently part of the process.
- **Improve design ideas through learning to criticize and critique the work of others and yourself.** Develop a filtering system that helps you to identify what is valuable, good, and wasteful. Then use it.
- **Finding new ideas and using them is the center of design work.** Develop practices that encourage divergent uses of media. Creativity, application, and innovation are critical to advancing the field. Creativity, as a skill, can be developed through conscious practice.
- **Strive for continuous innovation and advancement in design; nothing is ever perfect.** The instructional designer should develop dissatisfaction with the status quo, striving to be better with a reach exceeding one’s grasp, striving for flow; seeking failure. There needs to be a constant questioning of the ideas, values, assumptions, and procedures of the designer. Self evaluation and critical thinking need to be integrated into the instructional design process.
- **Involvement with others, particularly peers, is valuable to professional work.** Meet, present, publish, engage, and share—discussing and critiquing one’s work in a public setting helps people to think divergently.
- **Delaying functional perfection allows aesthetic aspects to evolve.** It is important to experiment with technology and ask questions such as, “What can be done with this medium?” Relevant instructional applications need not be immediately apparent, as the artist creates learning artifacts without consideration for an intended audience or use. Instructional designers, indeed all creative professionals, would be well served by following the model of the 3M

Table 4. Moving to the left: Steps toward becoming an instructional architect or artist

Tactic	Short-hand strategy	Individual tasks/actions	Firm tasks/actions	Curriculum tasks/actions	Outline your tasks/actions
Technological immersion leads to insight	Get your hands dirty	Develop a strong expertise in at least one ID media or technology	Expand divergent skills; encourage cross-team communication of technological advancement	Provide opportunities for technical skills development: include a studio component as part of ID program	
Diversity of background leads to better practice	Become an expert at something else	Develop skills in another domain; enrich your 'day job' by expanding your skill set	Support professional development and cultural activity among employees	Provide flexibility and encouragement for non-ID course work	
Understand one's audience, colleagues, and clients	Understand people	Ask questions and listen; invite others to use your designs during the design process	Employ active user testing, prototyping, and other public engagement	Include psychology and user-testing courses in curriculum	
Improve design ideas throughout the development process	Learn to criticize and critique	Seek feedback on design work; develop a habit/process of self reflection; put your work on display when possible	Celebrate design work with open critiques; publish work through peer review	Model and include active critiques in courses and studios	
Finding and using new ideas is the essence of design	Learn to be creative	Choose the other path, the one less taken; destroy your routine; be receptive to new inspirations in any environment	Develop as a creative organization; support and develop creative ideas by all	Add creativity courses; require multiple concepts in problem solving across curriculum	
Strive for continuous innovation and advancement in design	Never finish	Integrate self evaluation and critical thinking into the design process; develop dissatisfaction	Always strive for new products; reward exploration and failure; 3M's 15% rule (Kao, 1997)	Develop skills in critical thinking and design critique; encourage and model self-reflection and improvement	
Interaction with peers improves critiquing skills, ideas, and the design process	Connect	Talk to someone else; present at conferences in ID and other fields; become active in the design community	Support employees in attending conferences, courses, and community events	Encourage participation, within ID and with other disciplines; encourage projects with other majors	
Delaying functional perfection allows aesthetic aspects to emerge	Work as an instructional artist	Create experimental instructional projects; build instructional experiences; do something wrong; value failure	Use competitions and 'what-if' sketches to investigate ideas; become less utilitarian	Reorient priorities of the design process; support "way out" projects; embrace the experimental failures of students	

Corporation, where it is expected that 15% of budgets will be used for research and experimental development (Kao, 1997).

Table 4 summarizes these topics, and both the table and the listing above are merely begin-

nings; we ask that you complete the last column in each row, outlining a set of tasks, strategies, or even daily goals to help improve your work as an instructional designer by *moving to the left*.

APPLICATION

How one describes one's work deeply affects the procedures, ideas, and quality of the work itself. We hold that instructional design has long focused on the productive and technical aspects of instructional design, the pedagogical issues or the software delivery system, and has for a long time, ignored the aesthetic and affective domains. Instructional design generally remains a craft based system, with modest theoretical direction. Adherence to traditional procedures, even perfecting the means of production, will continue to produce projects and designs that only have the same capabilities.

Now, as we close, we return to the original questions of the chapter: How *should* you solve an instructional design problem? How could you solve your most common design problem in a different way? How has this changed in reading this chapter?

Instructional designers are not engineers, or artisans, or crafts people, or manufacturers. Their work must go beyond each of these appellations. Instructional design should include all of the aspects reviewed here: commodity, firmness, and delight. Each of these qualities is essential to good design and must be addressed in the design process.

Designers begin each project without knowing the nature or quality of their ultimate solutions. We are not designing if we already know the answer. We are not designing if we follow a cookbook of theories and pedagogy. Yet, we know that the design process, of creating without a net, is engaging, challenging, and leads to superior solutions. To truly design is to extend understanding, to create something new and innovative. To design is a *goal*.

To change education you need to change your perception of your profession. To change your work, you will need to change your mind.

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Chapter 7.4

Performance Case Modeling

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ABSTRACT

This chapter introduces performance case modeling as a means of conducting a performance analysis. It argues that the design of any instruction focused on practical subjects should be preceded by understanding of the performance requirements for graduates of a course of instruction. This understanding is facilitated by the collaborative creation of diagrams that identify the different roles a performer takes and their associated goals, together with documentation of performance measures for the goals. The measures serve as a baseline for the evaluation of instructional effectiveness. Other approaches to visual languages in instructional design have been more focused on modeling the architecture of the instructional system rather than the performance environment

in which its graduates will be expected to perform. The approach described is based on UML use cases and serves to focus thinking on the performance analysis that should occur prior to the design of instruction.

INTRODUCTION

The performance analysis stage of most instructional system design process models has long been seen as one of the most crucial stages (Harless, 1970). If designers do not sufficiently understand the problem they are unlikely to create an optimal solution. In addition to aiding the understanding of the problem, performance analysis is also focused on establishing performance measures and collecting initial data. It is not possible to determine the value of a solution, such as a new course of instruction, without having analysis

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data that would allow one to show improvement over a baseline level of performance (Deming, 1982). This is especially true if designers are aiming to achieve Kirkpatrick's level 3 (on the job application of acquired skills and knowledge) and level 4 (improved organizational outcomes as a result of the acquired skills and knowledge) (Kirkpatrick, 1998). Clark and Estes (2002) present a number of case studies illustrating that data-driven analysis leads to better solutions for performance improvement.

Some terms that are often used interchangeably in performance analysis are: needs assessment (Kaufman, 1988), needs analysis (Mager & Pipe, 1984), performance assessment (Robinson and Robinson, 1995), front-end analysis (FEA) (Harless, 1988), and training needs analysis (Rossett, 1998). In this chapter the term performance analysis is used as a general term for all of these types of analyses.

The majority of attempts to adapt visual languages for instructional design have been focused on designing the solution space (the nature of the instructional system). In this chapter we will consider an approach that is specifically focused on understanding the problem space (the performance requirements for the employers of the instructional system graduates). Understanding the desired performance is an important first step that should occur prior to developing instruction or any other means of improving human performance.

The specific approach is an adaptation of use case modeling, which is part of the unified modeling language (UML). UML is a systems modeling tool which, although developed primarily for computer systems modeling, is adaptable to the modeling of other types of systems. Despite its origins in software engineering, elements of it have been adapted for such diverse purposes as business process modeling (Marshall, 2000; Eriksson and Penker, 2000) and educational modeling (IMS, 2005). Different aspects and applications of UML relative to instructional design are described in a number of chapters in this book. In this chapter

we will focus on one area of UML that has been relatively neglected.

UML is not a single language but rather a collection of diagramming techniques and specification languages that serve different purposes in systems analysis and design. It can be used both to model existing systems and to envisage models of new systems. The nine different diagramming techniques found in UML serve different purposes: describing what the static structure of a system is like (class, object, and component diagrams), describing how a system operates and information flows through the system (activity, collaboration, sequence, and statechart diagrams), describing how a system is deployed (deployment diagram), and describing the functional requirements of the system (use case diagrams). A number of the chapters in this book describe the adaptation of elements of UML for instructional systems architecture design (e.g., Chapter IX). They primarily focus on the use of Structure and Flow diagrams. In this chapter the focus will be exclusively on use case diagrams.

Given that they are concerned with system inputs and outputs rather than the internal technical details, use cases are often seen as a crucial part of UML when used in software development. Use cases aim to establish what an efficient and effective system should achieve. They serve as the starting point and driving force behind all other analysis and design activities (Jacobson, 1992; Rosenberg & Scott, 1999).

This chapter explains the concept of use case modeling, shows how it can be adapted for performance analysis (performance case modeling), discusses software tools for repositories and reuse, and suggests guidelines for applying performance case modeling.

PERFORMANCE ANALYSIS

There are a number of approaches to performance analysis prescribed and studied in the literature

(Rummler & Brache, 1995; Swanson, 1994; Wedman & Graham 1992; Schaffer, 2000).

The major tasks of performance analysis that they tend to share are the following process:

- Identify what people in particular roles are required to achieve.
- Identify gaps between exemplary (or expert) performers and typical performance or novice performers.
- Analyze causes for those gaps.
- Identify and select the solutions (e.g., required instruction) to close the gaps.

Modern approaches to performance analysis move beyond being tied to a single specific solution such as classroom instruction, and often include job support through electronic performance support systems (Raybould, 2000). Managers, supervisors, and executives may be inclined to believe that when performance problems exist it is the individual's knowledge or skills at fault; less frequently do they consider environmental factors. As a result, instruction in a traditional training setting is usually the solution they select. Optimal performance analysis identifies all factors contributing to performance by focusing on a performer and his or her work environment (Wedman & Graham, 1992).

There is evidence that the performance analysis stage of design is sometimes overlooked. Often the reason given for this is lack of time (Swanson, 1994). Rossett and Czech (1995) studied the practices of graduates of San Diego State University's Instructional Systems program and found that professionals are often unable to use their analysis skills because organizational leaders prefer a silver bullet approach to fixing problems. Ideally, performance analysis involves a partnering between the analysis team and stakeholders to define and achieve organizational goals, and it is during this process that some kind of visual modeling is likely to provide assistance in achieving a shared understanding. Performance analysis

is used to describe what is happening, what ought to be happening, and what can be done to improve the current status of the organizational problem (Wedman and Graham, 1992).

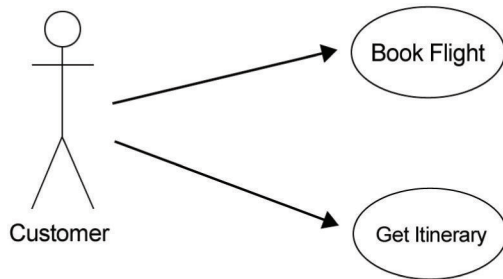
USE CASE MODELING

Use cases (Schneider & Winters, 2001) are one of the main modeling approaches that were brought together into the initial version of UML. They were developed by Jacobson (1992) as an improvement over the situation of communicating software system requirements in a purely textual form. Cockburn (1997) notes that despite the formal appearance of use case models, they are usually used informally. This is particularly so in the early stages of development.

There are two parts to creating use cases: diagramming and documentation. Diagram creation is done either on paper or a whiteboard, or using a diagram creating software tool. It is an iterative process and initial diagrams are often discarded. Figure 1 represents an initial use case diagram for a software system to support a travel booking system. The diagram elements are deliberately simple to allow sketching by people with little graphic design skill. The stick figure, referred to as an actor, represents an entity that is external to the system and interacts with it to obtain some service. This entity often represents human end-users, but it can also represent another computer system that exchanges data with the system being designed. The ellipses represent the actual use cases, which are the services provided by the system to the actors to enable them to achieve some goal.

Use case modeling is a useful informal tool for communicating with non-technical stakeholders during the domain analysis and requirements phase of a development project. Use case diagrams can also be used to brainstorm around possible functions of a new system, prior to more formal use cases being created to specify the actual

Figure 1. Use case diagram for a flight booking system



functionality of a system to be built. UML diagrams are often used in an iterative development process, where you start at a high level and go through a process of review and further refinement. The diagrams become increasingly complex as the process continues.

Once the diagrams have become established and the key use cases are identified and named, the next stage is to document them. The documentation of use cases should be done after the informal modeling leads to a stable use case diagram. As with diagramming, this is also likely to go through an iterative process, starting with sketchy and informal narratives and progressing to more detailed formal documentation. For example, Brugge and Dutoit (2000) recommend the process of identifying informal scenarios of

use. These take the form of stories about how the identified people would achieve some goal with the system being modeled. From a collection of these informal stories, a more formal representation of how a goal is achieved in the system is outlined in the use case documentation (see Table 1).

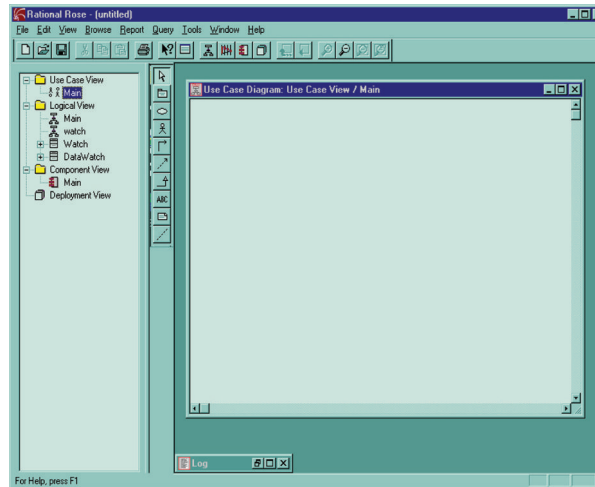
This is not necessarily a finished use case, as a stakeholder may find certain parts need to be clarified (e.g., how the customer selects the preferred trip). Once the use case is refined and in a stable state it becomes a useful resource for software engineers to identify which objects and components will be required for building the system (e.g., an interactive calendar). They would use the items highlighted in bold in the use case narrative as a starting point for UML object, class, and component diagrams which describe the structure of the system and the flow, and Interaction diagrams which show how data flows throughout the system. Many of the software tools that exist for creating UML diagrams allow the interrelating of the different diagram types (see Figure 2).

It should be emphasized that Table 1 illustrates just one example of how a use case can be documented. Practitioners of use case modeling often use variants of this basic model. Cockburn (2001) suggests that different documentation models are

Table 1. Typical documentation for a use case

use case Name	Book Flight
Participating Actor	Initiated by Customer
Entry Condition	1. Customer has logged into the system and has identified a specific travel date and destination
Flow of Events	2. System presents flight booking screen to the customer 3. Customer fills in the form by entering starting and ending point in entry fields , selecting roundtrip or one way button and travel dates from calendar object 4. Customer presses the go button 5. System searches the database using the entered requirements 6. System presents the results to the user in table format 7. Customer selects preferred trip 8. System presents detailed information on itinerary 9. Customer selects purchase or exit button
Exit Condition	10. Customer selects confirm booking or selects exit
Special Requirements	E-mail confirmation is sent within one day of confirmation

Figure 2. Screenshot from a computer-aided software engineering tool that incorporates UML (Reprint Courtesy of International Business Machines Corporation copyright © International Business Machines Corporation)



appropriate depending on the purpose of the modeling. He identifies four basic functions that use case models can perform in an organization:

- Describe a business' work process (domain analysis)
- Focus discussion about new software features (establishing the possibilities)
- Create the functional requirements for a system (determining what will be built)
- Document the design of the system (creating a map for maintenance)

He also notes that the functions might vary depending on whether they are written by a small, close-knit group, or by a large, distributed group. In addition, use cases might be used by documentation and training specialists to identify training and documentation needs of the users. They can also be used as the basis for constructing system functionality and usability tests; with the completed system you should be able to get a test subject to play the role of the actor and, with representative input data, reach the exit condition of the use case. This should be done without en-

countering problems through failure of the system or poor usability (such as not easily being able to identify and use the appropriate controls).

The use case documentation is a resource for analysts and stakeholders, which captures a description of the functionality they wish to achieve in the system (why it is being built). It is also a documentation resource for designers and developers, allowing them to start the process of identifying and connecting the structural components and information flows required within the systems they will design and build (how it should be built). In this sense, use cases drive all other modeling and development.

ADAPTING USE CASE MODELING FOR HUMAN PERFORMANCE

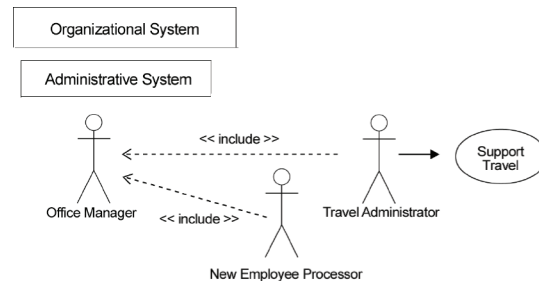
It follows that when adapting a similar modeling approach to UML for instruction, that an equivalent of use cases (to help determine why the system should be built) should be included. Those who have looked to UML to support non-software systems have tended to focus more on adapting

the structural and flow diagram techniques (IMS, 2005). This modeling is focused on describing what will be built, how it is structured and how it works, rather than answering the important question of why the system should be built. That is, why will the system being built result in a better performance from the individuals that use it and the organizations that they participate in? This is as legitimate a question for a learning system as it is for a software system. Creating the equivalent to a use case would help determine the value, in terms of individual performance, that is to be obtained by the creation of a new learning system.

In order to adapt the use case modeling scheme to the task of modeling for learning and performance support systems, we need to re-conceptualize what is meant by the actor, the use case and the system. Actors can be re-characterized as Performance Roles and use cases can be re-characterized as performance cases (Douglas, 2003). Performance Cases are goals that a person attempts to achieve with his or her own skills and knowledge, using the available tools and support available. The system refers to the organizational system of which the individual's role is an integral part. The role does not reside outside the system as the actor does in software use case modeling.

The UML concept of a package is used to collect related performance cases into a meaningful unit and to illustrate the alignment of individual performance goals with organizational goals and processes. The performance cases within packages will usually represent high-level performance goals. A high level performance case can be refined into a more detailed model. For example, Figure 3 shows a package of administrative roles and goals. 'Office Manager' is an organizational role that corresponds to an identified job title within the organization. It includes the two operational roles identified in this diagram as 'New Employee Processor' and 'Travel Administrator.' An operational role is a role someone has to adopt as part of his or her job; a given job title is likely to encompass several operational roles. Operational roles in

Figure 3. Performance case for a company travel administrator

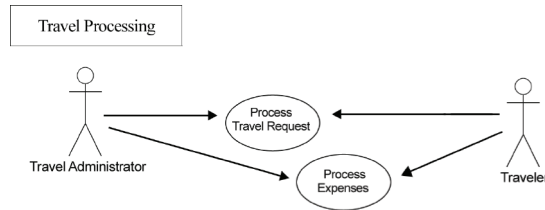


small companies may be primary roles in larger organizations. For example, a large organization may have a job title for travel administrator.

This diagram introduces the 'secondary role' to the interactions needed to achieve the performance goal. Identifying secondary roles is important because when looking at performance in an organization, people tend to focus on the knowledge and skills of the person occupying the primary role and often fail to consider those in the secondary roles. Failures in performance can be due to a lack of knowledge of the person in the secondary role, on whom performance is partially dependent, or poor communication between the two people occupying the roles.

Each of the use cases in Figure 4 is a high level Uses Case that can be refined to a lower level. Figure 5 represents an extended use case model for "Process Travel Request." In this model the person in the traveler role has to submit a travel authorization request (TAR) form, and this is processed by the travel administrator, who will check to see that the organization's travel rules are correctly applied. Already we are starting to identify knowledge needs, in that someone in the traveler role will need to know where to obtain the form, and how and when to fill it out. The travel administrator will have to know what organizational rules apply. In this particular case, the travel administrator is responsible for actually booking the trip and you will note that the use case book flight is contained within a package.

Figure 4. Travel processing performance case diagram

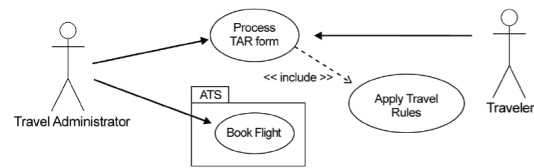


The package here is used to illustrate that the 'Book Flight' performance case is accomplished through a computer system (automated travel system or ATS).

While it is possible to adapt the notation of use case diagrams to learning and performance systems modeling, it is not so simple to apply the documentation schemes. As was noted earlier, practitioners of use case modeling in software engineering often use variants of the basic model presented in Table 1. Cockburn (2001) suggested that different documentation models are appropriate, depending on the purpose of the modeling. Certainly Table 1, which represents a basic task analysis, could be adapted to the needs of performance modeling. Any type of task analysis could be performed and documented in the performance case. Different documentation schemes would be appropriate, depending on the needs of the user and the role that performance case models can serve in an organization. This includes:

- Focusing discussion on the possibilities for improving performance through new instructional systems
- Understanding the environment in which graduates of a course of instruction will be expected to perform
- Focusing discussion on the possibilities for complementing instruction with other performance improving solutions, for example, an EPSS

Figure 5. Extended performance case for a company travel administrator



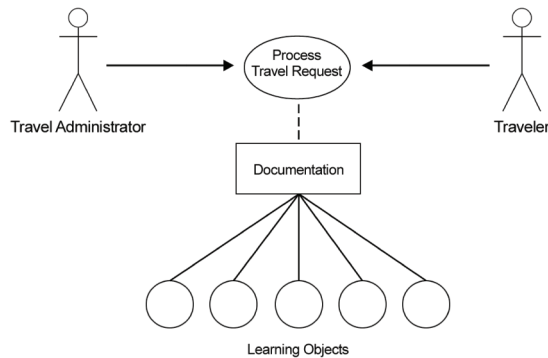
- Creating the functional requirements for a proposed instructional system
- Creating the functional requirements for solutions that complement instruction (e.g., a quick reference sheet on the company travel rules)

In the above example, the examination of the travel processing would lead to an identification of the performance roles and goals of the various participants in this system. This would serve as a starting point to enable the identification and specification of performance aids and instruction, to help them achieve their individual goals and thus serve the higher-level goal of the organization (having an efficient travel process).

In software systems, use cases not only serve to identify requirements but also, once documented, allow developers to begin to determine the software objects required to build the system and how they will interact. performance cases can serve a similar role in regard to learning systems, which are beginning to utilize an object approach (Wiley, 2000). For example, if a course of instruction for travel administrators contained a set of learning objects (see Figure 6), some of which were of general relevance (e.g., an introduction to company travel rules). These objects could be adapted for the instruction of all the employees who are likely to find themselves in the traveler role in this performance model.

Performance case modeling would best be done in association with a methodology for performance analysis of the kind developed by scholars such as Gilbert (1996) and Robinson and

Figure 6. Performance case with documentation for a company travel administrator



Robinson (1995), and promoted by the International Society for Performance Improvement (ISPI). It should be seen as preceding instructional design and should not specifically presuppose the need for new instruction. Complementary (e.g., electronic performance support systems or EPSS) or alternative solutions (e.g., automating human tasks) should also be considered.

There are several approaches to performance analysis but they all tend to be in agreement on the need for the following:

- Take a systems view of problem solving
- Focus on results that should be achieved rather than tasks under taken
- Identify good measures of performance
- Identify gaps in performance and analyze their causes using evidence rather than opinion
- Consider a full range of potential interventions that can be applied to address the causes and close the gaps

For people trained in the application of a particular solution (instructional design or software design), there is a need to recognize a potential bias towards their method, which may not always be the most appropriate or sole answer to a particular problem. Inadequate performance from individuals in organizations may be due to a lack

of skills and knowledge, but it may also be due to a dearth of good tools or of motivation. Any solution development should be preceded by a careful front-end analysis that looks at the intended goals of performance and the barriers to attaining them.

The following is some important performance-related information that could be included in the documentation of a performance analysis:

- A description of the desired performance result and linkage to desired organizational results
- The interaction of other performance roles
- The requisite knowledge and skills required by the performance roles
- Performance measures that identify standard and exemplary levels of performance

In addition, other information that may be linked to each performance case includes the following:

- Task analyses
- Cognitive models
- Detailed study of exemplary or expert performers

It is up to the community of analysts to decide the optimal documentation approaches to accompany performance diagramming and to work towards creating acceptable standards. The rest of this chapter will define and illustrate one approach that can be used to begin such a process.

PERFORMANCE CASE MODELING

Performance case modeling is a combination of the typical non-visual methods that performance analysts use, and an adaptation of the visual modeling method of the use case. Performance case modeling provides a visual method for identifying and analyzing performance requirements at the operational/individual performer level.

Performance cases represent a performance goal within an organization or process that is the responsibility of one or more people. Performance goals are attained through the effort of people undertaking a performance role. Performance roles have individual responsibilities in relation to a performance case that can be achieved by anyone with the proper knowledge and skills.

Performance case models can provide a framework for examining optimal human performance in an organization and for selecting and specifying the appropriate instruction and performance support. Exemplary performers will provide analysts with a scenario, that is, specific information on how best to achieve the goals of the case. The performance cases documentation will be abstracted from several exemplary scenarios. The documentation for each performance case will provide the foundation for identifying the resources necessary to achieve performance support for those occupying the roles responsible for achieving the performance. The performance case documentation will also enable analysts, in collaboration with stakeholders, to determine the barriers to achieving optimal performance. These barriers help classify the performance problems by causes and potential solutions, which helps analysts develop recommendations to close performance gaps.

In the course of working with specialist performance analysis units in different parts of the U.S. military, Douglas et al. (2003, 2004) examined the methods used, data collected, and knowledge management practices. In the course of this work the concept of the performance analysis object was developed. An analysis object is a proposal for the standard digital capture of a unit of analysis (defined by a specific goal). It separates out the components of an analysis, rather than merging them all into a traditional analysis document. The analysis object distills knowledge into digital objects that can be stored in a searchable database. From the database they can be linked to elements in a diagram or any other digital objects relevant

to a particular performance. Table 2 identifies the key elements of an analysis object, which form a potential standard documentation scheme for a performance case.

The key elements identify what performance is required, who is involved in attaining it, and how to measure it. The measurement indicators are particularly important not only in informing analysis and design, but also in serving as a template for subsequent evaluation efforts. That is, if a course of instruction is created based on the analysis of this performance, once someone graduates from the course you would expect to see an improvement in the identified performance measures in order for the instruction to be declared effective. The metadata requirement for the Analysis Object provides the background data on the object (e.g., what it is and who created it); the Dublin Core Metadata Initiative schema (Dublin Core Metadata Initiative, 2007) is a commonly accepted means of defining this metadata. Metadata is useful for assisting in the search for, and the reuse of, existing information resources.

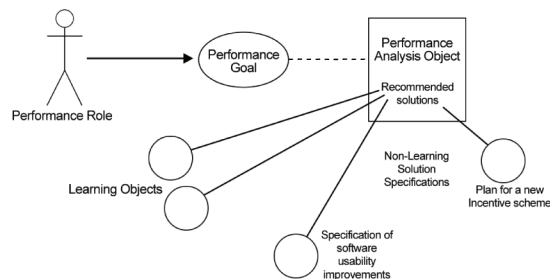
Figure 7 illustrates a refinement of Figure 6 that demonstrates the interlinking of a performance case diagram, performance analysis objects, and digital solution objects. The performance analysis object will link to digital components and documents that relate to the solutions whether they are learning or non-learning. The solutions could be existing solutions stored in digital libraries and repositories, or solutions designed and developed subsequent to the analysis.

Figure 8 illustrates a performance case diagram from an actual analysis carried out by the Center for Army Lessons Learned, a specialist performance analysis unit in the U.S. army. It illustrates the stepwise nature of constructing such diagrams. The main performer in the system is the fire support officer, the person who is responsible for planning the supporting fire from aircraft and artillery. A performer in this role will have a number of high-level goals to achieve when supporting the planning of missions. Each one of

Table 2. Elements of an analysis object

Data Element	Description	Example Data
Performance Goal	The desired achievement, result, or output that occurs at the individual level	Travel Administrator completes travel requests in a manner that is satisfactory for both the traveler and the organization
Primary Role	The individual performer who is the focus of the performance analysis process	Travel Administrator
Secondary Role	Other roles that interact with the primary role to achieve a performance goal	Traveler
Optimal Performance	Describes the desired performance at the individual level required to reach organizational goals	Process completed No errors in processing Organizational regulations are adhered to The traveler is satisfied Processed within three days
Gap Statement	The difference between desired performance and current performance	30% of travel transactions not meeting optimal performance goal
Indicators	Quantifiable criteria for a performance goal	Time to complete Errors requiring correction during processing Errors identified during auditing Traveler satisfaction survey
Cause	Statement of proposed root cause that is inhibiting optimal performance	The computer system has a difficult-to-use interface Travel requests received with little notice New staff not given enough time to adjust
Recommended Solution	Statement of a proposed instruction, or other intervention, that corrects the root cause	1. Recommend travel training be included in new employee orientation 2. Create computer system job aid 3. Request computer system usability improvements for next release 4. Create incentives for early submission of travel requests
Solution Links	Unique identifiers of any digital solutions that are reused or created subsequent to the analysis	Travel Training PowerPoint http://www.vpfa.fsu.edu/control/training/traveltraining.ppt
Metadata	Additional information provided that complies with established metadata standards	Author of object, date of creation, etc.

Figure 7. Performance case for a company travel administrator with interlinking of performance analysis objects and digital solution objects



these goals will have a number of more detailed sub-goals and the achievement of these goals will involve interaction with one or many (indicated by an asterisk) representatives of other performance roles. Indicating the interacting roles is crucial because any deficiency in performance may not just be due to lack of skills and knowledge of the FSO, it may be due to communication problems between people occupying the different roles. Thus in this example, analysts while looking at instructional requirements for a fire support officer, may in addition discover an instructional need for those who assist him.

Figure 8. Performance case package

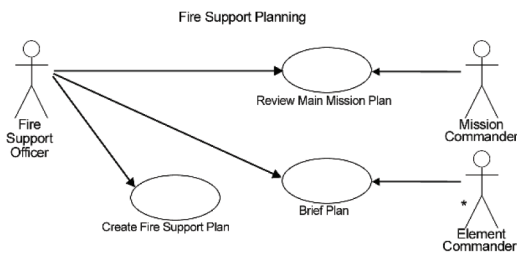


Figure 9 represents a more detailed view of the performance goals that contribute to one of the high level goals of the FSO role in the mission planning process. The diagram allows for immediate identification of the roles, goals and interactions involved in creating a fire support plan. The next step would be to create detailed documentation for the problems identified in this process that may require the development of instruction, or some other means of supporting the performer. Table 3 demonstrates how one of these performance cases would be documented. The data would be derived from interviews, surveys, observations, discussions and reviews.

It should be stressed that the creation of the models is an on-going collaborative process. These models are not meant to result in all performance cases being refined and documented to the lowest

level. The identified gaps in performance revealed through interactions with the stakeholders will guide the refinement process for the models.

Given that a great deal of effort is likely to be invested into an analysis process, it is important that the knowledge derived from this effort be archived and reused. If analysts need to reconsider problems or changes in the instruction of those involved in the various roles under consideration in the future, they will have this digital resource as a foundation to build on and modify, rather than having to redo all the analysis from scratch. It would therefore be useful for any large organization to store both completed diagrams and the related analysis objects in a digital repository. The metadata will be particularly important for this in that it will allow easy searching for relevant information in the repository.

There are a number of ways in which this documentation could be extended through the solution links and metadata relations. It has been noted that learning objects can be linked to the performance analysis object. In addition to relevant digital documents, archived interviews, and surveys, online discussions (informal analysis) can be linked into the analysis object. Another important resource that should be linked is any subsequent evaluation study on solutions created,

Figure 9. Refined performance case model for "Create Fire Support plan"

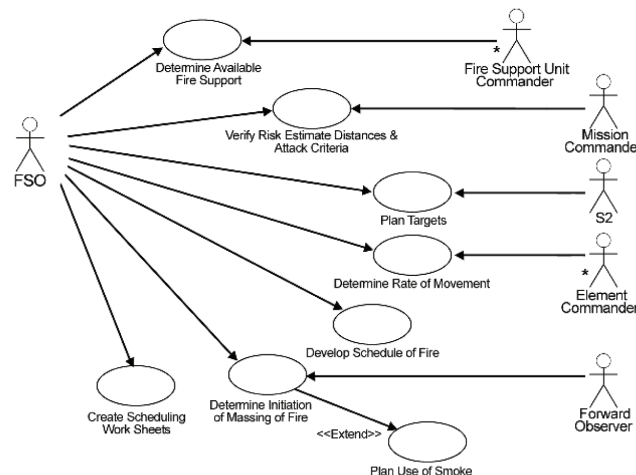


Table 3. An analysis object for the FSO analysis

Data Element	Data
Primary Role	Fire Support Officer
Performance Goal	Verify risk estimate distances & attack criteria (i.e. the risks of landing on your own forces when using long range weapons)
Secondary Role	Mission Commander
Optimal Performance	Correctly identify risks for each weapon system used Develop a comprehensive knowledge of mission plans No errors in processing
Gap Statement	Only 60% of plans after execution meet satisfaction of mission commander
Indicators	Errors identified during peer review of plan No friendly fire incidents during execution of plan Mission commander satisfied with the plan
Cause	FSOs have difficulty finding and retaining knowledge about varying risks involved in the many different weapon systems they have to deal with Calculations difficult to accomplish in available time frame
Recommended Solution	Create job aid for quick look-up of risk data Integrate job-aid into training Create software application to assist in calculation
Solution Links	Fires integration: http://www.globalsecurity.org/military/library/policy/army/fm/3-90-2/appg.htm
Metadata (derived from Dublin Core)	Title: Verify Risk Estimate Distances & Attack criteria Analysis Object Creator: Ian Douglas Subject: Military, Mission Planning Description: Contains information on the analysis of fire support planning. Identifies the roles involved, problem causes, performance indicators, and recommended solutions for achieving an optimal level of performance. Publisher: Learning Systems Institute Date: 2006-08-06 Resource Type: Analysis Object Format: XML file Identifier: 02993109 Relation: Fire Support Analysis Report, Archive of threaded discussion on this object, Performance Case Diagram for the FSO Language: eng

which will give an indication of how successful a given solution was at closing the performance gap identified in the analysis.

SOFTWARE TOOLS AND REPOSITORIES AND REUSE

Rather than using a written report at the end of a process of analysis as the main method of communicating knowledge, analysis knowledge can be collected, edited, and communicated on a continuous basis using the power of the Internet.

A digital library can serve as a single point where analysis thinking, in the form of performance case diagrams and associated analysis objects, can be reviewed, commented on, and critiqued by others on a continuous basis. If a written report is still required, it can be generated from the data entered into the objects. Roles and goals provide a useful scheme for organizing this knowledge in a way that is useful to all stakeholders.

In the work of Douglas et al. (2003), prototypes for a Net-centric performance improvement (Net-PI) system that incorporates such digital object management systems are described (see

Figure 10). The prototypes integrated the visual modeling scheme of performance cases, analysis objects, and a cataloguing system that contained records of previous roles and goals analyses. It also integrated a collaborative feature that allowed users to have threaded discussions on objects and diagrams under development. The latter is potentially important for maximizing the number of people that can review analyses and identify errors and misconceptions that would otherwise lead to faulty design and inferior performance support. The analysis is organized in the database according to roles (e.g., radio operator) and goals (e.g., establish communications), and a catalog feature that prevents the same role or goal from being analyzed and reported in two different geographic locations by two different analysts (which is easily the case without a centrally cataloged knowledge store). The analysis object also forms the basis for performance evaluation and performance support delivery. Thus, the basic model for organizing performance analysis knowledge is extended to delivery of performance support and tracking of individual and unit performance.

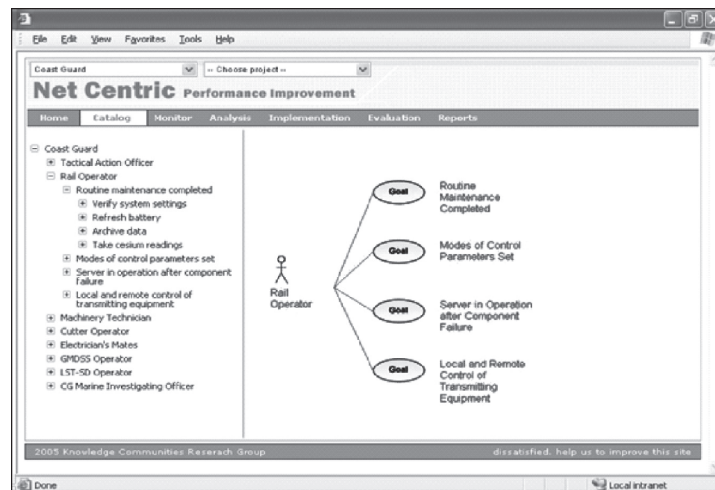
A standard system for modeling, together with a repository for analysis models and documentation, would mean that over time higher-level models would pre-exist to be reused in analysis.

Comprehensive and evolving performance models for the whole organization would emerge. This would enable the analysis of problems of similar roles and performance goals to be reused both within and across organizations.

GUIDELINES FOR APPLYING PERFORMANCE CASE MODELING

The emphasis of this chapter is that performance case modeling is a potentially useful tool in the analysis that should precede the design of instruction, or any other form of human performance improvement. No matter what modeling tool is being used, it is important not to overemphasize the power of modeling languages. The success of modeling probably has more to do with the person doing it than with the tool itself. It is important to recognize the need to develop the skills of analysis and design rather than look to a specific tool to provide a magic solution. Bell (2005) has written an influential article called *UML Fever: Its Diagnosis and Recovery*. He was motivated to do so by the seemingly blind faith being placed in UML by some advocates in the software engineering community. The critique serves as a precautionary note for those seeking to develop

Figure 10. Modeling performance in Net-PI



and use modeling schemes in instructional systems design. Here are some of the symptoms of UML fever that are also applicable to modeling languages in general:

A UML-Centric Training Curriculum

Many organizations, noting the popularity of UML, have bought tools and training for UML without focusing on the more general skill gaps among their developers. Knowledge of UML diagrams does not substitute for knowledge and experience of analysis and design methods. Without the latter, UML diagrams will be of little use.

Design Brainstorming Degrades into UML Syntax Free-For-All

Bell notes that informal diagramming around a whiteboard is a common activity in the early stages of systems development. In this chapter we have noted that use case diagrams are particularly well suited to this. Their informal use in brainstorming can be disrupted when advocates of the more formal aspects of UML push to formalize the diagramming too early.

Absence of Stakeholder Input in Artifact Development

Whoever creates a diagram should be able to state not only its purpose but also who, other than themselves, will find value in it. Ideally it should serve as a means of shared communication between stakeholders and developers, and not just be an artifact demonstrating the creative skills of a single individual (see Chapter II).

A UML Model has Turned into the Product

The models are a means to an end, creating the most efficient and effective instruction or performance support; they are not the ends in themselves.

There is the danger that if a lot of effort is put into diagram creation a project will be seen as having produced something of substance. Unless a diagram directly leads to system creation or improvement it has no substance. A diagram can even have a negative consequence if time that could be spent on building the system is instead spent on refining a diagram to perfection.

At no time should a design diagram be considered fixed and unalterable. It is also possible to initially draw diagrams only to help you understand the design (rather than document it) and then throw the diagrams away. In a sense, the process of creating the diagrams is more important than the diagrams themselves. Those who see design as a discrete process may be tempted to perfect all the diagrams before allowing any systems development to occur.

A set of guidelines for the use of modeling techniques include the following:

- Have a clear purpose for the diagram.
- Remember that the primary purpose of the diagram is communication—more than one person should be involved in its creation and as many people as possible should be involved in reviewing it.
- Do not feel you have to diagram everything.
- Do not feel you have to document everything you diagram.
- Focus your diagramming and documentation efforts on the most important things—i.e. do not create detailed, highly refined diagrams for areas where there are few performance problems.
- The effort involved in diagram creation should not substitute for system creation. The diagram is useful only if it leads to a solution of proven effectiveness.

CONCLUSION

Use cases form a key role in UML modeling, as they are the starting point for requirements

analysis, understandable by stakeholders and, through identifying objects and interactions within the documentation, an origin for the creation of other diagram types. This chapter has argued for a direct equivalent to use cases for those interested in developing modeling languages for instruction. Performance Cases as described in this chapter are intended to be used at the earliest point in the process to explore the problem, prior to selecting the appropriate solution.

Before planning instruction or any other solution aimed at improving human performance it is necessary to understand the performance environment in which individual performance takes place. It is also necessary to understand the metrics by which performance is evaluated. Performance Case modeling is a tool that can be used to facilitate this approach. It can focus instructional, and other solution designers, on what the solution is required to achieve and how it should be evaluated. It is aimed at understanding and overcoming identified causes for gaps in human performance.

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Chapter 7.5

Can Cognitive Style Predict How Individuals Use Web-Based Learning Environments?

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ABSTRACT

This chapter considers the question of whether Web-based learning environments can be employed to effectively facilitate learning. Several questions are considered around this issue, principally whether variations in hypertext architecture, and individual differences in information processing are salient factors for consideration. Furthermore, whether the effectiveness of learning depends precisely upon how learning is defined. Finally, differences in hypertext navigational strategies are assessed in terms of whether these can be predicted by individual differences in cognitive style. The chapter ends by concluding that the research on Web-based instructional systems is to some extent promising, although the field of cognitive style is diverse, and realistic predictions regarding the use of this construct in instructional design is, as yet, tenuous.

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INTRODUCTION

One of the salient features of web-based learning environments is that they can provide an explicit structure to instructional material, which should ultimately facilitate the learning process. For example, such structures can be designed to explicitly indicate the conceptual links between related information. The following chapter assesses the degree to which this theoretical position can be supported by the extant literature. More precisely, this chapter reviews the literature on how web-based or hypertext-learning systems have been employed in an educational context. We will consider issues such as the most facilitative hypertext architecture for assisting the learning process. Later in the chapter the evidence on the extent to which cognitive style mediates the effects of architecture are reviewed. Finally, evidence will be assessed regarding the way in which users navigate hypertext and how this may influence their comprehending of its structure.

BACKGROUND

Web-based learning environments are structured around hypertext systems, which allow conceptually related pieces of information to be connected or linked. Information on one page in the system can be linked to a related piece of information contained in a separate page. Such systems are user driven, in as much as individuals can choose to be 'transported' or moved within the system to pages containing related information. Furthermore, web-based or hypertext systems can be structured in a variety of ways, and the way in which the system is structured is referred to as the system architecture. Typical architectures found in the literature are 'linear', where pages of information are linked sequentially, rather like they are in a book; 'hierarchical' where superordinate information is contained in pages higher up the system, and linked to more detailed information further down in the structure and 'relational', which is similar to the hierarchical architecture, although this structure also contains lateral links between conceptually related information at the more detailed level. This chapter considers the effectiveness of learning from web-based systems, and it is appropriate at this stage to consider the term 'learning', and the way in which it has been applied in the literature. Perhaps one of the most expedient notions of learning to consider in this respect is that offered by Bloom's Taxonomy of levels of learning (Bloom, 1968). In essence, Bloom advocated that learning could be arranged at different levels ranging from basic knowledge or recall, up to a more sophisticated type of learning manifest in evaluation or synthesis of material. The notion that learning can be applied at different levels is important to consider as we review the extent to which learning may be facilitated by web-based learning environments.

WEB-BASED LEARNING AND HYPERTEXT ARCHITECTURE

A useful starting point would be to question whether using different hypertext structures differentially affect learning performance. The earlier studies considering this question seem to suggest that mixed or relational web-based or hypertext systems appear to be the most facilitative. For instance in a study by Mohageg (1982) the issue of whether question answering performance would vary following delivery of learning materials via three different web structures or architectures was considered. The architectures used in this study were hierarchical, where the learning material was constructed such that more general information was contained higher up the structure, and more specific information lower down; network, where the information was structured in a complex system of links; and mixed which was a combination of the other two structures. The findings indicated that learning performance was poorest in the network architecture condition. However, there were no differences in learning performance in the other conditions. The interpretation of this finding was that as the mixed condition featured more links than the other conditions, this may have increased the learners' facility for learning. McDonald and Stevenson (1998) employed 30 undergraduate and postgraduate students in their study of web-based learning. They also used three hypertext architectures, which were hierarchical (as described above), non-linear (in which the information was constructed in a type of network) and mixed (hierarchical with lateral links). After using one of the three systems, participants answered ten questions on information they had read in the learning system. The findings revealed that those student participants who had used the mixed system found information quicker than participants in the other conditions, which is possibly due to the fact that the mixed architecture made it easier for the users to understand the overall structure. The

above studies sought to measure learning using tests of recall, which is synonymous with basic knowledge or recall at the lower level of Bloom's Taxonomy of Learning (Bloom, 1968). However, as outlined earlier, learning also takes place at a deeper level, which could be said to involve an appreciation of the interrelationships between the various concepts and procedures in a particular subject domain. This more sophisticated approach to learning might necessitate comprehending how related concepts within a subject domain, may be arranged or constructed into a unified whole. This issue is considered with respect to web-based learning, in the following section.

Learning at a Deeper Level

In one study, Shapiro (1998) used an essay question to investigate how effectively learners showed an appreciation of the overall structure of the information contained within a web-based learning system. Three different architectures were employed in this study, which were hierarchical with some lateral links, unstructured, which had the same links as the hierarchical, but with no specific information about the structure, and linear where the material was presented sequentially, one step at a time. Seventy-two participants were asked to write an essay which required them to integrate the material they had learned from reading information from one of the web architectures. Essays were rated on four criteria which were integration of material in the essay, how well the participant understood the topic about which they were writing, the clarity of the essay and the overall quality of the essay. On all of these criteria, it was found that participants in the unstructured hypertext condition scored higher than those in the other conditions. The interpretation of this finding was that the lack of any explicit information in this condition required a deeper level of processing of the information in order for participants to understand it, and this resulted in a higher level of performance.

Concept Maps

Concept maps provide a visual representation of the interrelationships among concepts or pieces of knowledge relating to a particular subject domain. This idea was pioneered by Joseph Novak in the 1960s, and it is suggested that the technique may facilitate an individual's learning of how the finer details contributing to a wider body of knowledge are integrated. It is also conceivable that concept maps may also be employed to facilitate a user's understanding of the interrelationships between smaller, more detailed pieces of information presented in web-based learning environments. Shapiro (1998) in the study outlined above, compared also the concept mapping performance of participants, assigned to one of the three hypertext learning environments outlined. Participants were required to recall the structure of the hypertext web by producing drawings, one measure of which was amount of detail present. Participants in the linear condition included less detail in their concept maps than participants in the hierarchical and unstructured conditions. This finding was explained in terms of participants in the hierarchical and unstructured conditions visiting the same pages in the structure more times than the participants in the linear condition, thus the amount of exposure to the information, led to differences in the amount of detail recalled. Shapiro also found that participants in the hierarchical and unstructured conditions produced concept maps which reflected the actual links in these structures, and it therefore seems that the links reflect the participants' internal representations of the hypertext. A slight variation to this finding was reported by McNamara, Hardy and Hirtle (1989). They found that despite using non hierarchical hypertext environments, their participants still produced map representations which tended to be hierarchical. They explain this finding in terms of certain types of information being mentally organised in a hierarchical manner. Such a mental organisation facilitates effective recall

of the information. We now move on to consider the different ways in which individuals navigate or move around hypertext environments, and assess how this may be used to provide information on the affect it has on an individual's ability to apprehend its structure. The reasoning behind this notion is that the route an individual takes through an environment is likely to influence their representation of that space. Indeed Maglio and Matlock (1999) found that the way in which individuals move around in hypertext affects the ways in which they think about it. From their interview data, they suggest that people view hypertext as a type of physical space in which they move around. Their participants remembered landmarks and routes, and also the key information they found while navigating. In addition to this they found that participants relied on personal routines, similar to the types of routines individuals employ when travelling from one point to another. The suggestion is that the way in which an individual navigates will affect their mental representation of the hypertext. In the next section the types of navigational strategies which have been identified in the literature are examined. In the literature, the terms 'navigation' and 'browsing' are sometimes used interchangeably with regard to moving around in hypertext. The broad distinction would appear to be that browsing is considered to be a more casual non-goal related task, whereas navigating is more purposely directed towards some final end. Nevertheless, both terms refer to how we move around a hypertext system.

Navigational Strategies

Batra, Bishu and Donohue (1993) identified differences in navigational behaviour according to the hypertext architecture to which users were assigned. The two architectures they employed in their study were hierarchical and hypertorus (pages arranged in a rectangular pattern). They also looked at the effect of each type of archi-

tecture on participants' ability to answer ten questions, the answers to which could be found in the hypertext. Their results suggested that the hypertorus structure generated more exploratory browsing behaviour, but despite this the hierarchical structure made it easier for participants to locate information. However, it is easy to interpret the findings as being attributable to the number of links in each architecture. In their study Canter, Rivers and Storrs (1985) categorised navigational strategies as being related to the function each strategy serves for the user of the hypertext. These strategies included pathiness, where users follow long linear paths; loopiness, where users navigate around the hypertext in circles; ringiness, which are small loops or circles and spikeiness, where users follow paths to dead ends. The researchers also examined the number of pages within the hypertext users visited, and number of different pages visited, and the ratio of different pages visited to the total number of pages visited. From this information, they devised five distinct navigational strategies, which were scanning (covering a large area without depth), browsing (following a path until a goal is reached), searching (striving to find an explicit goal), exploring (finding out the extent of the information system) and wandering (purposeless and unstructured globe-trotting). The authors also concluded that these navigational strategies apart from wandering, have a function in navigating hypertext. Scanning and exploring are used to get an overview of the hypertext, whereas browsing is following a train of thought through the hypertext. All in all, this study provides a useful way of categorising navigational behaviour. Despite the fact that the above studies provide comprehensive information regarding the relative effectiveness of different hypertext architectures on learning, none of the studies reviewed so far has considered individual differences in the ways in which various users engage with hypertext. Because it specifically refers to individual differences in information processing

the construct of cognitive style is pertinent to consider in assessing how effectively individuals learn from hypertext.

COGNITIVE STYLE, HYPERTEXT AND LEARNING

Cognitive style can be defined as a variation in the ways in which individuals process information, in terms of differences in perceiving, remembering, recalling and applying this information. Various cognitive style constructs have been proposed by various researchers, for example reflective-impulsive (Kagan, Rosman, Day, Albert and Phillips, 1964), convergent-divergent (Guilford, 1959), leveller-sharpener (Holzman and Klein, 1954) and serialist-holist (Pask, 1972). All these style constructs are based on the notion that different style types exist at opposite ends of a continuum. The style type field dependent-independent which developed from the work of Herman Witkin is one of the most extensively used models of cognitive style. Field dependence-independence is defined in terms of whether individuals perceive entities as separate units, (field independent) or as complete wholes (field dependent). There is also evidence to suggest that there are differences in the ways in which field dependent and field independent individuals learn (Witkin, Moore, Goodenough and Cox, 1977). Field independent learners are able to see a degree of structure in what they learn, whereas field dependent learners rely more upon being provided with a structure externally. Theoretically, a highly structured hypertext instructional architecture will be of greater benefit to field dependent learners, because this will provide an organisational aid to their learning. Conversely, a poorly structured learning environment where a degree of organisation would need to be provided by the learner would be less beneficial to field dependent learners, although in such an unstructured environment, field independent learners would suffer no debilitation in learning,

because of their superior capacity for imposing structure on the material they are attempting to learn. However, the empirical evidence reviewed in the following does not necessarily support this reasoning. For example, Lin and Davidson-Shivers (1996) assessed verbal recall in a group of 139 undergraduate students, following a period of time using one of five hypertext architectures. The architectures corresponded to linear, hierarchical, hierarchical-associative, associative and random, and all of the architectures contained the same information. The participants were also assessed using the Group Embedded Figures Test (GEFT) designed to measure field dependence-independence (Witkin, Oltman, Raskin, and Karp, 1971). The results of this study revealed that participants who were more field independent as indicated by their higher GEFT scores, outperformed participants who were assessed by the GEFT as being more field dependent. In addition to this, field independent users displayed more favourable attitudes to using the hypertext than field dependent participants. The researchers explained the results by suggesting that field independent learners are more self motivated and have greater expectations of achievement. Consistent with the previous study, a further investigation assessing the differences between field dependent and field independent learners' ability to answer questions following a period of time browsing a hypertext architecture, again revealed that field dependent participants performed less well than field dependents (Korthauer and Koubek, 1994). In this study the learners were experienced with the hypertext document they used. The findings are explained by the fact that the existing knowledge of the field dependent learners and the way in which these learners attempted to represent the information, conflicted with the more explicitly structured hypertext, thus affecting their learning. However, one possible drawback with the above studies, is that the GEFT has been found to correlate with standard tests of spatial intelligence (McKenna, 1984, 1990). Accordingly, another

possible interpretation of the above studies is that field independent learners possessed greater intelligence, and this accounted for their superior performance rather than any differences in the strategies they employ in organising the information they learn. Accordingly, there is a need to consider potential differences in learning from hypertext employing a cognitive style measure independent of spatial intelligence. Melara (1996) employed forty participants who were students of computer science, maths or engineering and required them to complete Kolb's Learning Style Inventory. This instrument identified participants as possessing either a reflective or active style. Following this participants were assigned to one of two hypertext architecture conditions, which were either hierarchical or network in structure. The design of the network structure was such that it linked together related concepts in order to form a web, and the task of the participants was to answer ten questions on the information featured in the hypertext. The results revealed no differences between the participants of different learning styles in each condition, however the results were approaching significance with superior performance from participants in the hierarchical condition. Furthermore, individuals with active and reflective styles displayed superior performance when using the hierarchical architecture. In essence the results merely show that a difference exists between the two hypertext structures, although style seemed to have no effect. One further difference was that the participants in the hierarchical architecture condition took significantly longer to complete the task, than participants in the network condition, which seems to be a more likely explanation for the superior performance of participants in this condition.

Learning Measured by Essay Questions

In an extension to the studies described above, Graff (2003a) looked at whether the way in which

learning was assessed made a difference to the effect of matching different hypertext architecture conditions to the cognitive style of the learner. This study employed three hypertext architectures, which were linear, hierarchical and relational, with each representing a way in which the information to be learned was arranged. Cognitive style was measured using the Cognitive Styles Analysis (Riding, 1991), which identifies cognitive style in a way similar to the Group Embedded Figures Test (Witkin et al, 1971), but uses the label wholist for field dependent and analytic for field independent. Essay scores were measured by length and amount of detail included. The results indicated that in the relational architecture condition, intermediates (i.e. individuals between wholist and analytic styles) achieved superior scores. The findings reviewed so far appear to indicate that cognitive style does have an impact on the degree to which individuals learn from hypertext, and therefore need to be considered in the design of web-based instructional systems. However, the findings from the above studies are somewhat perplexing as they derive from an array of style measures, and therefore more research is required, with a view to unifying and consolidating different measures of style. We now move on to analyse how the application of style research can be applied to slightly more complex cognitive tasks performed within the parameters of hypertext. Graff (2002a, 2005a) assessed differences in the types of concept maps produced by learners, and whether the types of maps could be predicted from measures of cognitive style. In one study 55 participants were assigned to one of three hypertext architecture conditions which were linear, hierarchical or relational, and were instructed to recall information and produce maps of the hypertext used (Graff, 2005a). In this study cognitive style was measured with the analysis-intuition measure of cognitive style (Allinson and Hayes, 1996), and the results revealed that analysts scored highest in the hierarchical condition, intermediates scored highest in the relational condition and intuitives

scored highest in the linear condition. In terms of assessment of the concept map density (the degree to which users were able to integrate the concepts in the hypertext), participants using the hierarchical condition produced the least dense maps, with little difference between the relational and linear architectures. The higher density scores which users in the relational architecture condition produced was explained by the fact that the intricate relational architecture encouraged participants to produce dense maps purely because of the impression that this architecture gave them. The finding differs from that of Shapiro (1998) as here no differences in density scores were found between participants performing in different architectures. However, in the study by Graff (2005a), no differences in maps were found between individuals possessing different cognitive styles. In terms of assessment of map complexity, (how representative the map was of the architecture) the results revealed that participants performing in the relational architecture condition produced the most complex maps, with participants in the hierarchical condition producing the least complex maps. These results were explained by the fact that there were differences in perceived ease of use by participants in each architecture condition. The rather complex array of findings presented here provide no real evidence that cognitive style is a factor in predicting differences in concept map production.

Hypertext Segmentation and Overview Provision

When considering hypertext design, two further considerations need to be addressed. Firstly, the degree to which the hypertext should be segmented, in other words whether it should be designed with long scrolling pages, or whether the pages should be segmented and topics which are conceptually related be connected via hyperlinks. Secondly, whether the provision of an overview of the hypertext provides any advantage in guiding the user through the structure. Indeed, Dee-Lucas and

Larkin (1995) discovered that the provision of a diagrammatic overview of the hypertext system made it easier for users by directing them to significant information within the system. Similarly, Hsu and Schwen (2003) compared the effects of structural cues derived from single and multiple metaphors in the design of hypermedia documents. Fifty-four undergraduate students were required to perform selected information searching tasks, and the findings indicated that the provision of metaphorical cues helped participants to find a greater number of accurate answers and do so in a shorter period of time. However, it is entirely possible that an individual's cognitive style could influence the degree to which segmentation and provision of an overview is useful. An investigation of this issue, Graff (2003b) employed 50 participants who browsed one of two hypertext architectures containing information on psychological ethics, and also completed the Cognitive Styles Analysis (Riding, 1991). The differences between the architectures was in terms of the degree of segmentation, with one being more segmented (required less scrolling of pages) than the other. Furthermore, half the participants were provided with an overview of the architecture, and the other half received no overview. After spending a period of time browsing one of the two hypertext systems, participants were requested to answer questions regarding their understanding of the material featured in the hypertext. Both cognitive style and degree of segmentation influenced the degree to which participants learned from each architecture. More specifically, analytics displayed superior learning performance in the less segmented architecture, whereas wholists showed superior performance in the more segmented architecture. However, the provision of an overview of the system had no effect here.

Cognitive Style and Hypertext Navigation

The final question to be considered in this chapter is whether cognitive style can predict differences

in the ways in which individuals navigate hypertext, and several studies on this issue are considered here. Firstly, Ellis Ford and Wood (1992) investigated this issue employing postgraduate student participants and who completed a Study Preferences Questionnaire (SPQ) which was a non standardised test developed by the authors of the study, and which measured holist and serialist study strategies, presumably conceptually similar to field dependent and field independent respectively. Participants were provided with navigation tools for using the hypertext, which were: a self-orientating global concept map, keyword index menus and a backtracking facility, and the subject matter of the hypertext was the European Single Market. The 40 participants used the hypertext, and were then required to answer several questions which required both factual recall and also integration of information from different parts of the hypertext. Their findings revealed that participants with a holist approach tended to make more use of the maps provided, whereas participants with a serialist strategy used the index menu. In a further study, Chen and Ford (1998) employed 20 postgraduate students who used a hypertext system in order to attempt to learn about artificial intelligence. Using the Cognitive Styles Analysis to test style they discovered that wholists made greater use of a menu system for navigation, whereas analytics were more likely to use the backward and forward buttons on the browser software they were using. It must be said that the sample size in this study was small, and accordingly, it is unlikely that the results can be generalised from the findings. The above studies however, tell us more about the user's typical selection of hypertext navigational aids, and it is also relevant to examine navigation of hypertext in terms of the routes users take to move through the system. In a study employing 60 participants, who used a structured hypertext and completed the Embedded Figures Test, Stanton and Stammers (1990) found that field dependent participants used bottom-up navigational strate-

gies, progressing from the more basic information upwards, whereas field independent users tended to use top down strategies, which was viewing the most important information first. This finding is rather perplexing and seems contrary to the reasoning that field dependent users would be able to apprehend the structure of the whole hypertext, and therefore use a top-down strategy, whereas the opposite would be the case for field independent users. What was also contrary to what might have been predicted was the fact that field independent individuals viewed fewer pages than field dependent individuals, whereas the more likely finding would have been that as field dependent learners should have been able to gain an overview more easily, they would have viewed fewer pages. Verheiji, Stoutjesdijk and Beishuizen (1996), performed a study where navigation was assessed by requesting participants to search for information in a hypertext. They identified style by using the Dutch Inventory of Learning Styles which identifies individuals as deep or surface processors (Vermunt and Van Rijswijk, 1987). The findings revealed that different strategies were employed by individuals with different styles, more precisely that those identified as deep processors used a more global approach to navigate the text, whereas surface processors adopted a more step by step approach. The final study considered (Graff, 2005b) employed two groups of participants, who were assigned to either a hierarchical or a relational hypertext architecture and allowed ten minutes to read information contained in the hypertext. Participants were told in advance that they would be expected to answer questions on the information they read, and hypertext navigational patterns were measured by using various indices, including the number of pages visited and the proportion of pages visited to pages revisited. Cognitive style was measured using the Cognitive Styles Analysis (Riding, 1991) which also reveals the extent to which individuals display imager or verbaliser styles. Variations were found between imagers and verbalisers, with the latter visiting

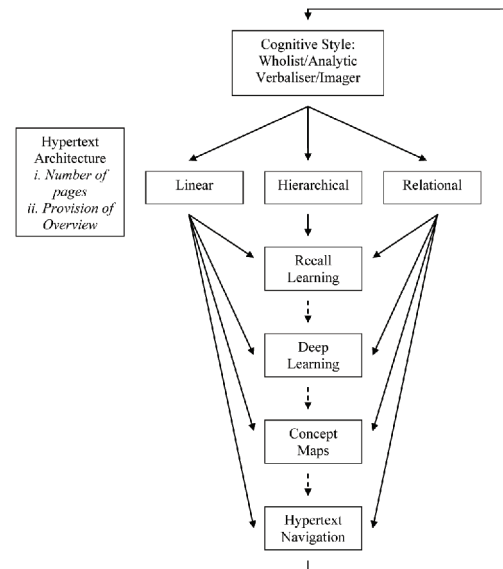
more pages in the hierarchical architecture, and the former visiting more pages in the relational architecture. This preliminary evidence is somewhat encouraging in as much as it would appear to suggest that individuals with different cognitive styles do exhibit different navigational strategies.

CONCLUSION

This chapter has examined much of the evidence on the effectiveness of using hypertext or web-based learning systems as a medium of instruction. The general conclusion which can be drawn here is that the most facilitative hypertext architecture for effective learning is hierarchical in structure with lateral links, although to some extent it appears that cognitive style also influences the effectiveness of the hypertext architecture employed, and this is illustrated in the model shown in Figure 1. For example, cognitive style may to some extent determine how effective a particular architecture is to an individual for learning. Furthermore, the manner in which an individual navigates hypertext also influences his/her ability to understand its structure, and this is because the route followed has an effect on the individual's mental representation of the hypertext. It is possible then that the route followed by an individual browsing hypertext could have an influence on the effectiveness with which they learn.

From the literature, it is clear, that numerous research questions regarding use of hypertext and cognitive style remain. More precisely, further research should pursue an attempt to investigate learning at a deeper level. As mentioned learning in many previous studies has been measured in a relatively simplistic way, and studies should now focus on attempts to assess learning in more realistic situations. While a few studies have sought to investigate the navigational strategies of users, further research should attempt to investigate this in relation to users' cognitive style. Finally, in the

Figure 1. Model of performance in using hypertext, determined by cognitive style/cognitive style mediated by architecture design



literature, definitions of the term cognitive style appear fragmented, with little agreement on how the term may be properly operationalised. Accordingly, attempts to consolidate the construct under a single definition are now well overdue. Regardless of the pressing need for further work in the area, the initial conclusion indicates cognitive style to be a pertinent factor for consideration in the design and implementation of instructional systems. The evidence presented here, although mixed and rather unsettled at present, is nevertheless promising, and cognitive style ultimately has implications for the design of hypertext instructional systems.

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Chapter 7.6

Multimedia, Cognitive Load, and Pedagogy

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ABSTRACT

The current emphasis, in education and training, on the use of instructional technology has fostered a shift in focus and renewed interest in integrating human learning and pedagogical research. This shift has involved the technological and pedagogical integration between learner cognition, instructional design, and instructional technology, with much of this integration focusing on the role of working memory and cognitive load in the development of comprehension and performance. Specifically, working memory, dual coding theory, and cognitive load are examined in order to provide the underpinnings of Mayer's (2001) Cognitive Theory of Multimedia Learning.

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The bulk of the chapter then addresses various principles based on Mayer's work and provides well documented web-based examples.

INTRODUCTION

Improving the efficiency and effectiveness of instruction has consistently been a primary goal of education and training. In pursuit of this goal, cognitive psychology has provided considerable insight regarding the processes that underlie efficient and effective instruction. The past 50 years are replete with empirical studies addressing the characteristics inherent in human learning and the influence of these characteristics on instruction. Unfortunately (Anderson, Reder, & Simon, 1998), this "science of human learning has never had a

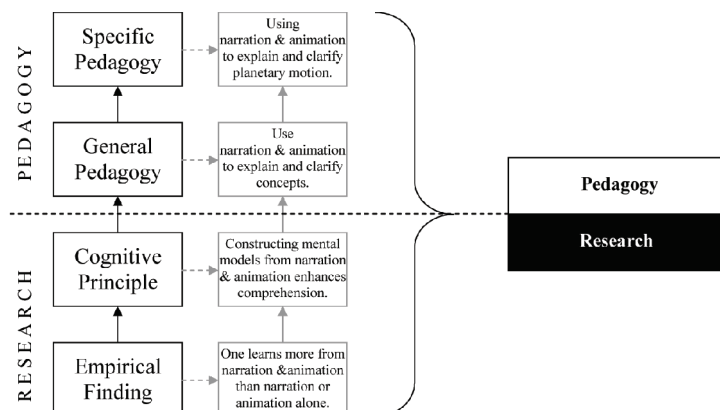
large influence upon the *practice* of education [or training]” (p. 227; italics added). This gap between research and practice is lamentable and serves to deny learners and teachers access to powerful forms of teaching, training, and learning.

Fortunately, the current emphasis on the use of instructional technology has fostered renewed interest in integrating human learning and pedagogical research (see Abbey, 2000; Rouet, Levonen, & Biarreau 2001). As Doolittle (2001) has stated, “it is time to stop professing technological and pedagogical integration and to start integrating with purpose and forethought” (p. 502). One area within instructional technology that has begun this integration is multimedia. The domain of multimedia has matured beyond technology-driven applications into the realm of cognition and instruction. As stated in Rouet, Levonen, and Biarreau (2001), “There is a subtle shift of attention from what *can* be done with the technology to what *should* be done in order to design meaningful instructional applications” (p. 1). This shift has involved the technological and pedagogical integration between learner cognition, instructional design, and instructional technology, with much of this integration focusing on the role of working memory in the development of comprehension and performance.

Specifically, a focus has developed addressing the limited resource nature of working memory and cognitive load. Cognitive load simply refers to the working memory demands implicitly and explicitly created by instruction and how these demands affect the learning process. Those learning tasks that are poorly designed or involve the complex integration of multiple ideas, skills, or attributes result in increased cognitive load and decreased learning. This relationship between cognitive load, working memory, and instruction/training has proved to be especially significant when the instruction is in the form of multimedia. According to Mayer (2001), “the central work of multimedia learning takes place in working memory” (p. 44).

This chapter focuses on multimedia and the mitigating effects of cognitive load on teaching, training, and learning. A central organizing theme throughout the chapter is the development of theoretically sound pedagogy (see Figure 1). Theoretically sound pedagogy involves instruction that is based on empirical research and sound theory designed to illuminate the nature of human learning and behavior. Such theoretically sound pedagogy may then be molded to fit specific learning environments, learning goals and objectives, and learners.

Figure 1: The development of theoretically sound pedagogy



WORKING MEMORY, DUAL CODING AND COGNITIVE LOAD

When pursuing theoretically sound pedagogy, it is essential to ground one's conclusions in the human memory literature. Unfortunately, while there is a plethora of research findings exemplifying the structure and function of human memory, a singular model of memory to which one can refer has yet to emerge. Currently, the three most prevalent models are Atkinson and Shiffrin's (1968) dual-store model, Baddeley's (Baddeley, 1986; Baddeley & Hitch, 1974) working memory model, and Anderson's (1983, 1990, 1993) functional ACT-R model. Each of these models has roots in the early information-processing work of Broadbent (1958) and Peterson and Peterson (1959).

Memory Models and Working Memory

Atkinson and Shiffrin (1968) emphasized the structural nature of memory, delineating three essential structures, *sensory memory*, *short-term memory*, and *long-term memory*. Atkinson and Shiffrin asserted that individuals experience the world through their senses, momentarily storing these senses in raw sensory formats at their sensory sites. These sensations, if attended, may then be encoded into a mind-friendly format and consciously held in short-term memory, where if the individual rehearses this encoded experience, the experience may be transferred to long-term memory. The *dual-store* of Atkinson and Shiffrin's model refers to the short-term memory store, where a small amount of information or experience may be held temporarily, and the long-term memory store, where an unlimited amount of information or experience may be held indefinitely. This idea that there were two storage components, each with different processing capabilities, was developed from Broadbent in the 1950s through Atkinson and Shiffrin in the 1960s and was well accepted in the early 1970s. Unfortunately, in the 1970s, testing

of the dual-store model revealed inconsistencies in the need for two storage components. By the 1980s, the dual-store model, with its two storage components, was being replaced by a unified working and long-term memory model.

Two separate memory stores were eliminated, and what remained was a single memory store, long-term memory, and a constellation of related processes, termed working memory, responsible for the regulation of reasoning, problem solving, decision making, and language processing (Miyake & Shah, 1999). Working memory is often confused with, or made synonymous with, short-term memory, as working memory has retained certain short-term memory characteristics. For example, a central characteristic of short-term memory was a limited capacity due to a hypothesized small storage space. This limited capacity is also a characteristic of working memory, but the rationale has changed from a limitation based on structure (i.e., space) to a limitation based on function (i.e., processing). Working memory limitations are currently seen as a function of ongoing processing and the nature of the information being processed (see Miyake & Shah, 1999). While working memory and short-term memory share certain similar characteristics, although for differing reasons, they are also significantly different.

Perhaps the most obvious difference between short-term memory and working memory is that short-term memory was construed as a storage location or "box," while working memory is defined as a set of cognitive processes responsible for the support of complex cognition. A second, and related, difference involves purpose. Typically, short-term memory is described as subservient to long-term memory, where long-term memory is responsible for the cognitive processing and short-term memory is merely a workspace for memorization (Baddeley, 1999). Working memory, however, is interpreted as working synergistically with long-term memory, playing a primary role in control and regulation functions (Cowan, 1999). This emphasis on synergy underlies the

third difference, which is related to the influence of long-term memory on short-term and working memory. The traditional relationship between short-term memory and long-term memory is one of *independence*, where short-term and long-term memory communicate, as two individuals talking on the telephone, sharing ideas but each operating in only distantly related realms. The relationship between working memory and long-term memory, however, is one of *interdependence* (Baddeley & Logie, 1999; Ericsson & Kintsch, 1995). The interplay between working memory and long-term memory is integrated to such an extent that any discussion of human cognitive performance in the absence of either working or long-term memory would be incomplete.

Thus, an exploration of human cognitive performance in a multimedia environment would need to address this working and long-term memory interdependence. This interdependence is evident in two theories that are currently guiding the development of multimedia instructional technology—dual-coding theory and cognitive load theory.

Dual-Coding Theory

Building on working and long-term memory interdependence, Paivio (1971, 1990) created a theory of cognition that emphasizes the mind's

processing of two types or codes of information, verbal and nonverbal. Specifically, Paivio (1990) stated that memory and cognition are represented within two functionally independent, but interconnected, processing systems (see Figure 2). One system, the *verbal system*, is specialized for the representation and processing of verbal information (e.g., words, sentences, stories), while the other system, the *nonverbal system*, is specialized for the representation and processing of nonverbal information (e.g., pictures, sounds, smells, tastes). Each system holds and processes representations that are modality-specific (i.e., visual, auditory, tactile, gustatory, olfactory), that is, the representations retain certain properties of the concrete sensorimotor events on which they are based (Clark & Paivio, 1991). It is important to note that these representations are not exact copies of one's experiences, but rather they represent imprecise facsimiles (Paivio, 1990).

The interaction between the verbal/nonverbal processing and modality-specific perceptions can be somewhat confusing. A central point is that regardless of modality, verbal experiences are processed by the verbal system, and nonverbal experiences are processed by the nonverbal system (see Table 1). An everyday example of dual coding would include an individual looking at a weather map on the computer while listening to a weather report (e.g., <http://www.weather.com/>

Figure 2. A schematic representation of Paivio's (1990) dual-coding model, including both verbal/non-verbal channels and representational, associative, and referential processing

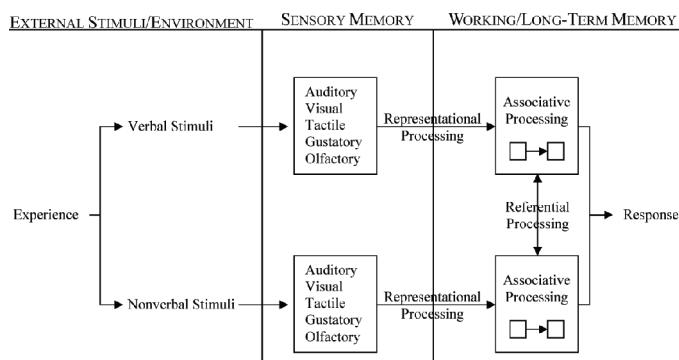


Table 1. Examples of verbal/nonverbal cognitive processing based on specific modality experiences

	Cognitive Processing	
Modality	Nonverbal	Verbal

activities/verticalvideo/vdaily/weeklyplanner.html). The words encountered listening to the weather report would be processed by the verbal system, while the visual images encountered looking at the weather map would be processed by the nonverbal system.

Paivio (1990), upon delineating this relationship between verbal/nonverbal processing and modality-specific perceptions, focused primarily on the verbal/nonverbal processing aspects of the dual-coding theory. According to Paivio (1990), three levels of processing enable verbal and nonverbal representations to be accessed and activated during cognitive tasks (see Figure 2). *Representational processing* is characterized by direct activation; that is, a verbal or linguistic sense experience directly activates a verbal representation and a nonverbal or nonlinguistic sense experience directly activates a nonverbal representation. For instance, reading on-screen text (verbal) directly activates the verbal system, while seeing an on-screen image (nonverbal) directly activates the nonverbal system. *Referential processing* refers to the indirect activation of the verbal system through experience with nonverbal information and the indirect activation of the nonverbal system through experience with verbal information. For example, reading on-screen text (verbal) may indirectly activate a mental image (nonverbal) based on the on-screen text; similarly, viewing an on-screen image (nonverbal) may indirectly activate a concept label (verbal) for that image. Consequently, referential processing is indirect in nature, because it requires cross-over activity from one symbolic system to another. Finally, *associative processing* refers to the activation of representations within either system

by other representations within that same system. For example, for a student with an aversion to technology, the word “computer” (verbal) might elicit verbal associations such as “hate” or “stupid” (verbal); conversely, the sight of a computer (nonverbal) might elicit images or visceral responses (nonverbal) reminiscent of unpleasant experiences using the computer.

Studies examining verbal/nonverbal processing have revealed two central findings (Mayer, Heiser, & Lonn, 2001; Sadoski & Paivio, 2001). First, processing experiences verbally and visually lead to greater learning, retention, and transfer than do processing experiences only verbally (Clark & Paivio, 1991; Paivio, 1975). For instance, in studying the process of osmosis, viewing an animation with a text description of the process (see <http://edpsychserver.ed.vt.edu/5114web/modules/slideshows/slideshows.cfm?module=4>) results in better learning, retention, and transfer than simply reading a text description. Second, both verbal and visual channels of information processing are subject to memory limitations such that each channel may be overloaded, reducing processing capacity and speed, and learning, retention, and transfer. For example, a multimedia slide show that includes auditory narration (verbal), subtitles of the auditory narration (verbal), and text within the slides themselves (verbal) is certain to overload an individual’s verbal channel (http://edpsychserver.ed.vt.edu/5114web/modules/memory5_apps1/slideshow1.cfm). These two findings play a central role in multimedia pedagogy (see Mayer & Anderson, 1991; Schnotz, 2001) and are further explored in the next section, which addresses cognitive load theory. The construct of cognitive load is a means for assessing the memory limita-

tions mentioned previously and for understanding the beneficial effects of adding visual information to verbal information.

Cognitive Load Theory

Cognitive load is a multidimensional construct that refers to the memory load that performing a task imposes on the learner (Paas & van Merriënboer, 1994; Sweller, van Merriënboer, & Paas, 1998). Inextricably linked with cognitive load theory is the notion that working memory is a limited resource; therefore, a careful distribution of the cognitive load within working memory is needed to successfully perform a given task (Chandler & Sweller, 1991, 1992). Further, cognitive load theory is based on several assumptions concerning human cognitive architecture (Mousavi, Low, & Sweller, 1995), including the following:

1. People have limited working memory and processing capabilities
2. Long-term memory is virtually unlimited in size
3. Automation of cognitive processes decreases working memory load

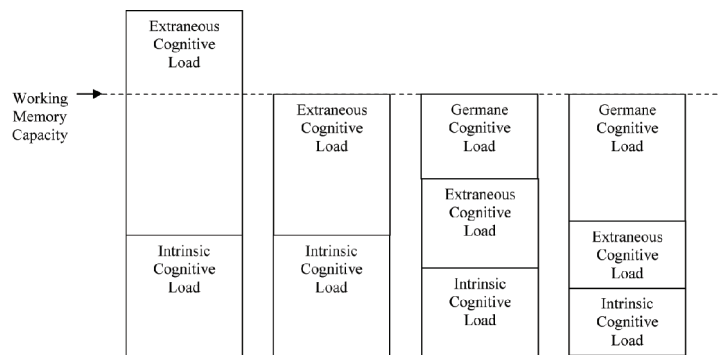
Ultimately, the central premise of cognitive load theory is that working memory is limited and, if overloaded, learning, retention, and transfer will be negatively affected.

Cognitive load theory posits that instructional materials impose upon the learner three independent sources of cognitive load—*intrinsic cognitive load*, *extraneous cognitive load*, and *germane cognitive load* (Gerjets & Scheiter, 2003; Paas, Renkl, & Sweller, 2003). Together, intrinsic, extraneous, and germane cognitive load comprise the total working memory load imposed on the learner during instruction (Tindall-Ford, Chandler, & Sweller, 1997) (see Figure 3).

Intrinsic cognitive load represents the inherent working memory load required to complete a task. As an inherent component of a given task, intrinsic cognitive load is beyond the direct control of the instructional designer. Sweller (1994) suggested that the amount of interaction between learning elements, *element interactivity*, is a critical factor influencing intrinsic cognitive load. *Element interactivity* (Tindall-Ford et al., 1997) occurs when the “elements of a task interact in a manner that prevents each element from being understood and from being learned in isolation and, instead, requires all elements to be assimilated simultaneously” (p. 260). For example, learning the syntax of a computer language imposes a heavy intrinsic cognitive load, because to learn word and rule orders, all the words and rules must be held in working memory simultaneously.

What constitutes an element does not depend solely on the nature of the material, but it also depends on the expertise of the learner (Gerjets

Figure 3. Scenarios of the relationship between working memory capacity and the three components of cognitive load (i.e., intrinsic, extraneous, and germane cognitive load)



& Scheiter, 2003; Tindall-Ford et al., 1997). High element interactivity may not result in high cognitive load if expertise has been attained, thus allowing the learner to incorporate multiple elements into a single element, or “chunk,” through schema acquisition or automaticity. This may be evidenced in the use of online simulations. For example, the Neurodegenerative Disease Simulation Model, a Java applet, can be daunting and create significant cognitive load for the novice due to the multiple options available, the complexity of the graphs, and the lack of automated skills related to the operation of the simulation (<http://www.math.ubc.ca/~ais/website/guest00.html>). For the experienced Neurodegenerative Disease Simulation Model user, however, the cognitive load is significantly reduced as the options are incorporated into schemas that act as an independent element, and the actual operation of the simulation is automated. Thus, using the simulation may result in extremely high intrinsic cognitive load for novices while imposing very little cognitive load on experts.

In addition to intrinsic cognitive load, the manner in which information is presented to learners and the activities required of learners can impose additional cognitive load (Paas, Renkl, & Sweller, 2003). While intrinsic cognitive load is determined by the nature of the material, *extraneous cognitive load* reflects the effort required to process instructional materials that do not contribute to learning the material or completing the task. In this sense, extraneous cognitive load can be seen as “error” in the overall instructional process. Fortunately, extraneous cognitive load is, to a large extent, under the control of instructional designers (Sweller et al., 1998). For example, when animation and text are combined, extraneous cognitive load is increased if the animation and text are not presented simultaneously (Moreno & Mayer, 1999). Specifically, imagine a simulation in which the directions are presented first, followed by the simulation (see <http://webphysics.ph.msstate.edu/jc/library/2-6/index.html>). In this case, the learner

must read the directions, maintain the relevant directions in working memory, and then attempt to use the simulation. The simulation has an innate level of cognitive load, intrinsic cognitive load, to which is being added an additional cognitive load, extraneous cognitive load, as the result of having to maintain the directions in working memory. A simple solution to this extraneous cognitive load would be to provide the directions on the same page as the simulation.

The third type of cognitive load is *germane cognitive load*. Germane cognitive load is the cognitive load appropriated when an individual engages in processing that is not designed to complete a given task, but rather, is designed to improve the overall learning process (e.g., elaborating, inferencing, or automating). Engaging in processes that generate germane cognitive load is only possible when the sum of intrinsic and extraneous cognitive load is less than the limits of an individual’s working memory. In addition, like extraneous cognitive load, germane cognitive load is influenced by the instructional designer. The manner in which information is presented to learners and the learning activities are factors relevant to the level of germane cognitive load. However, while extraneous cognitive load interferes with learning, germane cognitive load enhances learning by devoting resources to such tasks as schema acquisition and automation (Paas et al., 2003). For example, a student may engage in solving an historical murder mystery (<http://web.uvic.ca/history-robinson/>), resulting in both intrinsic and extraneous cognitive load. If sufficient working memory capacity remains, the student may also engage in practicing a metacognitive strategy for assessing the primary sources that serve as data for solving the murder mystery. Using a metacognitive strategy is not essential to engaging the murder mystery, however, this use will lead to greater automaticity of the strategy, elaboration on the primary sources, and ultimately, enhanced learning.

Overall, total cognitive load is comprised of the sum of intrinsic, extraneous, and germane cognitive load. This summative nature leads to several interesting scenarios (see Figure 3), all limited or constrained by an individual's working memory capacity (see Figure 3a). These differing scenarios will all be examined using a common example, a Social Justice Resource Center database site (see <http://edpsychserver.ed.vt.edu/diversity/>).

In the first scenario, if the sum of the intrinsic and extraneous cognitive loads exceeds one's working memory capacity, then learning and performance of the given task will be adversely affected (see Figure 3b). In the case of the Social Justice site, the Advanced Search page could easily overwhelm the working memory capacity of a database/search novice (Figure 4). The Advanced Search page contains complex functions for Boolean searches, data restriction, and layout control, all possibly contributing to excessive extraneous cognitive load.

If, however, the sum of intrinsic and extrinsic cognitive load is equal to one's working memory capacity, then one should be able to complete the given task successfully (see Figure 3c). Continuing the Social Justice example, the extraneous cognitive load may be reduced by instructing a student to focus only on understanding and using the Boolean operator search fields and ignoring the data restriction and layout options. Providing or focusing on fewer options is likely to reduce extraneous cognitive load.

While this situation is acceptable, it does not provide any cognitive resources for engaging in additional and beneficial processing beyond the mere completion of the task. If cognitive load is reduced further, such that the sum of intrinsic and extraneous cognitive load is less than one's working memory capacity, then one may engage in additional synergistic processing, yielding germane cognitive load, resulting in increased overall performance (see Figure 3d). For a database/search

Figure 4. The Advanced Search page of the Social Justice Resources Center that when used by novices to search for social justice resources results in high intrinsic and extraneous cognitive load

The screenshot shows a web browser window with the address <http://edpsychserver.ed.vt.edu/diversity/AdvancedSearch.cfm>. The page is titled "Social Justice Resources Center" and features a navigation menu on the left with links to "Basic", "Advanced", "Add a Site", "Library", and "Home". The main content area is titled "Advanced Search:" and includes a "Search for:" field, a "Search" button, and a "Help | Basic Search" link. Below this are three "AND" search fields and three "Common Keywords" dropdown menus. A note states: "These 'Common Keywords' represent the 20 most frequently cited keywords present in the SRC database." Further down, there are sections for "Include Only:" (with checkboxes for Articles, Artifacts, Books, Chapters, Events, Lesson Plans, Media, Websites) and "Display:" (with radio buttons for Short Record and Long Record, and a "10 matches per page" option). At the bottom, there is a "Focus on:" section with checkboxes for various subjects like English/Language Arts, Fine Arts, Foreign Language/ESL, History/Social Studies, Mathematics/Health, Media Literacy, PE/Health, Science, Special Education, Theatre, Vocational Education, College/University, Elementary School, High School, Middle School, Curriculum and Classroom Materials, and Teacher Background Materials.

novice, no use of the Social Justice Advanced Search page is likely to result in germane cognitive load. To facilitate germane cognitive load, a new Web page may need to be developed that simplifies the task at hand, such as a Basic Search page (Figure 5). The Basic Search page has only one field to complete with very simple directions. The use of the Basic Search page would allow the user to engage in secondary processes, generating germane cognitive load, such as generating a schema of database use, elaborating on potential keywords, and combining keywords into more precise search phrases.

Thus, the ultimate goals of instruction are to (a) create tasks that have inherently low to moderate intrinsic cognitive load, (b) develop instructional designs that reduce extraneous cognitive load, and (c) foster engagement in active processing that facilitates germane cognitive load (see Figure 3e). An example that satisfies all three of these criteria would include searching the Social Justice Resources Database using the Basic Search page that combines a manageable task with an efficient environment to produce effective learning and performing.

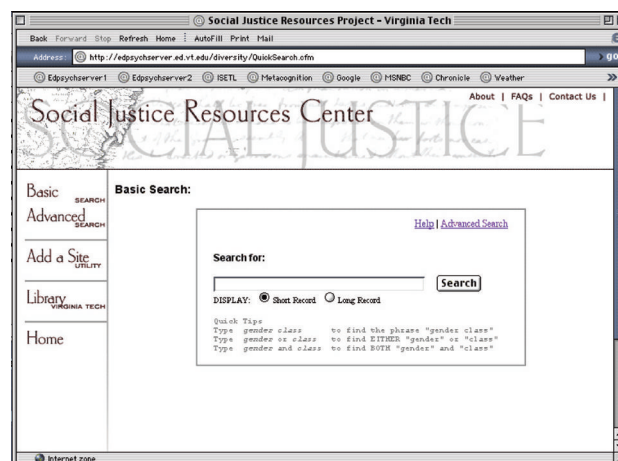
This effective and efficient learning and performing is shaped by careful attention to the con-

straints and guidelines provided by dual-coding theory and cognitive load theory. And, just as dual-coding theory informs cognitive load theory, cognitive load theory informs the cognitive theory of multimedia (see Mayer, 2001). By considering factors that may place an undue burden on the learner while engaged in multimedia cognition, designers can develop multimedia environments that promote effective and efficient learning.

A COGNITIVE THEORY OF MULTIMEDIA

Creating multimedia that balances the constraints of human memory (e.g., dual coding and cognitive load) with the goals of education and training (e.g., meaningful learning, retention, and transfer) requires a theory of multimedia instruction grounded in the science of human learning. Until recently, multimedia meant multiple media *devices* used in a coordinated fashion (e.g., cassette tape player and a slide show) (Moore, Burton, & Myers, 1996). However, advances in technology have combined these media so that information previously delivered by several devices is now integrated into one device (e.g., computer, kiosk)

Figure 5. The Basic Search page of the Social Justice Resources Center that when used to search for social justice resources results in low intrinsic and extraneous cognitive load



(Kozma, 1994). Thus, multimedia is now typically defined as the integration of more than one medium into a common computer-based communication framework; specifically (von Wodtke, 1993), “multimedia refers to the integration of media such as text, sound, graphics, animation, video, imaging, and spatial modeling into a computer system” (p. 3).

This common computer-based communication framework for multimedia instruction resulted in early research on multimedia focusing on capturing the capabilities of this new framework to deliver instruction (Moore, Burton, & Myers, 1996). However, the current focus of multimedia instruction has shifted away from this technology-centered approach to a more learner-centered approach, where the emphasis is on how to design multimedia frameworks to aid human cognition (see Abbey, 2001).

This learner-centered approach to multimedia instruction focuses on the cognitive processing of multimedia messages and the influence of this processing on learning, retention, and transfer. This processing of multimedia messages within a computer-based instructional environment is typically reduced to two channels of presentation/sensation—auditory and visual. Within this limited two-channel environment, *words* and *pictures* comprise the two main formats available for engaging in multimedia instruction. Words, or verbal information, include primarily auditory speech or printed text, whereas pictures, or visual information, include primarily static graphics (e.g., illustrations and photos) and dynamic graphics (e.g., animation and video). Fortunately, advances in computer technology have resulted in the emergence of numerous ways of presenting these words and pictures. These advances allow designers to combine words and pictures in ways that were not previously possible. As a result, new research has emerged concerning the effectiveness of presenting instruction using both words and pictures.

Research focusing on exploiting the benefits and limitations of the mind’s verbal and visual-processing channels in multimedia instructional environments has been championed by Richard Mayer and his colleagues (see Mayer, 2001). Mayer (2001), in pursuing this dual-channel multimedia research, specifically defines multimedia as “the presentation of material using both words and pictures. . . . I have opted to limit the definition to just two forms—verbal and pictorial—because the research base in cognitive psychology is most relevant to this distinction” (pp. 2–3). This research base to which Mayer refers is centered on Baddeley’s *working memory model* (Baddeley, 1986, 1999), Paivio’s *dual-coding theory* (Clark & Paivio, 1991; Paivio, 1990), and Sweller’s *cognitive load theory* (Chandler & Sweller, 1991; Sweller, 1994). As mentioned previously, these three theories are not independent but rather overlap, creating theoretical interdependencies. This interdependency is evident in Mayer’s construction of the *cognitive theory of multimedia learning* (Mayer, 2001).

Mayer’s (2001) *cognitive theory of multimedia learning* is premised on the following three assumptions: (a) learners process visual and auditory information in different cognitive channels—the dual-channel assumption; (b) each cognitive channel has a limited processing capability—the limited-capacity assumption; and (c) learners actively process this visual and auditory information—the active-learning assumption.

The *dual-channel assumption* holds that individuals have separate cognitive channels for processing auditory and visual information. For example, if a learner is watching a video clip with auditory narration, then the visual channel will process the video images, while the auditory channel will process the narration. This dual-channel assumption is consistent with Baddeley’s (1986) working memory model and Paivio’s dual-coding theory (Paivio, 1990).

The *limited-capacity assumption* builds on the premise that humans are limited in the amount

of information that can be processed in either channel at one time. For instance, if a learner is watching a video clip with subtitled text, the visual channel could easily become overloaded attempting to process both the video images and the subtitled text, because the images and the text are processed visually. This limited-capacity assumption is consistent with Baddeley's (1986) working memory model and Sweller's (1994) cognitive load theory.

The *active-processing assumption* posits that learners actively engage in processing multimedia environments by (a) *selecting* relevant information from the environment, (b) *organizing* the information into coherent representations, and (c) *connecting* both visual and verbal representations (Mayer, 1997). For example, if a learner is watching a video clip with auditory narration, the learner will select relevant pictures from the video and relevant words from the narration, organize the pictures and words into coherent representations, and then combine these coherent representations into an overall conceptual model of the video clip. The active-learning assumption is consistent with Paivio's (1986) dual-coding theory and Baddeley's (1986) working memory model.

These three assumptions combine to create a model of multimedia processing based on a dual-channel, limited-capacity, active-processing learner. It is important to think of these three assumptions as an integrated whole, not as isolated factors, as each affects the other and in turn affects learning within multimedia instructional environments. For example, if too much visual information is presented (e.g., animation and on-screen text; <http://basepair.library.umc.edu/movies/mitosis1.mov>), then the visual channel's capacity will be exceeded, leading to insufficient processing of that visual information (i.e., either the animation or on-screen text will not be attended to in their entirety). This situation could be corrected, however, by either eliminating some of the visual information (e.g., removing the on-screen text) or switching some of the visual information to

an auditory channel (e.g., using audio narration instead of on-screen text (<http://basepair.library.umc.edu/movies/mitosis.mov>)).

Within these three assumptions, Mayer (2001) posited five cognitive processes necessary for the generation of meaningful learning, retention, and transfer. These five processes are evident in the cognitive theory of multimedia and include the following: (a) selecting relevant words from the multimedia environment, (b) selecting relevant images from the multimedia environment, (c) organizing the selected words into a coherent representation, (d) organizing the selected images into a coherent representation, and (e) integrating the word and image representations with prior knowledge into a coherent mental model (Mayer, 2001). A learner watching a narrated slide show demonstrates these five processes (see <http://edpsychserver.ed.vt.edu/5114web/modules/classical/slideshow1.cfm>). The learner selects relevant words from the narration and relevant images from the slide show. The learner then generates meaningful representations of the words and images. Finally, the learner integrates the words, pictures, and relevant prior knowledge into a coherent mental model of the narrated slide show.

These three assumptions and five processes, based on working memory, dual-coding theory, and cognitive load theories, serve as the framework for much of Mayer's work in multimedia learning. Mayer's work addressing multimedia learning has resulted in several principles of multimedia learning. It is important to note that Mayer's research focuses on the derivation of cognitive principles from empirical research, where the principles may then be used to create general pedagogy (see Figure 1). This clarification is important, as Mayer uses short tutorials within his research. However, the principles that are derived are not limited to tutorial-based instructional environments. The benefit of focusing on the derivation of cognitive principles is that these principles have generalizability beyond the contexts in which they are originally demonstrated. In the following section,

several cognitive principles of multimedia are delineated and examples are provided that extend these principles into nontutorial instructional environments.

MULTIMEDIA, PRINCIPLES AND PEDAGOGY

The development of cognitive principles of multimedia is essential in the quest for theoretically sound pedagogy for multimedia instructional environments (see Figure 1). These cognitive principles serve as the bridge between empirical findings and general pedagogical principles. Over the past 15 years, Richard Mayer, Roxana Moreno, and their colleagues have continued in their efforts to generate empirical findings relative to multimedia learning. These empirical findings have coalesced into a series of cognitive and pedagogical principles relevant to learning and instruction within multimedia environments. The following section will introduce seven cognitive principles of multimedia that have emerged from their work. These seven principles include the multimedia principle, the modality principle, the redundancy principle, the coherence principle, the

contiguity principle, the segmentation principle, and the signaling principle (see Table 2).

Multimedia Principle

The multimedia principle simply states that individuals learn, retain, and transfer information better when the instructional environment involves words and pictures, rather than words or pictures alone. Specifically, individuals who experienced a short tutorial explaining how bicycle tire pumps worked, where the instruction was in the form of words and pictures or narration and animation, learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of narration or animation only (Mayer & Anderson, 1991, 1992). Thus, when constructing multimedia instructional environments, learning, retention, and transfer are facilitated by the use of both words and pictures, or narration and animation.

Theoretically, these results and the multimedia principle may be explained based on Paivio's (1990) dual-coding theory. When an individual experiences instruction both verbally and visually, the individual constructs verbal and visual

Table 2. Brief definitions of the cognitive principles of multimedia

Principle	Definition
Multimedia principle	Individuals learn, retain, and transfer information better when the instructional environment involves words and pictures, rather than word or pictures alone.
Modality principle	Individuals learn, retain, and transfer information better when the instructional environment involves auditory narration and animation, rather than on-screen text and animation.
Redundancy principle	Individuals learn, retain, and transfer information better when the instructional environment involves narration and animation, rather than on-screen text, narration, and animation.
Coherence principle	Individuals learn, retain, and transfer information better when the instructional environment is free of extraneous words, pictures, or sounds.
Signaling principle	Individuals learn and transfer information better when the instructional environment involves cues that guide an individual's attention and processing during a multimedia presentation.
Contiguity principle	Individuals learn, retain, and transfer information better in an instructional environment where words or narration and pictures or animation are presented simultaneously in time and space.
Segmentation principle	Individuals learn and transfer information better in an instructional environment where individuals experience concurrent narration and animation in short, usercontrolled segments, rather than as a longer continuous presentation.

representations of the explanations and subsequently integrates the two representations into a coherent model. This dual-channel integration has been demonstrated to provide for increased learning when compared to learning based on a single-channel representation (Clark & Paivio, 1991; Paivio, 1991). Further, these results and the multimedia principle are consistent with Mayer's (2001) cognitive theory of multimedia. Mayer posits that verbal and visual representations are informationally distinct, such that the informational sum of the integration of verbal and visual representations always exceeds the information present in the verbal or visual representations alone. This integration of distinct verbal and visual representations, in turn, leads to greater learning, retention, and transfer. As Mayer (2001) stated, "In short, our results support the thesis that a deeper kind of learning occurs when learners are able to integrate pictorial and verbal representations of the same message" (p. 79).

This integration has ramifications for pedagogy, specifically, that multimedia instructional environments should utilize words or narration and pictures or animation. Combining words or narration and pictures or animation can be as simple as using static images to clarify on-screen text. For example, ACKY.NET provides a wealth of information regarding Web design, including several effective tutorials that consist primarily of static images and text (http://www.acky.net/tutorials/flash/bouncing_ball/). Another basic method of combining words or narration and pictures or animation is the use of streaming video for disseminating lectures (<http://sinapse.arc2.ucla.edu/streaming/cnsi/seminars/spring2003/mceuen-rm8-mbr.ram>). The video lecture scenario may be made more complete through the use of streaming video, with a concurrent slide show and hyperlinks (http://ra.okstate.edu:8080/ramgen/zayed/leadership_skills_a/trainer.smi). The key in these instances is that words or narration and pictures or animation are being combined for the purpose of enhancing instruction.

Modality Principle

The modality principle, which further clarifies the multimedia principle, states that individuals learn, retain, and transfer information better when the instructional environment involves auditory narration and animation, rather than on-screen text and animation. Specifically, individuals who experienced a short tutorial explaining the creation of lightning, where the instruction was in the form of auditory narration and animation, learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of on-screen text and animation (Mayer & Moreno, 1998; Moreno & Mayer, 1999). Thus, when constructing multimedia instructional environments, learning, retention, and transfer are facilitated by the use of auditory narration and animation.

Theoretically, these results and the modality principle may be explained based on Baddeley's (1986) working memory model and Sweller's (1991) cognitive load theory. When on-screen text and animation are presented simultaneously, an individual is confronted with the task of attending to and creating two visual representations, which can easily overload the visual channel. When the visual on-screen text is transformed into auditory narration, the cognitive load of the visual channel is reduced, and the overall cognitive load of the instructional environment is better balanced between the auditory and visual channels. Further, these results and the modality principle are consistent with Mayer's (2001) cognitive theory of multimedia. Mayer supports the limited-capacity, dual-channel structure of memory responsible for the cognitive overload created by the presentation of two visual stimuli: on-screen text and animation. According to Moreno and Mayer (1999), "When learners can concurrently hold words in auditory working memory and pictures in visual working memory, they are better able to devote

attentional resources to building connections between them” (p. 366).

Pedagogically, using both channels to foster connections implies that multimedia instructional environments should utilize narration and animation, as opposed to on-screen text and animation, whenever possible. Integrating audio and video in multimedia environments is reasonably common these days. Stanford University’s Center for Professional Development provides a series of *Online Seminars* that consist of simple streamed lectures, which combine narration and video, on a variety of topics (<http://stanford-online.stanford.edu/murl/cs547/>). Another example that demonstrates the blending of narration and animation is the International Association of Intercultural Education’s *The Big Myth* that provides lessons on creation myths and cultural pantheons from around the world (http://www.mythicjourneys.org/bigmyth/1_webmap.swf). In each of these instances, the multimedia instructional environment is enhanced through the use of concurrent auditory narration and animation.

Redundancy Principle

The redundancy principle, which provides an extension of the multimedia and modality principles, states that individuals learn, retain, and transfer information better when the instructional environment involves narration and animation, rather than on-screen text, narration, and animation. Specifically, individuals who experience a short tutorial explaining the creation of lightning, where the instruction was in the form of auditory narration and animation, learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of on-screen text, auditory narration, and animation (Mayer, Heiser, & Lonn, 2001; Moreno & Mayer, 2002). Thus, when constructing multimedia instructional environments, learning, retention, and transfer are

facilitated by the use of auditory narration and animation, without on-screen text.

Theoretically, these results and the modality principle may be explained based on Baddeley’s (1986) working memory model and Sweller’s (Chandler & Sweller, 1991) cognitive load theory. When on-screen text, auditory narration, and animation are presented simultaneously, an individual is confronted with the task of attending to and creating two visual representations based on the on-screen text and the animation, and attending to and creating an auditory representation based on the auditory narration. The task of attending to and creating two visual representations can easily overload the visual channel and impair the individual’s ability to attend adequately to the auditory channel. When the visual on-screen text is eliminated, the cognitive load of the visual channel is reduced, and the overall cognitive load of the instructional environment is better balanced between the auditory and visual channels. Further, these results and the modality principle are consistent with Mayer’s (2001) cognitive theory of multimedia. Mayer supports the limited-capacity, dual-channel structure of memory responsible for the cognitive overload created by the presentation of two visual stimuli: on-screen text and animation. According to Mayer et al. (2001), “in this case, learners are less likely to be able to carry out the active cognitive processes needed for meaningful learning” (p. 195) (e.g., elaboration, organization, reflection).

While the redundancy principle has significant ramifications for pedagogy, these ramifications will be combined with the recommendations from following principle, the coherence principle, and will be discussed at the end of the next section.

Coherence Principle

The coherence principle, which refines the redundancy principle, states that individuals learn, retain, and transfer information better when the instructional environment is free of extraneous

words, pictures, or sounds. Specifically, individuals who experienced a short tutorial explaining either the creation of lightning or the workings of a hydraulic break, where the instruction was in the form of narration and animation, learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of narration, animation, and interesting, but irrelevant, words, pictures, or sounds (Mayer, Heiser, & Lonn, 2001; Moreno & Mayer, 2000). Thus, when constructing multimedia instructional environments, learning, retention, and transfer are impeded by the inclusion of extraneous, irrelevant materials; therefore, multimedia should be kept simple and include only those attributes necessary for the instruction.

Theoretically, these results and the coherence principle may be explained based on Baddeley's (1986) working memory model and Sweller's (Chandler & Sweller, 1991) cognitive load theory. When extraneous materials are introduced into the multimedia instructional environment, these extraneous materials compete with the instructional materials for the limited resources of the individual's working memory. If these extraneous materials are significant, then cognitive overload can occur, and learning and performance will be negatively affected. According to Moreno and Mayer (2000), "these findings suggest that auditory overload can be created by adding auditory material that does not contribute to making the lesson intelligible" (p. 121).

The redundancy and coherence principles each have a common message for the building of pedagogy, specifically, that multimedia instructional environments should be clear and concise, avoiding the duplication of information and the inclusion of extraneous, noninformative elements. While the tendency in creating multimedia instructional environments is often to add "bells and whistles" (multiple representations of the same content, interesting sounds, or moving text), simple designs that are focused on the learner's attention and

process are more effective. A simple, yet effective multimedia instructional environment is the *Who Killed William Robinson?* Web site at the University of Vancouver, British Columbia Web address (<http://web.uvic.ca/history-robinson/>). This site is composed of primarily static text and pictures, yet the design and implementation of the project is simple and straightforward. There is no redundant or extraneous material. Another that is simple, yet effective is the Advanced Education Psychology site at the Virginia Tech Web address (<http://edpsychserver.ed.vt.edu/5114web/modules/classical/>). These particular sites are prime examples of effective multimedia instructional environments that are not "tech heavy," that is, sites that do not rely on advanced technology but rather on effective multimedia design.

Signaling Principle

The signaling principle, which is related to the coherence principle, states that individuals learn and transfer information better when the instructional environment involves cues, or signals, that guide an individual's attention and processing during a multimedia presentation. Signaling (Meyer, 1975) "serves as guides...by giving emphasis to certain aspects of the semantic content or pointing out aspects of the structure of content so that the [individual] can see the relationships stated in the passage more clearly" (p. 1). Specifically, individuals who experienced a short tutorial explaining the creation of lift in aeronautics, where the instruction was in the form of narration and animation, and included auditory signals (e.g., intonation changes, pausing) and visual signals (e.g., arrows, color emphasis, summary icons), learned and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of narration and animation but did not include signals (Mautone & Mayer, 2001). Thus, when constructing multimedia instructional

environments, learning and transfer are facilitated by the use of auditory and visual cues and signals.

Theoretically, these results and the signaling principle may be explained based on Baddeley's (1986) working memory model and Sweller's (1991) cognitive load theory. When signals or cues are provided that focus an individual's attention on relevant, rather than irrelevant, information, the individual's expenditure of cognitive resources is more efficient, thus reducing cognitive load. In addition, this reduction in cognitive load, when coupled with cues and signals designed to make explicit relational links within the presentation information, results in the increased generation of connections between auditory and visual representations. According to Mautone and Mayer (2001), "signals encourage learners to engage in productive cognitive processing during learning, including selecting relevant steps in the explanation, organizing them into a coherent mental structure, and integrating them with existing knowledge" (p. 387).

Pedagogically, the signaling principle posits that multimedia instructional environments should include cues to assist in focusing learner's attention and fostering appropriate learner processing of the relevant information. Students often find Web pages and online instruction overwhelming, with too much to see and do. Using cues to guide a learner's attention and processing provides the learner with instructional scaffolding and learner support. As part of the online experience in the Department of Entomology, students have the option of participating in an online "course" called *The Whole Student*. This course combines streaming audio with static slides and provides cues for students through the use of effective navigation and by placing on the static slides the main points discussed in the audio (http://www.ento.vt.edu/ihs/distance/lectures/whole_student/). Another site that provides effective cues is Biology in Motion's *Evolution Lab*. This site provides cues through section headers, color, and graphics (<http://biologyinmotion.com/evol/>). The Whole

Student and Evolution Lab sites both provide effective cues through strategic use of text and text attributes (e.g., boldface, color).

Contiguity Principle

The contiguity principle states that individuals learn, retain, and transfer information better in an instructional environment where words or narration and pictures or animation are presented simultaneously in time and space. Specifically, individuals who experienced a short tutorial explaining the creation of lightning, where the instruction was in the form of integrated on-screen text and animation (i.e., the text was presented spatially within the animation), learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of separated on-screen text and animation (i.e., the text was presented spatially separated from the animation) (spatial contiguity effect; Moreno & Mayer, 1999). In addition, individuals who experienced a short tutorial explaining the creation of lightning, where the instruction was in the form of simultaneous narration and animation, learned, retained, and transferred the knowledge within the tutorial significantly better than individuals who experienced a tutorial where the instruction was in the form of narration *followed by* animation (temporal contiguity effect; Moreno & Mayer, 1999). The contiguity principle, as stated here, combines what Mayer and Moreno referred to as the spatial contiguity principle and the temporal contiguity principle (Mayer & Anderson, 1991; Moreno & Mayer, 1999). Thus, when constructing multimedia instructional environments, learning, retention, and transfer are facilitated when text or narration and pictures or animation are concurrent and are not separated in either time or space.

Theoretically, these results and the contiguity principle may be explained based on Baddeley's (1986) working memory model and Sweller's

(Chandler & Sweller, 1991) cognitive load theory. When on-screen text is presented spatially separate from animation, the individual is forced to split attention between the two sources of information (Mayer & Moreno, 1998). This attention split requires extra working memory and processing resources and is more likely to result in cognitive overload than when the on-screen text and animation are integrated. Similarly, when narration is provided *prior to* viewing an animation, the individual must maintain the narration in working memory while viewing the animation if any connections between the narration and animation are to be created. This narration maintenance is cognitive resource intensive and is likely to result in cognitive overload at the onset of the animation. Mayer's (2001) cognitive theory of multimedia is consistent with these findings and rationales: "If we want students to build cognitive connections between corresponding words and pictures it is helpful to present them contiguously in time and space—that is, to present them at the same time or next to each other on the page or screen" (p. 112).

Applying the contiguity principle implies that multimedia instructional environments should be constructed such that words and pictures or narration and animation are displayed simultaneously and close together. Prime examples of this synchronization of time and place include the fusion of audio and video. For example, Brainware.tv's *Boardband Business Videos* (<http://www.brainware.tv/previews/p1harn2.asx>) and the Electronic Scholar's *Study of Teaching Videos* (<http://www.electronic scholar.com/videos.html>). Another example of synchronization includes the synthesizing of text and animation, where the text is integrated into the animation. An example of this type of synchronicity includes the *Projectile Motion* Java applet (http://galileoand einstein.physics.virginia.edu/more_stuff/Applets/ProjectileMotion/jarapplet.html). This applet plots the path of a simulated projectile, given specific parameters (i.e., velocity, angle, mass), and provides integrated feedback on the projectile's maximum

distance, maximum height, end velocity, and time aloft. The previous video examples represent temporal contiguity, where multimedia are experienced simultaneously, while the applet example represents spatial contiguity, where multimedia are experienced close together in space. It is important that multimedia instructional environments be both temporally and spatially contiguous.

Segmentation Principle

The segmentation principle states that individuals learn and transfer information better in an instructional environment, where individuals experience concurrent narration and animation in short, user-controlled segments, rather than as a longer continuous presentation. Specifically, individuals who experienced a short tutorial explaining the creation of lightning, where the instruction was in the form of 16 short, user-controlled segments of concurrent narration and animation, learned and transferred the knowledge within the tutorial significantly better than individuals who experienced the tutorial as a single, continuous narration and animation presentation (Mayer & Chandler, 2001; see also Mayer & Moreno, 2003). Thus, when constructing multimedia instructional environments, learning and transfer are facilitated by the user being able to control the rate of information presentation.

Theoretically, these results and the segmentation principle may be explained based on Baddeley's (1986) working memory model and Sweller's (Chandler & Sweller, 1991) cognitive load theory. When an individual has control over the rate of information presentation, the individual may pace the presentation such that time and cognitive resources are allotted for making connections between verbal and visual representations. Alternatively, during an automatically paced presentation, the individual may lack sufficient time and cognitive resources to make representational connections, resulting in cognitive overload. Mayer and Moreno (2003),

in discussing the segmentation principle in light of the cognitive theory of multimedia, stated that “the learner is able to select words and select images from the segment; the learner also has time and capacity to organize and integrate the selected words and images” (p. 47).

The segmentation principle, pedagogically, supports the position that multimedia instructional environments should be created to allow the user control over the pacing of the environment, if the environment is likely to foster cognitive overload. A well-constructed example of allowing user control includes Virginia Tech’s *Critical Media Literacy in Times of War* site (<http://www.tandl.vt.edu/Foundations/mediaproject/>). This site integrates text, graphics, animation, and audio, while providing the learner with step-by-step navigational control. Similarly, the Joliet Junior College tutorial *Using a Secant Line to Approximate a Tangent Line* provides the learner with the ability to experience the tutorial in small steps (<http://home.attbi.com/~waterhand/tangent.html>). In each of these cases, the user is provided with the ability to slow his or her interaction with the multimedia instructional environment and thus provide added time and resources for active cognitive processing.

Summary

The explanations and examples of pedagogy based on the cognitive principles of multimedia provide an initial framework for creating multimedia instructional environments that are empirically and theoretically well grounded. This grounding is essential, as it has been demonstrated repeatedly that media itself, even multimedia, has little effect on learning unless the pedagogy that drives the media is focused on student learning (see Clark, 1983, 1994).

Collectively, these seven cognitive principles of multimedia provide a grounded framework within which to begin to build this learner-centered pedagogy. The multimedia and modality

principles clearly delineate the benefits of using concurrent narration and animation in multimedia instructional environments. Furthermore, the redundancy principle extends the multimedia and modality principles by demonstrating that providing redundant information in both auditory and visual-processing channels is detrimental when the visual channel also needs to process images. Further, the coherence principle refines the redundancy principle by demonstrating that irrelevant stimuli, as well as redundant stimuli, are detrimental to learning, retention, and transfer. However, the signaling principle may provide a potential solution to the overload caused by irrelevant or redundant stimuli by providing cues that may focus the learner’s attention and processing and thus ameliorate the cognitive overload. While signaling may ameliorate the presence of extraneous stimuli, the coherence principle demonstrates, more generally, that proximity in time and space of narration and animation is beneficial to learning, retention, and transfer. Finally, the segmentation principle demonstrates that when a narration and animation sequence is likely to proceed too quickly for the learner to process information adequately, then allowing the user to control the progress of the narration and animation sequence pace is beneficial.

CONCLUSION

Improving instruction has been a primary goal of education and training. To foster this goal, educators have employed cognitive principles to highlight effective instructional practices. Unfortunately, a disconnect continues to exist between this science of human learning and daily educational practice. This gap denies learners and teachers access to powerful forms of teaching, training, and learning.

Fortunately, the field of instructional technology, generally, and the domain of multimedia learning, specifically, is providing an avenue for

bridging this educational gap. Current research into pedagogical and technological integration within multimedia instructional environments is yielding significant and meaningful findings related to the improvement of learning, retention, and transfer. As discussed previously, the cognitive principles of multimedia, derived from Mayer's (2001) cognitive theory of multimedia, provide a solid foundation upon which to build a theoretically sound pedagogy. This process, however, of creating pedagogy from theory is fraught with difficulty and thus must be undertaken with care and forethought. According to William James (1899-1958):

I say moreover that you make a great, a very great mistake, if you think that psychology, being the science of the mind's laws, is something from which you can deduce definite programmes and schemes and methods of instruction for immediate schoolroom use. Psychology is a science, and teaching is an art; and sciences never generate arts directly out of themselves. An intermediary inventive mind must make the application, by using its originality. (p. 23)

Thus, pedagogy of any type is at least once removed from its theoretical underpinnings. With this caution in mind, it is necessary that we not only apply the pedagogy arising from the cognitive principles of multimedia with due diligence, but that we also continue to further investigate and refine the pedagogy of multimedia.

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Chapter 7.7

Instructional Game Design Using Cognitive Load Theory

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ABSTRACT

This chapter proposes an instructional game design framework based on the 4C/ID-model and cognitive load theory, its associated theoretical foundation. The proposed systematic design framework serves as the processing link to connect games' powerful characteristics in enhancing learning experience with desired learning outcomes. In this chapter we focus on the cognitive aspect of learning outcome: the development of transferable schema. This chapter introduces design guidelines to attain specific game characteristic by prioritizing the design components in 4C/ID-model. Each game characteristic consists of three levels of design emphasis: preliminary, secondary, and tertiary. The ultimate goal of this chapter is to initiate a series of dialogue between cognitive

learning outcome, systematic instructional design, and instructional game design thereby seeking to improve the overall game design and instructional efficiency.

INTRODUCTION

In recent years, the use of games for teaching and learning has grown significantly in the training industry and K-16 educational settings. There is, however, a lack of understanding between what games readily provide (i.e., games' characteristics) and what the learners need from games (i.e., learning outcome). Such deficiency makes it difficult for instructional designers to systematically apply a design framework as well as to justify their decisions in using games to enhance learning. Being equipped by their multi-dimensional characteristics, the instructional potential of games therefore

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cannot be fully utilized until there is substantive evidence linking specific instructional benefits to various game characteristics. Moreover, the lack of systematic instructional game design process supports unnecessarily prolonged, costly, and inefficient game design.

Games today are usually designed and developed based on generic film production procedures as well as filmmakers' mental models. Entertaining is the key design *objective*. All actions taken in game design are focused on one reason: to entertain the players. But what happens if we are to design instructional games? Does the entertainment element still override everything? While this key objective works for game developers, if games are to become a viable tool with instructional value, games need to more than entertain, they need to facilitate learning. This chapter believes that the design focus should be shifted to enhancing learning experience while still utilizes entertainment to support learner engagement. The ultimate goal of designing instructional games is to preserve the complex nature of games in order to optimize their impact on learning. The lack of a systematic design framework, however, often leaves some games' learning-enhancing features unexplored. As a result, instructional games' capabilities are not fully manifested for the purposes of enhancing learning and learning transfer to performance settings.

The purpose of this chapter is to describe a systematic instructional game design framework to address the issues just presented. We identify the cognitive load theory-based 4C/ID-model as the prototypical model to base the instructional game design framework, emphasizing the 4C/ID-model's focus on schema construction for complex learning and performance transfer. The following sections first discuss games' characteristics based on previous studies. Second, the chapter introduces the 4C/ID-model in the context of cognitive load theory; and third we propose an instructional game design framework based on 4C/ID-model to attain specific game characteristics in support of complex

cognitive learning. Finally, the chapter proposes a design framework for future research with the intention to initiate meaningful dialogue on how we can empirically investigate the learning impact of instructional games.

Background

What Are Games

A game is a context in which individual and teamed players, bounded by rules and principles, compete in attaining identified game objectives. There is a series of decision-making processes are required by the game players. Elliot Avedon and Brian Sutton-Smith (1971) explained that game playing is a voluntary exercise of controlling a system (i.e., the game) intended for a state of disequilibrium. In other words, game players continuously try out new methodologies and strategies during the game-playing process based on the system's feedback until they achieve the game objectives or the equilibrium state. The following section explains several game components that include:

- Games create experiences
- Rules and interactions in games
- Games are complex
- Games are models

Games Create Experiences

Games are known for their capabilities to promote collaborative and active learning (Downes, 2004; Klabbers, 2006; Vygotsky, 1978). Game players learn from their success and mistakes in order to improve their gaming skills and playing strategies. Players learn about the games and how to win the games from playing games and reflecting on the game interactions. The process begins with concrete playing experience. Players observe how the system responds to their actions in the form of scoring. Players then revise their playing strategies and try them out at similar situations.

A player can play the game many times and never quite get the gist of the game (experience alone is not sufficient). At some point, however, a player who thinks about what they are trying to learn (reflection and self feedback) can begin to master the game.

Rules and Interactions in Games

Games requiring individual participation offer a rich environment for players to be interactive with the game system (UNIGAME, 2002). Games comprise a system that consists of rules, process, and interactions that players must experience in order to attain desired outcome. Game rules help players connect the game contexts with players' existing schema; they also impose limits and guidelines on actions and to ensure that all players are seeking to achieve the game goals. Rules represent the criteria for evaluation of the player performance in the form of scoring, as well as to acknowledge players' performance during the game-playing process. Rules further enable players to analyze the interrelationships between different rules to generate feasible and "winning" strategies (Bennett & Warnock, 2007; Björk & Holopainen, 2003; Garris, Ahlers, & Driskell, 2002; Hays, 2005; Leemkuil, de Jong, & Ootes, 2000). Interactions in games are considered as structural components allowing players to interface with other players, game context, and the system. It is the interaction component that makes the game rules and the playing process meaningful (Asgari, 2005; Crawford, 1982; de Felix & Johnson, 1993; Kirriemuir & McFarlane, 2006; McGrenery, 1996; Myers, 1990; Thornton & Cleveland, 1990; Waal, 1995). The interactions within a game allow players to directly acquire first-hand experience thereby helping them to learn about the system presented in the game.

Games Are Complex

An engaging game can be more complex than a boring game. Players must consider multiple

factors before finalizing a winning decision. Sim City™, for example, players are responsible for planning, developing, and sustaining a prospering city. Building a new hospital is usually an effective strategy to attract new residents to move to the "simulated" city. The decision-making process for players is everything but simple and straightforward. One game play or action could impact the overall outcome since all pieces are causally connected by the game rules and system. Games are capable of linking critical elements together and hence can create a complex learning environment, that helps learners see the complex nature of a given model and also can help to develop transferable and predictive problem-solving strategies (Björk & Holopainen, 2003).

Games Are Representations Models

Games can embody abstract concepts and rules. The winning game play or game strategy is the translation of problem-solving strategies intended by the game model. The game adds contextual information to the model as to how to apply the information in different situations. This contextual information is often represented by a story line which implicitly or explicitly guides the players throughout the process. Simulation games, for example, are powerful in creating authentic situations for players to experience realistic and immediate performance feedback. Learners playing simulation games can directly interfacing with the intended model in a tangible way (Bennett & Warnock, 2007; Björk & Holopainen, 2003; Garris et al., 2002; Hays, 2005; Leemkuil et al., 2000).

Gaming Characteristics

An exhaustive literature review has identified 11 prominent and yet interrelated characteristics found in games regardless of their delivery formats. Each game characteristic is described in Table 1.

Table 1. Game characteristics

1.	Challenge	7.	Engagement and Curiosity
2.	Competition	8.	Role-Playing
3.	Rules	9.	Control
4.	Goals	10.	Multimodal Presentation
5.	Fantasy and Changed Reality	11.	Task
6	Story or Representation		

Challenge

A challenging activity provides an achievable level of difficulty for game players that consists of clearly identified task goals, unpredictability, immediate performance feedback, and a sense of accomplishment and conquering after completing the activities (Baranauskas, Neto, & Borges, 2001; Belanich, Sibley, & Orvis, 2004; Bennett & Warnock, 2007; Csikszentmihalyi, 1990; Garris et al., 2002; Malone, 1981; Malone & Lepper, 1987; McGrenery, 1996; Rieber & Matzko, 2001).

Competition

Competition stimulates players to take risk-taking actions in a consequence-free environment enriched with social interactions. Players develop their skills during the game-playing process by matching and exceeding the opponents' skill levels. The competition can be implemented between individual players, among teams, and even between players and the system (Baranauskas et al., 2001; Crawford, 1982; Csikszentmihalyi, 1990; Leemkuil et al., 2000; Rieber & Matzko, 2001; Vockell, 2004).

Rules

Rules of games serve as the guidelines for players' actions. Fair play is also sustained by the enforcement of game rules. Players need to learn about the game rules either by designated training or via the actual playing experience. In the context of

games for learning, game rules could be the direct or indirect translations of intended instructional materials such as scientific concepts of economic principles (Bennett & Warnock, 2007; Björk & Holopainen, 2003; Garris et al., 2002; Hays, 2005).

Goals

Goals in games clearly state the final status for players to attain via a series of planned tasks and actions by following the game rules. Sub-goals in games are often presented to present various stages of accomplishment for motivational and evaluation purposes. The presence of goals is also the major difference between games and simulations (i.e., simulations could be goal-less) (Bennett & Warnock, 2007; Björk & Holopainen, 2003; Csikszentmihalyi, 1990; de Felix & Johnson, 1993; Gredler, 1996; Hays, 2005; Hirumi, 2006; Leemkuil et al., 2000; Malone, 1980).

Fantasy and Changed Reality

Fantasy creates entirely unreal situations and environments for game players. This characteristic encourages players to take risks in a safe environment. Fantasy also motivates players to follow the story line to achieve desired game goals (Bennett & Warnock, 2007; Garris et al., 2002; Kirriemuir & McFarlane, 2006; Malone, 1981; Malone & Lepper, 1987; McGrenery, 1996). Changed reality in games allows players to have exaggerated experiences in a specific context, which must reflect a certain degree of reality, but not entirely.

Usually changed reality separates itself from reality by altering time, space, role-playing, and the complexity of situations (e.g., simplified reality) (Belanich et al., 2004; Björk & Holopainen, 2003; Crawford, 1982; Csikszentmihalyi, 1990).

Story or Representation

Story line or representation in games provides paths for players to interact, react, and progress. It summarizes the game goals, rules, constraints, role playing, and contexts for players in a seamlessly interconnected and embedded fashion (Hirumi, 2006; Rieber & Matzko, 2001). Players usually favor the representation of game rules in stories since it not only informs them the game guidelines, but also provides a holistic view of the entire game context.

Engagement and Curiosity

Engagement created by games allows players to become deeply involved in the game where players lose their sense of realistic self. In other words, players perceive themselves as part of the game and enjoy the intrinsically motivating game-playing experiences. Playing the game itself is rewarding enough without extrinsic motivators. Implementing elements of mystery and curiosity is also considered effective in creating engaging game experiences (Asgari, 2005; Bennett & Warnock, 2007; Csikszentmihalyi, 1990; Leemkuil et al., 2000; Malone, 1980; Malone & Lepper, 1987; McGrenery, 1996).

Control

Control in games enables players to determine and predict the outcome of actions or events. Providing options or choices to players, for example, is an effective approach to allow players to exercise control over the game progression (Belanich et al., 2004; Bennett & Warnock, 2007; Csikszentmihalyi, 1990; Garris et al., 2002; Gredler, 1996;

Malone, 1981; Malone & Lepper, 1987; McGrenery, 1996; Waal, 1995).

Role Playing

Role playing in the game involves the player becoming a character embedded in the story line of the game. Usually the player's role is pre-identified with specific position, access to resource and control, dominance over the progression of the game, functionality (if within a team), and behavioral patterns. Role playing helps players establish connection with the fantasy world of the game in order to better engage players with the game-playing experience (Björk & Holopainen, 2003; Gredler, 1996).

Multimodal Presentation

Games usually utilize multimodal presentation to effectively enhance the interest and instructional effect. This is particularly true in video games. Aural, visual, and textual presentations are combined in order to enrich the experience. Animations, for example, are popular as a major game component since they seamlessly integrate multimodal presentations and can be easily modified for different game contexts (Bennett & Warnock, 2007; Björk & Holopainen, 2003; de Felix & Johnson, 1993; McGrenery, 1996).

Task

Within the game mission, there are several tasks that comprise the building block of a game's goal. Players often are required to take on sequences of tasks in order to achieve the game's final goals. Task feedback or performance scores serve as player assessment of accomplished tasks that help players improve their playing strategies (Björk & Holopainen, 2003; Gredler, 1996). Games tasks can be derived from a learning task analysis and can be used to help players reach of intended learning goals.

Problem

In addition to the aforementioned finding on game characteristics, the literature review (Johnson, Spector, Huang, & Novak, 2007) did not reveal a systematic nor pedagogically sound design model available for optimizing games' effects on learning. Further, there was no evidence that suggested that a specific gaming characteristic or gaming strategy was linked to a specific learning goal. Given the multi-dimensional and multi-layered characteristics of games, the lack of practical design model diminishes the power of the game design to supporting complex learning and also prolongs the design cycle.

The absence of empirical design model for instructional game also poses an immediate concern to the evaluation of games' pedagogical impact. A majority of studies on games and their impact on learning are conducted as post-hoc analyses (O'Neil, Wainess, & Baker, 2005). Without a validated design model to purposefully control the inclusion and exclusion of design elements based on intended learning outcome, it is only possible to speculate the linkage between game characteristics and desired learning outcomes (O'Neil et al., 2005).

Solution

In order to enhance the decision-making associated with game design, we propose that game designers use the underlying principles found in the 4C/ID-model (van Merriënboer, & Sweller, 2005). This model is based on cognitive load theory (Chandler & Sweller, 1991; van Merriënboer & Paas, 1998), to address several of the concerns presented. The 4C/ID-model is suitable for designing and researching instructional games due to the model characteristics that include:

- Affordability to design complex learning environments;

- Flexibility to be applied for non-linear and compact design sequence;
- Scalability for design projects in various scopes;
- Validity and reliability of measuring learning outcome; and
- Emphasis on performance transfer.

Cognitive Load Theory

Cognitive load theory (CLT) (Chandler & Sweller, 1991; van Merriënboer & Paas, 1998) has established a sound theoretical foundation to connect cognitive research on human learning with instructional design and development (van Merriënboer, Clark, & de Croock, 2002). The purpose of CLT is to bridge the gap between information structures presented in the instructional material and human cognitive architecture so learners can use their working memory more efficiently (Paas, Renkl, & Sweller, 2003). "Learning," in the context of CLT, is thought to involve acquisition and automation of schema. Acquisition of schema is the process of how learners construct schema and store them in long-term memory, whereas automation is how learners perform certain tasks without accessing working memory. Information required for the performance of a task is retrieved directly from the long-term memory (Paas et al., 2003). Successful construction and automation of schema will lead to a more efficient use of working memory for desired performance since both attributes require little working memory capacity and yet are critical to meaningful learning (Mayer, 2001).

Three types of cognitive load are suggested by CLT to construct cognitive load: intrinsic cognitive load, extraneous cognitive load, and germane cognitive load. When combined, the three types of cognitive loads compose the total cognitive load, which can never exceed learner's working memory capacity for learning to occur. The total of extraneous cognitive load and germane cognitive load is assumed to be equal to the overall cognitive load minus the intrinsic cognitive load. Since

the intrinsic cognitive load is fixed (i.e., the load cannot be manipulated by instructional design), instructional design's main purpose is to reduce the extraneous cognitive load while increasing the germane cognitive load (van Gerven, Paas, van Merriënboer, & Schmidt, 2003).

Intrinsic cognitive load is associated with the element interactivity inherent to the instructional material itself. Element interactivity is described as the degree to which information can be understood alone without other elements' involvement (Paas et al., 2003). As suggested by Paas et al. (2003), information with high element-interactivity is hard to understand because it usually depends on the involvement of other information units in order to see the full interaction. Therefore, instructional material with high element interactivity is assumed to induce a higher intrinsic cognitive load since the instruction requires more working memory for information processing (Paas et al., 2003). The intrinsic cognitive load is also considered to be independent of instructional manipulations because the manipulation only involves the amount of information a learner needs to hold in working memory without decreasing the inherent element interactivity (Pollock, Chandler, & Sweller, 2002). The extraneous cognitive load and germane cognitive load, in contrast, can be manipulated by instructional design (Brünken, Plass, & Leutner, 2003).

Extraneous cognitive load is also known as *ineffective cognitive load* as it only involves the process of searching for information within working memory as opposed to the process of constructing schemas in long-term memory (Paas et al., 2003). This type of cognitive load can be influenced by the way information is presented and the amount of working memory required for given learning tasks. The extraneous cognitive load is considered as the necessary cost of processing information that is not related to the understanding of information. Instructional design's purpose therefore is to reduce the ineffective (i.e., extraneous) cognitive load (Brünken et al.,

2003). Well-designed instructional multimedia components have been found to be effective in reducing the extraneous cognitive load (Khalil, Paas, Johnson, & Payer, 2005a, 2005b; Mayer & Moreno, 2003). Cobb (1997) suggested similar multimedia application in designing instructional materials to increase "cognitive efficiency, where he used multimedia component (non-verbal and non-textual components) as cognitive capacity external to learners' working memory, to facilitate cognitive information processing. Consequently learners should spend less cognitive effort in understanding given information.

In contrast to the desired low degree of the extraneous cognitive load, instructional materials should be designed to increase the germane cognitive load. The germane cognitive load, also known as *effective cognitive load*, is described as the effort learners invest in order to facilitate the process of constructing schema and automation (Paas et al., 2003). Higher germane cognitive load is suggested to lead to a deeper learning since learners are compelled by the design of the instructional material to reexamine every new piece of information (de Crook, van Merriënboer, & Paas, 1998).

In summarizing CLT, the overall goal of manipulating cognitive load with instructional design is to decrease the level of ineffective cognitive load (i.e., extraneous cognitive load) and to increase the effective cognitive load that promotes deeper learning (i.e., germane cognitive load) (Paas et al., 2003). The CLT further suggests that the combination of extraneous and germane cognitive load should remain relatively constant after removing the fixed intrinsic cognitive load (Paas et al., 2003). The decrease of extraneous cognitive load should lead to the increase of germane cognitive load, or vice versa (Paas et al., 2003; van Gerven et al., 2003).

In order to better apply CLT in practical instructional design, van Merriënboer, Clark, and de Croock (2002) proposed the four-component instructional design system (4C/ID-model) for

designing complex learning environments (van Merriënboer & Sweller, 2005). The following section will discuss the 4C/ID model in detail and its applicability in designing complex game-based learning environments.

4C/ID-model (Four Components/ Instructional Design Model)

4C/ID-model is a non-linear, systematic, integrated, and performance transfer-oriented instructional design model intending to reduce extraneous cognitive load while increasing germane cognitive load during the learning process in complex learning environments. The model includes four non-linear, interrelated design components: *learning tasks*, *supportive information*, *just-in-time (JIT) information*, and *part-task practice*. All design actions center around the learning tasks component.

Learning tasks are concrete, authentic, whole-task experiences that are provided to learners to promote schema construction for non-recurring aspects and, to a certain degree, rule automation. Learning tasks must be complex and require the coordination and integration of all constituent skills. Task classes are used to define simple-to-complex categories of learning tasks and to steer the process of selection and development of suitable learning tasks. Learning tasks within a particular task class are equivalent in the sense that the tasks can be performed on the basis of the same body of knowledge (i.e., mental models and cognitive strategies). Learners are required to elaborate upon their existing knowledge base when given a higher task class. Various supports are also provided with learning tasks. Learner support informs learners about the problem in hand and guidance for generating effective solutions; product-support provided solution models in terms of worked-out examples and case studies; process-oriented support explains performance requirement and criterion reference for learners. The design should primarily aim at the induction process. That is, the design should focus on con-

structing schemata through attentive abstraction from the concrete.

Supportive information mainly supports the learning and performance of non-recurring aspects of intended tasks. Theories and models are often included in supportive information since learners can apply them universally for problem-solving in the same task class. The design of learning environments aims at the construction of meaningful relationships between learners' prior experiences and the learning tasks with experiential approach. More importantly the design should promote the elaboration process with cognitive feedback (Reigeluth, 1999) thus to enable learners to develop complex schemata.

JIT information facilitates learners' development in generating automated responses. Rules and principles are embedded in this design component and applied with the part-task practice. This design component uses demonstrations and instances to effectively explain the rules for all classes of learning tasks.

Part-task practice promotes rule automation for selected recurrent aspects of the intended complex task. The design approach aims to gradually develop learners' ability to automate the performance of recurrent skills via small task building blocks.

In addition to help learners develop desired skill levels separately, the 4C/ID-model stresses the integration and coordination of different levels of skills with intentional design, which traditional ISD models seem to lack. The main design goal of 4C/ID-model is to situate learners in authentic, complex learning environments with realistic contexts. The attainment of desired performance is more than just "assembling parts" together. Efforts also should go into the identification, evaluation, selection, combination of learned separated skills (constituent skills), to solve complex problems. 4C/ID-model suggests the necessity to purposefully design the relationships among different constituent skills (i.e., the outcome of task analysis) in complex learning environments. The

relationships could be temporal as desired tasks need to be performed step-by-step; it is also possible that learners need to demonstrate proficient performance on different task procedures simultaneously (e.g., air traffic controllers must monitor multiple aircrafts at the same time).

The model operates under these assumptions: (1) an upper level learning skill can be attained by assembling sets of simplified task procedure; and (2) performance transfer can be easily achieved after completing simplified learning tasks (van Merriënboer & Sweller, 2005). It further divides constituent skills in general into two categories: non-recurrent skills and recurrent skills. Non-recurrent skills morph themselves from problem to problem. As a result they require learners' cognitive reasoning since every situation is different from their previous experiences. Cognitive strategies are applied to extract existing schema in order to facilitate the problem-solving process in a novel context. Recurrent skills, on the other hand, are less effortful for learners to process and perform. Problem-solving process, in the case of recurrent skills, is very close to what learners have experienced before.

The design of the learning environment should focus on the abstraction of effective problem-solving process for non-recurrent skills since the goal is to enable learners to redevelop their own schema under various scenarios. In other words, the abstraction helps learners transfer the desired performance from context to context. The design approach proposed by this model is to provide concrete cases for learners to fully experience the cycle of abstraction and schema redevelopment. Additionally supportive information is utilized as one of the design component, to facilitate the development of non-recurrent skills, which will be discussed later in this section. When designing for recurrent skills, authentic and full application of rules and principles is crucial. The goal is to help learners automate the desired performance procedures with the least effort. This model proposes a layer-by-layer approach to compile

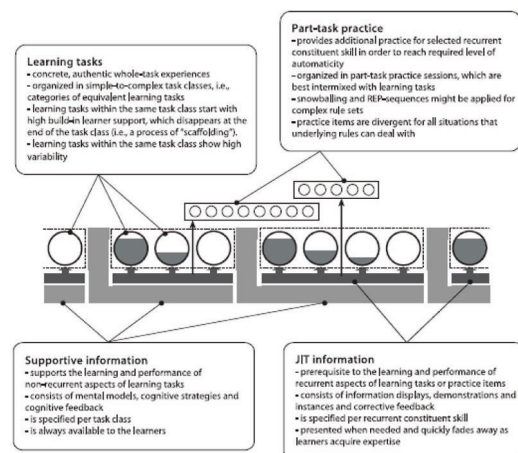
rules and procedures in the form of part-task practices. The entire task is dissected into inter-related part-task practices and learners are only asked to finish one of them at a time. The repetitive application of rules in order to accomplish all the part-task practices strengthens learners' automated responses toward similar problems. Moreover learners should have spontaneous access to rules and principles while accomplishing part-task practices. The just-in-time (JIT) information thus is proposed in the design model to facilitate the automation development process. By addressing both aspects of skill sets with 4C/ID-model's design approaches, learners will be able to transfer the desired performance efficiently into different contexts.

See Figure 1 for the visual presentation of the 4C/ID-model (van Merriënboer et al., 2002).

USING 4C/ID FRAMEWORK FOR GAMING DESIGN

In this section we describe use of the 4C/ID-model as the framework to compare the design components with games' characteristics in order to answer following questions:

Figure 1. Visual presentation of the 4C/ID-model (in van Merriënboer, Clark, & de Croock, 2002, p. 44)



- What game characteristics, based on previous literature reviews, should be able to directly support cognitive learning?
- How are design components of 4C/ID-model capable of informing the design of specific game characteristic?

Game Characteristics and Cognitive Learning

Cognitive learning, as described in the context of cognitive load theory as well as the 4C/ID-model, mainly focuses on the construction of transferable schema (van Merriënboer & Sweller, 2005). Such construction requires integrations of interrelated knowledge units and problem-solving processes. Learners should be able to understand the relationship among them and be able to apply them effectively in different and most of the time, new, problem-solving situations. Learners not only construct new schema as the result of the learning process, but also relate, flex, and expand existing schema to make the learning experience more meaningful. The instructional information should be delivered as the building blocks for developing learners' cognitive structures in the forms of solved and unsolved cases, worked examples, process-explicit solutions, and so forth. Each building block is self-contained and yet interconnected with other pieces. The learning environment (i.e., instructional games) must help learners acquire what is included in each building block as well as how to assemble all building blocks together. Below is the list of game characteristics that can potentially support the schema construction process:

Challenge: To encourage learners explore and experiment new processes, in other words, to flex their existing schema.

Competition: Learners strive to facilitate the problem-solving process with effective solutions, in order to defeat the opponent(s), be it the game system, or competing units.

Rules: Rules in instructional games provide learners with information that guide the problem-solving process. They also can be composed in a way that requires learners to abstract and modify their existing schema.

Goals: Goals of instructional games oftentimes are not explicitly related to the cognitive tasks intended in the game. But they provide specific performance objectives for learners to pursue in the forms of scores, accomplished missions, and conquered territories. In another words, goals are the performance criteria of assessing learners' newly developed schema.

Fantasy and Changed Reality: This is where instructional games can flex learners' existing cognitive structure. Fantasy enables learners' imaginations based on their experiences. Learners voluntarily extract existing schema that might be useful to accomplish given tasks in the fantasized context. The difference between fantasy and changed reality is manipulated by the foreignness of the gaming context perceived by learners. Learner's prior experience plays a critical role in designing meaningful fantasy or changed reality in instructional games.

Story and Representation: This characteristic in games illustrates operational schema for learners. Ideally, a story contains a problem to be solved, resources required to solve a problem, conditions necessary to implement the solution, and the outcome of applying such solutions. In instructional games the story should be incorporated as the contextual information for learners to see the big picture of the game. Rules of the game can also be implicit in the storylines to guide the learners' actions.

Engagement and Curiosity: Engagement sustains learners' attention during the learning process while curiosity drives learners to explore and experiment. This set of game characteristic enables learners persistently expand their existing cognitive structure.

Role Playing: Role playing does not necessarily have to be in a fantasized context. Learners

can be assigned with a completely different set of skills and environmental and situational characteristics to experience the instructional game. This game feature could enable learners to transfer problem-solving principles from role to role. It also familiarizes learners with various bodies of knowledge given different roles' diverse expertise.

Control: Learners prefer to control their own schema development processes. Self-pacing is one popular mechanism in playing games. Learners are able to monitor their progress in the process of achieving game goals with accumulated scores and number of mission accomplished.

Multimodal Presentation: This is an important game characteristic that affords effective manipulations of cognitive load during the learning process. Application and variation of multimodal presentation aims to reduce unnecessary usage of learners' cognitive capacity therefore facilitating schema development.

Task: Tasks represent a structure on which to construct schema for learners in instructional games. They are the building blocks of a game. Learners are required to accomplish sequenced or classed tasks in order to attain the final game goal. Each task encompasses all the aforementioned game characteristics in an operational form.

4C/ID-Model Design Components and Game Characteristics

This section focuses on the process of using 4C/ID-model design components to create the instructional game environment, which bears the aforementioned game characteristics that are capable of facilitating cognitive learning process. Each game characteristic is paired with a primary component (denoted as 3 for highest priority), a secondary (denoted as 2) component, and tertiary design components (denoted as 1) from 4C/ID-model based on each component's definition to attain corresponding game characteristics. The radar graph in each game characteristic visually depicts the design priority we suggest. The combi-

nation of all components (learning tasks, part-task, supportive information, and just in time) aims to optimize the design outcome.

Challenge

Primary Design Component

Learning task is the main design focus to create a challenging game-based learning environment. Tasks are designed with various difficulty levels of attainable task objectives. Task variability also allows designers to manipulate the challenge levels of the learning environment. (Figure 2)

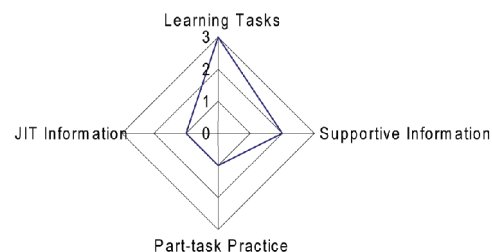
Secondary Design Component

Supportive information needs to be carefully designed in order to create a challenging instructional game. The amount of supportive information available to learners in the game should be determined by learners' performance in prior tasks. Providing all supportive information to learners without performance analysis might reduce the level of challenge perceived by learners.

Tertiary Design Component

Part-task practice and JIT information are suggested to the tertiary design components.

Figure 2. Design emphasis for challenge



Game Design Guideline for Challenge Characteristic

When creating learning games, designers need to focus on using varying levels of the learning task as the primary focus for creating a challenging game. If game challenge is based on other non-task factors, players will not spend the resources engaging in the critical tasks to be learned. Games need to engage and provide experiences related to the key learning tasks. Challenge can be presented in the form of a score or winning, but the score or success determinant needs to be directly related to the learning task. When designing game challenge, supportive information and part-task practice need to be aligned with learning tasks, thereby strengthening the learning focus of the game. The degree that these design features are present determines the degree of challenge. For example, if supportive information is present then the degree of challenge is less than when the supportive information is absent.

Competition

Primary Design Component

Competition requires immediate feedback on learners' performance as well as information regarding model performance or peer performance. Therefore the primary design components for this game characteristic include supportive information, that provides cognitive feedback, and JIT information that provides corrective feedback. (Figure 3)

Secondary Design Component

Competition loses its attraction while every participant has similar skill level or resources as the result of practicing. Designers need to be cautious about not providing excessive part-task practices thus the competition feature can be fully demonstrated.

Tertiary Design Component

Learning tasks is the tertiary design component for this characteristic.

Game Design Guideline for Competition Characteristic

To facilitate game competition, players need to get immediate feedback on their performance. This feedback is presented primarily in the form of supportive information as well as JIT information. The learning tasks and the part-task practice are related to the game play, but not fundamental to enhancing the competition aspects of games. Competition is based on one player's interest compared to another player or a specified performance standard. The comparison information is either a score or performance feedback for both the player and the competition. This would be considered primarily supportive information. This information can be used as feedback to help the player regulate their level of game involvement.

Rules

Primary Design Component

Rule acquisition is best instilled via repetitive practice. In most cases game rules are translated from intended instructional information. Learners need to be able to automate the use of rules into recurrent aspects of problem-solving tasks. Both

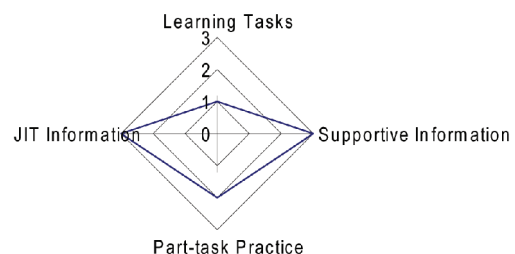
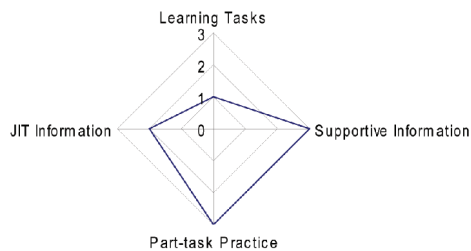


Figure 3. Design emphasis for competition

Figure 4. Design emphasis for rules



supportive information and part-task practices are cable of achieving this game characteristic. (Figure 4)

Secondary Design Component

Designers need to be cautious about inserting too much information about intended rules with the JIT information component. Although it is important to support learners' performance with the recurrent aspect of task by providing learners with JIT information such as rules, the instructional game should aim to develop learners' automation without any support external to learners' cognitive structures.

Tertiary Design Component

Learning task is the tertiary design component for this characteristic.

Game Design Guideline for Rules Characteristic

One of the first tasks in game playing is learning the rules. Once the rules are acquired, players are able to formulate appropriate decision making to compete successfully. Facilitating players' development of games rules is important. Providing supportive information as well as part-task practice can facilitate rule acquisition. Supportive information is direct and can quickly support rule acquisition. Practice allows players to test out

their understanding and revise their rule models. Rules as part of JIT information does not give learners the information at the decision making and strategic point. Plus the use of the rules needs to become automatic for the learners. Optimal task performance occurs as part of the players having a fluent understanding of the game rules.

Goals

Primary Design Component

Goals should be identified in the learning task. The game goals should directly connect to the learning goals with explicit rationales. (Figure 5)

Secondary Design Component

Supportive information and JIT information need to provide cognitive as well as corrective feedback to ensure learners are staying on the right track to attain the game goal.

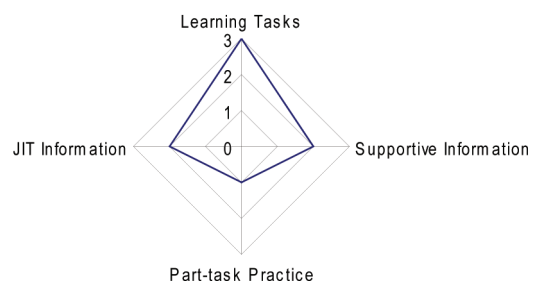
Tertiary Design Component

Part-task practice is the tertiary design component for this characteristic.

Game Design Guideline for Goals Characteristic

Of the various components of the 4C/ID model, learning tasks need to be aligned with the game

Figure 5. Design emphasis for goals



goals. If the game goals and the learning tasks are not parallel, then the game goals that drive the game play will be more deliberate thereby diminishing the learning tasks.

Fantasy, Changed Reality, and Role Playing

Primary Design Component

The design of learning task is the key component for this characteristic. Contextual information in each learning task enables learners to situate themselves into the specific game setting. (Figure 6)

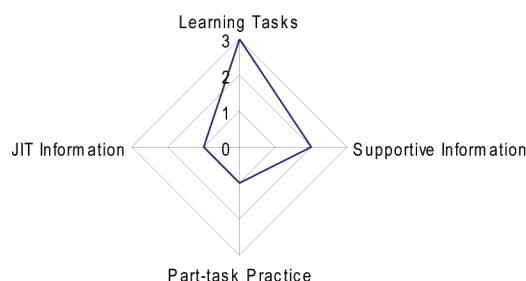
Secondary Design Component

Designers need to make sure that supportive information can provide additional support for learners to be able to operate effectively in the fantasy world. Common senses or general knowledge might not be sufficient to accomplish given tasks in an unrealistic context.

Tertiary Design Component

Part-task practice and JIT information are the tertiary design components for this characteristic.

Figure 6. Design emphasis for fantasy, changed reality, and role-playing



Game Design Guideline for Fantasy, Changed Reality, and Role-Playing Characteristic

Learning task and to a lesser extent supportive information are important in the development of these game characteristics. The context of the learning tasks will support or weaken the intended setup for fantasy, reality, or role play. The critical element in making the set-up believable is that both the task and supportive information are aligned with the intended environmental setup.

Story and Representation

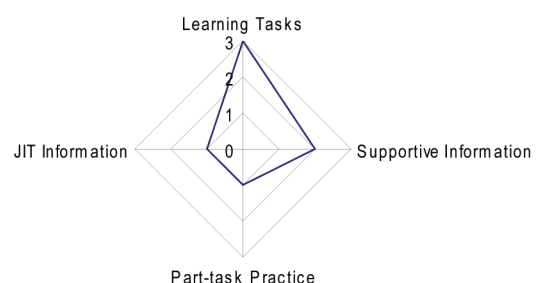
Primary Design Component

Designers should focus on the learning task for this characteristic. In addition to emphasize individual tasks' function to contain necessary elements in order to complete certain pieces of the story, this part of the design also needs to focus on the connectivity between tasks. Thus learners are able to assemble all pieces together and finish the story. (Figure 7)

Secondary Design Component

Similar to the design of fantasy or changed reality, designers should to provide sufficient background information for learners to see the whole story line as soon as possible. Supportive information

Figure 7. Design emphasis for story or representation



should be designed closely with the background story of learning task.

Tertiary Design Component

Part-task practice and JIT information are the tertiary components.

Game Design Guideline for Story and Representation Characteristic

Similar to fantasy, reality, or role play, the contextual setting for the learning task needs to be primarily considered in the creation of the story or game representation. Aligning the game design with the learning task will impact the quality of the overall game story and representation.

Engagement and Curiosity

Primary Design Component

The design focus should aim to maintain learners' interests in continuing participating in the game-playing process. From the viewpoint of cognitive learning, the learning environment needs to be relevant to learners' prior experience and be able to attract learners' attention in the initial stage of the learning process. Therefore the JIT information needs to be emphasized since it provides learners with support on prerequisite information, which must closely aligned with the learning task. (Figure 8)

Secondary Design Component

Given the complexity involved in creating an engaging instructional game, designers should focus on the learning task and supportive information to continuously guide learners to explore new ways of processing information as well as to stretch their existing cognitive structure.

Tertiary Design Component

Part-task practice is the tertiary design component for this characteristic.

Game Design Guideline for Engagement and Curiosity Characteristic

Engagement and curiosity can be support with JIT information. This type of information can provide players with assistance to decrease frustration levels as well as prompt players with hints about the specific game play. By providing JIT information, players are given information to string them along the game and facilitate their personal interest and curiosity.

Control

Primary Design Component

In order to perceive their full control in a game, learners want to have options in actions taken in a game. Players also need consistent and meaningful feedback from the system and other game participants to support decision-making to best help maintain control. The emphasis of design lies with supportive information for its cognitive feedback and JIT information for its corrective feedback. (Figure 9)

Figure 8. Design emphasis for engagement and curiosity

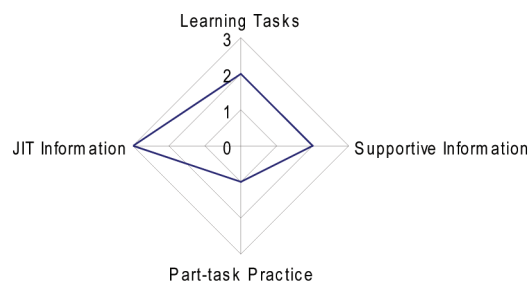
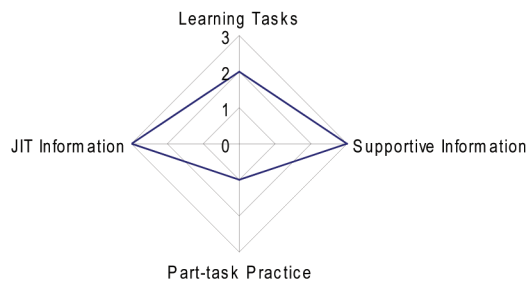


Figure 9. Design emphasis for control



Secondary Design Component

Learning task should be designed to offer learners multiple paths to solve one problem. Clear performance indicator during the game playing process also needs to be included (e.g., performance scores, enemies defeated, etc.).

Tertiary Design Component

Part-task practice is the tertiary design component for this characteristic.

Game Design Guideline for Control Characteristic

The learning task is predefined and offers little control for the player outside of the standard learning task steps. However the JIT information as well as the supportive information provide players with information about how they can better control the game play as well as giving them information about the game options thereby allowing them to control the decision-making tasks, thereby ultimately giving them control over the game. This is akin to the saying, “knowledge is power.”

Multimodal Presentation

This design principle can effectively reduce the overall cognitive load induced by the game-based learning environment. Designers need to be extremely cautious about not overloading learners’

cognitive load with abundance of multimedia stimuli. Rather, multimedia components should be utilized in a way to serve as the peripheral cognitive capacity for learners to process information. (Figure 10)

Game Design Guideline for Multimodal Presentation Characteristic

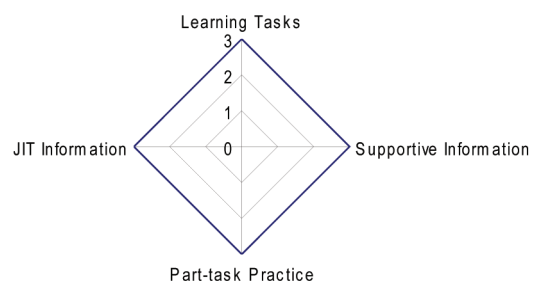
While multimodal refers to varying types of media, the 4C/ID-model automatically considers multimodal strategies: learning tasks, supportive information, JIT information, and part-task practice. These four components are collectively considered multimodal. Each one is unique, yet they all are focusing on different aspects of the game environment. In considering the components, this will allow the player game support from multiple directions.

Task

Primary Design Component

Similar to what 4C/ID-model suggested, tasks are the central piece of the design for most of the games. Game task is the embodiment of schema that learners must develop as the result of the learning process. The interconnection between game tasks is equally important as the content within each game task. Designers should focus on the learning task component for this characteris-

Figure 10. Design emphasis for multimodal presentation



tic. Additionally the supportive information and JIT information must be sufficient to provide the connection between all tasks, to develop learners' fluidity in applying intended skill sets to different contexts. (Figure 11)

Secondary Design Component

Part-task practice can be inserted between main game tasks to reinforce the automation of intended skills.

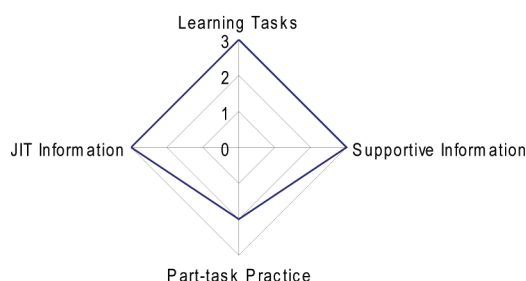
Game Design Guideline for Tasks Characteristic

This game characteristic focuses on the game task. As mentioned earlier, the learning task ideally needs to be aligned with the game task. In as much as these two are similar, the game design will enable players to simultaneously engage in learning during the game-play periods.

CONCLUSION

This chapter, based on cognitive load theory and the 4C/ID-model, proposes a systematic design framework for designing pedagogically sound instructional games. The ultimate goal is to initiate series of empirical inquiries on how designers can link game characteristics with intended learning outcome via systematic design processes.

Figure 11. Design emphasis for tasks



IMPLICATIONS

The adoption of 4C/ID-model not only presents viable opportunities for designing pedagogically sound games, but also reminds us the need for rigorous design research to continuously examine existing instructional design models for instructional game design and more importantly, to identify innovative design models and theories across disciplines. For example, Johnson (2001) proposed the “emergence perspective” to advocate a decentralized and multi-lateral system design approach based on his observations on ant colonies and human cities, which is considered an efficient design approach for video games (Irlbeck, Kays, Jones, & Sims, 2006). The feedback generated by the interactions between existing design model components, intended learning outcome, and preferred game characteristics should guide the overall design process, as opposed to following rigid and linear steps seen in conventional instructional design approach.

FUTURE TRENDS

In terms of systematic design process for developing instructional games, it is likely to see more streamlined process emerging from the field. We also anticipate more joint effort between computer science, learning technologies, and the game industry. The key is to connect theories of learning with design practices that are feasible by current industry standards for many reasons. First and foremost is to promote instructional games as efficient tools to enhance learning experience and to sustain improved performance. Second, designers want to be able to make design decisions with strong empirical support on the pedagogical effect of instructional games. Third, industry wants to be able to manage the design and development process with more efficiency and confidence.

On the research front of investigating instructional games' impact on learning and performance, we foresee research frameworks consist of all

aspects of learning (behavioral, cognitive, and attitudinal), blended methodologies (quantitative, qualitative, and physiological measurement), and human performance improvement. The outcome of such eclectic research undertaking will not only inform all stakeholders about the effect of instructional games, but also will provide concurrent evidence, from various disciplines, to further our understanding on human learning.

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KEY TERMS AND DEFINITIONS

4C/ID-Model: 4C/ID-model is a non-linear and systematic processing model for designing complex learning environment based on cognitive load theory. The model consists of learning tasks, supportive information, part-task practices, and just-in-time information. The design focus of this model is on the integration and coordination of various levels of intended problem-solving skills. As a result, learners are able to transfer desired performance to various contexts with efficiency.

Cognitive Load: The amount of mental effort learners invest during the learning process. Which is also closely associated with learner's working memory capacity. The purpose of instructional design is to optimize the allocation of cognitive load to induce the deep learning process.

Extraneous Cognitive Load: This type of cognitive load only associates with the searching and organization of information, which should occupy the least amount of working memory. Instructional designers should utilize multimedia and other cognitive-oriented design to reduce the extraneous cognitive load.

Game: A game is a context in which individual or teamed players, bounded by rules, compete in attaining identified game objectives.

Germane Cognitive Load: This type of cognitive load is directly associated with the construction of schema. Instructional designers should aim

to increase the level of germane cognitive load, induced by the instruction, as much as possible.

Intrinsic Cognitive Load: This cognitive load is inherent with the difficulty of the subject matter (e.g., organic chemistry versus multiplication). The cognitive load level cannot be manipulated by instructional design.

Schema: A schema is a memory unit stored in learners' long-term memory. Schema consists of mental models for reasoning and cognitive strategies for problem-solving.

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Chapter 7.8

Faculty Development in Instructional Technology in the Context of Learning Styles and Institutional Barriers

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ABSTRACT

This chapter describes the within-case analysis of ten faculty members who agreed to share their learning experience and struggles in learning instructional technology. The case focuses on the in-depth description of each participant stressing their unique personal approach and learning styles, describing the main steps experienced and resources utilized by the participants during the learning process. It also highlights one dominant learning characteristic of each participant, which is compared with the participant's result in the Index of Learning Styles Questionnaire of North Carolina State University, with potential implications for academic administrators in promoting the use of instructional technology by faculty members of diverse profiles. The case also discusses the

institutional barriers faced by faculty members while learning how to use instructional technology at a public university in the United States. Three institutional barriers were a major concern for the participants: Time, rewards, and cost. One hundred percent of the participants agreed that providing more time—along with financial and academic rewards—is critical to supporting the learning and implementation of instructional technology.

CASE BACKGROUND

Objectives

The purpose of this study was to collect and analyze information about the personal experiences of faculty members in learning to use instructional technology and to analyze how their learning experience was impacted by one professional

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development intervention. The main objectives of this study were:

1. Analyze the unique journey of individual faculty members in learning instructional technology and how their personal profiles and learning styles impacted their learning approach.
 2. Learn the story of faculty members describing their struggles, failures, achievements and successes in learning instructional technology.
 3. Discuss the major difficulties and institutional barriers that prevent faculty from learning and using instructional technology.
 4. Analyze which aspects of a technology workshop series the participants consider successful in promoting and facilitating learning in instructional technology.
 5. Address possible suggestions of faculty for policy-makers on ways to overcome institutional barriers and increase the positive impact of professional development programs in technology.
2. How do learning styles and personal experiences influence faculty learning experience?
 3. What are the major difficulties and institutional barriers that prevent faculty from learning and using instructional technology on a regular basis?
 4. How do professional development interventions impact faculty experiences in learning instructional

Theoretical Framework

Three major areas of literature are particularly useful in informing how the process of learning instructional technology is influenced by faculty personal styles in professional development programs: (1) Faculty attitudes towards change in technology, (2) learning styles models, and (3) Faculty Development Approaches. These areas are briefly addressed below.

Faculty Attitudes towards Change and Technology

Literature on faculty attitudes towards change and technology has direct implications for faculty development, because research suggests that the use of instructional technology by faculty members is intrinsically related to their attitudes and beliefs regarding the role of technology in education (Race, 2001; Mishra, Koehler & Zhao, 2007). The obvious implication for faculty development programs is that developmental interventions need to consider faculty attitudes and beliefs regarding instructional technology.

The adoption of instructional technology always involves a change process, and people will not always accept a change simply because others tell them of its practical advantages over an existing practice. In fact, the adoption process depends on a set of perceptions toward the change by the people involved in the desired change (Lee and Lawson, 2002), and this set of perceptions has been defined as the process by which people

Problem Statement

Many faculty members participate in professional development programs in instructional technology, but they may feel intimidated by the challenge of mastering the use of technological resources, and there is little information about the many factors influencing the way in which they learn about instructional technology. An in-depth look at how faculty approach this learning situation and the ways in which their learning can be successfully facilitated is an area that needs additional research.

Research Questions

The following research questions guided the study:

1. How do faculty cope with the fear and threat of failure in using instructional technology?

attach meaning to their experience (Eggan and Kauchak, 2004). In other words, without seeing real advantages to instructional technology, no one will actually change their teaching style to adopt technology in the classroom.

Like any other change process, the adoption of instructional technology faces different types of barriers and obstacles. Ertmer (1999) refers to two kinds of barriers: First-order barriers refer to extrinsic obstacles, which are factors external to the individual who are implementing the change, such as lack of equipment, time, training, or technical support; second-order barriers refer to intrinsic obstacles, which are related to the attitudes and beliefs of those involved in the change process, such as the challenge of traditional practices. According to her, “traditional approaches to change have focused on helping those involved in a change to overcome first-order barriers” (p. 151). However, as she says, the most effective approach to change is to focus on people’s belief systems, and not only on the extrinsic obstacles.

Analyzing the intrinsic factors of a change process in the adoption of instructional technology, Lee and Lawson (2002) developed what they call a Concerns Matrix addressing two major dimensions of change: The degree to which change is compatible with the values and beliefs of the target audience, and the levels of the institution affected by the change process. They found that some faculty members who were skeptical of technology were not persuaded to use computers even five years after being exposed to a faculty development intervention. They concluded that a concern analysis must be conducted before any change is introduced.

This discussion about the effects of personal beliefs on a change process is supported by Rogers’ (1995) Diffusion of Innovation Theory, according to which a technological innovation passes through four consecutive stages described as follows: (a) innovation, meaning the stage at which an idea is perceived as new, (b) diffusion or communication through channels within the social

system, (c) time for adoption of the innovation, and (d) integration within the social system, a set of interrelated units sharing a common goal and including potential adopters. Innovation diffusion research explains how and why users adopt a new information medium, such as the Internet.

Rogers’ theory also makes a distinction between different adopter categories, in which adopters are classified on the basis of their speed of adoption. Applying Rogers’ description to faculty members, the categories can be identified as (a) innovators, characterized as venturesome faculty; (b) early adopters, described as those having more years of education and higher social status; (c) early majority, the deliberate ones; (d) late majority, the skeptical faculty; and (e) laggards, who are the most traditional and change resistant faculty members (Clarke, 1999).

The basic characteristics of each group of adopters can be described as follows:

1. Innovators: The risk takers willing to take the initiative and time to try something new and different.
2. Early adopters: People who tend to be respected group leaders, the individuals essential to adoption by the whole group.
3. Early majority: People who are careful, safe, deliberate individuals who do not want to risk time or other resources.
4. Late majority: People suspicious of innovations and resistant to change. They are hard to move without significant influence.
5. Laggards: These are people who are consistent and sometimes inflexible in resisting change. They only change under some kind of pressure (Rogers, 1995; Pacific University, 2002).

Learning Styles

The importance of considering learning styles in professional development programs in instructional technology is supported by current research

that shows an increasing investment in innovative developmental interventions in instructional technology (Carliner & Shank, 2008; Garrison & Vaughan, 2008; Kidd and Song, 2007).

Research literature says that personal learning styles have an influence on the learning experience. Learning style is a generic term as an umbrella concept for recognizing individual learning differences. From different psychological and philosophical beliefs, a variety of authors have proposed different learning style models, and no one has a monopoly on the term or can claim to represent learning style in its entirety (Butler, 1987). In fact Dunn and Griggs (1998) explain that, despite differences in terminology, the models themselves overlap as they address different aspects of learning. Some researchers, for example, have focused on motivation and sociological traits, as well as on the structure of learning (Canfield and Lafferty, 1976; Dunn and Griggs, 1998; Gregorc, 1985; Hill, 1971; Ramirez and Castenada, 1974). Most of these researchers and Kolb (1984) have focused on the way learners perceive the world as a basis for developing their model, and all of them with the addition of Herrmann (1988) have addressed the way the human brain behaves and processes information. Listing all the learning styles models would be a very extensive task, therefore, this section briefly addresses a few models that focus on different learning dimensions and approaches.

Kolb's theory: Based primarily on Dewey (1938), Lewin (1951), and Piaget (1977), Kolb (1984) developed a model called experiential learning as a four-step process, starting with immediate *concrete experience* with people or the environment, and then thinking about this experience through *reflective observations* looking to the meaning of things, from which learners engage in *abstract conceptualization* by analyzing ideas to understand a situation. In the final step, learners apply this analysis in *active experimentation*, getting things done and acting in new and more

complex situations (Claxton and Murrell, 1987; Kolb 2000).

Gregorc's theory: The theory developed by Gregorc (1985; 1998) is similar to Kolb's dimensions, but identifies style in terms of the labels Concrete, Abstract, Sequential, and Random (Sarasin, 1998). Each combination of style describes a different type of learner and the way individuals relate to the world. In short, Gregorc proposes four types of mind styles: (1) concrete sequential, (2) concrete random, (3) abstract sequential, and (4) abstract random (Gregorc, 1998).

Felder-Silverman Learning Style Model: Synthesizing findings from Kolb (1984) and Gardner (1993), Felder and Silverman (1988) developed a learning style model at North Carolina State University, usually referred to as Index of Learning Styles Questionnaire developed (ILS). This model is based on four double dimensions: Sensing and intuitive, visual and verbal, active and reflective, sequential and global (Felder (1993).

Herrmann Brain Dominance Instrument (HBDI): This model of brain dominance combines Sperry's (1975) split-brain concept with MacLean's (1978) triune brain concept to explain the thinking process by the right and left-brain hemispheres, as well as cerebral and limbic sections. The theory is based on the assumption that, wherever there are two of anything in the body, one is naturally dominant over the other, such as being right or left handed. It classifies learners according to their preferences for thinking and mode of knowing as a metaphorical interpretation based on the functions of different hemispheres of the brain. Nasmith, Schultz, and Williams (2003) summarize the four quadrants as distinct groups of activities as follows:

1. Quadrant A (left cerebral): Logic, analysis, mathematical, problem solving.
2. Quadrant B (left limbic): Organizing, planning, control, sequential.
3. Quadrant C (right limbic): Interpersonal, emotional, musical, spiritual.

4. Quadrant D (right cerebral): Imaginative, holistic, intuitive, and conceptual.

The application of the instrument associated with the theory (HBDI) indicates the degree of preference or lack of preference for the type of thinking represented by each quadrant by generating a score for each quadrant (Herrmann, 1988). As Nasmith et al. (2003) explain, “a primary preference for a quadrant indicates the greatest preference for its characteristic process” (p. 4).

The Myers-Briggs Type Indicator (MBTI):

This instrument was designed to apply Carl Jung’s theory in counseling, education, and business (Myers, 1976; Claxton and Murrell, 1987). According to the Jung’s theory, the world can be perceived in two distinct ways, which are sensing and intuition. The theory also states that people use either thinking or feeling to come to conclusions and make judgments, employing two contrasting attitudes toward life, which is either a judging or a perceptive attitude, and using two contrasting preferences to deal with life: Extraversion and introversion. The main characteristics of each personality type can be described as follows:

1. Extraversion (E) versus Introversion (I): “This preference tells us how people ‘charge their batteries’” (Brightman, 1998, p. 1). *Extraverts* focus on the outer world of people and find energy in things and people, while *Introverts* find energy in the inner world of ideas, concepts, and abstractions. They are motivated internally, and their minds are sometimes so active that they are “closed” to the outside world (Personality Pathways, 2003).
2. Sensing (S) versus Intuition (N): Sensing people are detail oriented and focus on facts and practical solutions, while Intuitive people seek out patterns and relationships among the facts they have gathered (Brightman, 1998; Personality Pathways, 2003).

3. Thinking (T) versus Feeling (F): Thinking students value analysis, logic, honesty, and principle. They focus on tasks and on the work to be accomplished and are most convinced by rational arguments. Feeling learners are diplomatic and tactful and make decisions by focusing on human values and needs. They appear warm and friendly and tend to be good at persuasion and facilitating differences among group members. They avoid arguments and conflicts and value harmony by seeking consensus and popular opinion (Brightman, 1998; Personality Pathways, 2003).
4. Judging (J) versus Perceptive (P): Judging people are decisive and like to plan the details in advance before moving into action. They focus on completing the task, like to act quickly, and prefer working with deadlines and schedules. Perceptive people are curious, adaptable, and spontaneous, but may have difficulty making decisions. They start many tasks, want to know everything about each task, and often find it difficult to complete a task. They are naturally tolerant of time pressure and work best as the deadlines approaches. They usually question the need for many rules and feel comfortable in extending deadlines (Brightman, 1998; Personality Pathways, 2003).

Dunn and Dunn model: This model is based on the theory that each person “has biologically and developmentally imposed characteristics that respond either positively or negatively to a variety of environmental, emotional, sociological, physiological, cognitive and instructional variables” (Dunn and Griggs, 1998). Here is how Dunn (2000) summarizes the individual’s reaction to learning in different instructional settings:

1. Environmental preference: Learner’s reaction to sound, light, temperature, and class design.

2. Emotional preferences: Influenced by motivation, persistence, responsibility and structure.
3. Sociological preferences: Learning alone or in group, working with peers or with either a collegial or authoritative adult. Includes a variety of approaches as opposed to patterns and routines.
4. Physiological preferences: Related to perception such as auditory, visual, tactual, or kinesthetic inclination. This level also includes time-of-day energy levels, such as the preference for studying early in the morning or late in the night, and food intake (eating or not while studying), as well as mobility such as sitting still or moving around).
5. Psychological preferences: Related to global versus analytic processing, brain hemispheres, impulsive or reflective action.
4. Visual-Spatial Intelligence: Capacity to think in images and pictures, to visualize accurately and abstractly.
5. Bodily-Kinesthetic Intelligence: Ability to control one's body movements and to handle objects skillfully.
6. Interpersonal Intelligence: Capacity to detect and respond appropriately to the moods, motivations and desires of others.
7. Intrapersonal Intelligence: Capacity to be self-aware and in tune with inner feelings, values, beliefs and thinking processes.
8. Naturalist Intelligence: Ability to recognize and categorize plants, animals and other objects in nature.
9. Existential Intelligence: Sensitivity and capacity to tackle deep questions about human existence, such as the meaning of life, why do we die, and how did we get here.

Theory of multiple intelligences: Gardner (1993) took a more holistic approach in describing cognitive profiles by developing the theory of multiple intelligences. He performed interviews with hundreds of people and defined the first seven intelligences in 1983, adding the last two in 1999. According to Gardner, all human beings possess all nine intelligences in varying amounts, and each person has a different intellectual composition. Below are the nine intelligences proposed by Gardner (2000), as outlined by Disney Learning Partnership (n.d):

1. Verbal-Linguistic Intelligence: Well-developed verbal skills and sensitivity to the sounds, meanings and rhythms of words.
2. Mathematical-Logical Intelligence: Ability to think conceptually and abstractly, and capacity to discern logical or numerical patterns.
3. Musical Intelligence: Ability to produce and appreciate rhythm, pitch and timber.

Despite the popularity of the learning styles theories, it is important to mention that there is still a significant debate regarding the consistency of those theories. The strongest view against the existence of learning styles comes from Human Information Processing (HIP) theorists, who argue that learning style perspectives ignore the critical role that prior knowledge plays in a learning situation. Although agreeing with the importance of recognizing individual differences and providing students with personalized instruction, HIP theorists have the following disagreement with the learning styles theories: (a) confusion in the definition of the term "styles," (b) different learning style theories and instruments use different style categories to define learning style continuums, (c) weakness in reliability and validity of measurement instruments, and (d) identification of relevant characteristics in learners and instructional settings. According to those theorists, learners may react differently in different learning situations, and people have different ways of learning for particular tasks and for different contexts, so they recommend that teachers focus on the role that

encoding, attention, motivation, and metacognition factors play in all learning situations. (Curry, 1990; Denzine, n.d.).

Faculty Development Approaches

Interrelated to faculty development theories, another segment of literature relevant to this study provides a consistent theoretical basis for general approaches to faculty development programs and interventions. Davis and Davis (1998) developed a model for professional development based on learning theories. As they say, “a training strategy is a theory-based effort to maximize a particular kind of learning” (p. 98). Table 1 summarizes what they call “the seven training strategies.” The authors point out that each training strategy has its own strengths and weaknesses. Although it is tempting to select a training strategy that feels comfortable for the facilitator or is the preference of the participant, a trainer should make a rational choice of the strategy that best fits the desired learning outcomes.

These training strategies provide a framework for different faculty development interventions,

which are intended to address both faculty beliefs and skills development. Based on different theoretical models, several experts propose a variety of approaches to faculty development programs and activities, but exploring those models is beyond the scope of this study. As a general concept, however, it is important to understand that there is a distinction between professional development and training. As Chism (1998) explains:

One reason for resistance to teaching preparation is the belief that such preparation will consist of skills training, which seems trivial. Formal attention to teaching preparation involves cultivating habits of reflection and developing conceptualizations and frameworks for practice to organize and evaluate skills and experiential knowledge gained prior to employment or on the job (p. 8).

This distinction makes professional development programs much more complex than a simple training session. This is the assumption underlining the faculty development intervention described in this study.

Table 1. The seven training strategies – side-by-side comparison

Strategy	Best Use	Facilitator
1. Behavioral	Skill development	Setting objectives Performing task analysis Providing feedback
2. Cognitive	Presentations and explanations	Selecting and presenting information
3. Inquiry	Critical, creative and dialogical thinking	Establishing climate Asking questions
4. Mental Models	Problem solving Decision making	Providing information Guiding discussion
5. Group Dynamics	Collaboration and working in teams	Composing groups Developing and using instruments
6. Virtual Reality	Dependence on competence and confidence in a simulated environment	Role playing Setting the scene Designing scripts and scenarios
7. Holistic	Personal learning and self discovery through experience	Identifying and matching experiences to participants Providing useful mechanisms for reflection

Note. From: Davis & Davis, 1998, 404-405.

Methodology

As a multiple-case study, this research employed a qualitative approach, with an in-depth look at the many factors influencing the way faculty approach instructional technology and the ways in which their learning can be successfully facilitated.

Using a purposeful sample (Patton, 1990), ten participants were selected among faculty who attended a series of workshops and seminars in instructional technology, offered by the teaching center at a public university in the United States. In order to obtain a larger variety of data, the sampling strategy employed a maximum variation approach, including faculty from different disciplines and academic areas, and also from different levels of tenure and academic appointment.

Several different data collection methods were employed. The basic method consisted of in-depth face-to-face semi-structured interviews with the participants, supported by follow-up email interviews (Flick, 1998). The data included results of a learning style assessment obtained through participants' completion of the Index of Learning Styles Questionnaire developed at North Carolina State University. This inventory is easily accessible on the web and provides immediate automatic results without requiring any registration or fee payment. As far as validation, Zywno (2003) collected 557 valid questionnaires for a psychosomatic analysis and found that the ILS instrument has relatively high test-retest reliability in repeated measurements over time, and concluded that the ILS is an appropriate and statistically acceptable for characterizing learning preferences (Zywno, 2003).

In addition, samples of handouts, descriptions of content, and copies of the actual agenda of the workshops were gathered for document analysis. Finally, the data collection included non-participant observations of the environment during one offering of the technology workshop (Marshall & Rossman, 1995).

After transcribing the interviews, the data was stored and classified into different categories. This categorical aggregation was the first one of a four-step process (Creswell, 1998) in which a collection of statements was put together, along with ideas, and examples by the participants about their experience in learning and interacting with instructional technology. The participants' statements were classified to find relevant and meaningful points common to different cases.

The second step was developing direct interpretations of specific statements by the participants to draw meaning from the participants' experiences. The following step established patterns and looked for a correspondence between the different categories, in order to find common topics across cases. Finally, the written report put together several conclusions based on the major themes of the study.

SETTING THE STAGE

The Organization

This case study describes the experience of 10 highly motivated faculty members who participated in a technology workshop series at a large public university in the United States. Offering more than 200 degree programs, this university enrolls around 30,000 students with a high representation of international students from over 100 countries. The institution has a faculty development center that offers continuous support for faculty in developing instructional technology skills. All the faculty members participating in this case study agreed to share their learning experiences, motivation, and personal struggles in the journey to learn instructional technology. Each participant was assigned a pseudonym in order to maintain confidentiality.

Case Players

Carol has a Ph.D. in Theater, with a master's degree in Reading and English Language Studies. She has been teaching in higher education for 25 years and is still in love with her career choice.

Diana is an assistant medical physiologist and has practiced as a medical technologist. She graduated from the School of Medicine with a Ph.D. in Physiology and Biophysics and did her postdoctoral work in Pediatric Immunology and Oncology. Her background includes 25 years of teaching in the medical school.

Jennifer has a Bachelor's degree in Nursing and a doctorate in Nursing Science. She has specializations in Nursing Administration and Operating Room Nursing, and has taught nursing education for more than 35 years.

Ellen has a Ph.D. in Musicology and Music History, and began teaching at the college level in 1990. She is passionate about online teaching.

Karen worked in art museum administration for about ten years, and moved to an academic career after earning her Ph.D. in American Civilization. She has taught Art History for more than a decade.

Roy earned his Ph.D. in Urban Technological Environmental Planning and has worked in Social Work Policy and Technology. His career includes

over 22 years teaching and researching social work at three different universities.

Steve has a Master's degree in Physical Education and got his Ed.D. in Higher Education Administration, with a concentration in Human Performance (Physical Education). He has taught sports management courses over the last 30 years.

Nicole earned her Ph.D. in Anthropology and has been teaching this subject for over 12 years. Lately, she has been working in both teaching and faculty development.

Lisa has a background in Occupational Therapy and a master's degree in Applied Gerontology. She is finishing her doctorate in Education and has had a teaching career for more than eight years.

Bryan has a Ph.D. in Sociology and teaches courses in the sociology of religion, sociology of work, sociology of education and methodology. His research area is the scholarship of teaching and learning, but he also does some research on the intersection of religion and pop culture. He has taught Sociology for more than 13 years.

Table 2 shows the basic profile of each participant.

Table 2. Profile of participants

Pseudonym	Degree	Academic Discipline	Status	Teaching Experience
Carol	Ph.D.	Theater	Non Tenure	25 years
Diana	Ph.D.	Medical Physiology	Tenure	25 years
Jennifer	D.N.S.	Nursing Science	Tenure	30 years
Ellen	Ph.D.	Music History	Tenure	11 years
Karen	Ph.D.	Art History	Tenure	8 years
Roy	Ph.D.	Social Work	Tenure	19 years
Steve	Ed.D.	Physical Education	Tenure	29 years
Nicole	Ph.D.	Anthropology	Non Tenure	12 years
Lisa	M.A.	Applied Gerontology	Non Tenure	8 years
Bryan	Ph.D.	Sociology	Tenure	13 years

CASE DESCRIPTION

Introduction

With a clear sense of frustration, you may have had sometimes the same feeling expressed by a faculty member who said:

I find that the people who teach technology generally are good people, but I think they are really bored in teaching somebody like me . . . it is really painful for them to go at the speed that I catch things. They are repeating, but at the time they get to step four, I forgot what I did, and when they say, do it again, I may not remember anymore . . . Some of them are very patient, but I just sense in their spirit that they are kind of thinking that I am dumb, or that I am taking too much of their time.

Like this person admitted, many faculty members with high levels of expertise in different areas may feel intimidated when challenged to learn and use instructional technology. This multiple case study describes different learning stories emphasizing personal characteristics of the participants, their personal learning styles, and their struggles facing personal and institutional barriers.

Case 1: Carol, the Emotional Learner

The Journey to Technology

To sum up her experience with technology, Carol says: “Technology did not crush in on me.” All the schools she has worked at were Historically Black Colleges and Universities, which had no money. She recalls that her first experience with technology was when she received a National Endowment for the Humanities summer research grant on oral literature in Missouri in 1991. This is how she describes her emotions in her first encounter with technology:

There was a lady in the course who kept saying every day, “I got to go and check my email.” I had never heard of it. And she was so excited, and in every break we had, she would go and check her email. Then when I came here, I was working for a top administrator, who kept sending me messages by email, and I was not getting them because I didn’t want to. So he said, “You just have to learn this, because I am not going to send you messages in any other way! So, I learned enough to do email.”

But this was just the beginning for Carol. As she was still struggling to use email in an effective way, her boss sent her to a workshop off campus to learn enough to get his messages. And as the campus became more and more involved in the on-line revolution, Carol could not avoid it anymore.

Learning Styles Analysis

Carol is a very unique type of technology learner. Her emotional way of doing things became clear as she told her story. In fact, her scores in the learning styles inventory reflect her emotional approach to learning, as she scored very high as an intuitive learner (9 points on an 11-point scale) as opposed to being a sensor or concrete learner. She also scored high (9 points) as a global/random learner as opposed to sequential learner. Carol scores are shown on Table 3.

Both the intuitive and the global learning characteristics have more to do with emotions than with logical reasoning: in fact, intuitive learners are described in the literature as people

Table 3. ILS scores for Carol

Carol scores (11-point scale)			
Active	3		Reflective
Sensing		9	Intuitive
Visual	5		Verbal
Sequential		9	Global

who like creativity and dislike repetition (Felder, 1996; Kolb, 2000; Kolb, 2007). They also “don’t like ‘plug-and-chug’ courses that involve a lot of memorization and routine calculations” (Felder, 1996, p. 2), and usually prefer discovering possibilities and relationships, which describes how Carol described her learning experience with technology. The fact that Carol is also a global/random learner helps explain her struggles with technology, as Gregorc (1985) describes abstract-random learners as people who globally evaluate the learning experience atmosphere. They are attracted to nuances of mood and atmosphere, and tend to associate the medium with the message and relate the presenter’s personality with the content of the presentation. They have preference for unstructured information and multisensory activities with no rules or guidelines.

Discussing her experience with technology, Carol does not disguise the force of her negative feelings towards technology, as in this example:

Sometimes I was typing up a newsletter for the community organization I was working for, and I would spend hours and hours typing the newsletter and I would hit a button and it would all be gone, and I wanted to die because I didn’t save it. So it was an awful, awful, awful experience for me. I hated technology, and I hated anybody who used technology, and anybody who talked about it.

In spite of this negative feeling toward technology itself, Carol has a very positive attitude toward her technology instructors in the workshop setting: “What I liked the most was the attitude of the teachers. It was not in any way insulting. They never ever made me feel inadequate, which I knew I was.”

Asked to relate her learning style with the technology experience, Carol proposes a formula for an ideal learning situation:

For me it is hands-on. I think that for my learning style the critical thing is the teacher-student

ratio, and it almost will be like one-to-two or one-to-three. With any more than that, like 12 or 17 students, or whatever, instructors will be too busy with the other 12 and I am going to get lost.

A comparison of Carol’s experience in learning technology with her natural learning style seems to imply the Carol’s emotional nature has a direct impact on her learning process, thus explaining at least in part some of the difficulties that she has faced in her experience of learning technology. Her strong emotional reactions tend to make her more vulnerable to feelings of inadequacy for being slower than others, which results in anxiety and impatience with herself. In fact, she says she feels upset when she cannot perform as well as she would like, and she explains her disappointment: “If I press the wrong key I am upset because I didn’t get it right. So it is frustrating for the instructors and it is frustrating for me, because I want it, but I just cannot.” In other words, Carol’s emotions and variations of mood and sentiments affect her learning performance.

Case 2: Diana, the Risk-taker

Diana’s story is marked by a sequence of challenges and risks. Many episodes in her life stress how challenge and risk played an active role in her experience of learning instructional technology.

The Technology Challenge

Diana summarizes her story of learning instructional technology in a very short statement: “I am a risk taker, but I don’t approach suicidal.” She explains, for instance, that she did take some precautions to protect herself in the very first online class that she taught when she was still learning how to teach online courses. She decided to be part of a teaching team, with another instructor who was eager to learn and use technology, so, as she says, “we helped each other.”

But her journey to technology began many years before. Referring to her very first experiences with instructional technology, Diana still remembers spending an entire week to prepare for a one-hour lecture using slides, tapes and handouts. Years later, Diana challenged herself to attend an intensive program in faculty development including interactive video and computer-based teaching. At the beginning, she went just to try it out, but in the next year she went with the express purpose of teaching an interactive video course, which she did, starting with a few students in the freshman level. Now she talks about the success of this course with a bit of unabashed pride: “This last fall when I taught the course, I had 229 students on seven sites of classrooms. So that tells you how little by little I expanded the course. I still use the statewide system.”

Learning Styles Analysis

Diana admits that learning technology took a lot of hard work and persistence. Usually someone would show her how to do something and then she would go and do it, and when she got stuck, she would call a consultant to help her. Diana explains that her achievements with technology are due mostly to her willingness to take risks:

I was able to do that only because I used to try difficult things, even having minimal computer and technical knowledge. I think a lot of people get into it because they really love to work with computers, and computers are not a challenge for them. I have said more than once, if I can learn this technology, anybody else can.

Diana’s scores on the Index of learning styles inventory show a high level of an intuitive/abstract learner (9 points on an 11-point scale) as opposed to being a sensor or concrete learner. She also scored high (9 points) as a global/random learner as opposed to sequential learners. She does admit that her favorite learning style is that of the

Table 4. ILS scores for Diana

Diana scores (11-point scale)			
Active		3	Reflective
Sensing		9	Intuitive
Visual		5	Verbal
Sequential		9	Global

abstract learner. Table 4 shows the Diana scores on the ILS inventory.

Diana does not see the learning styles theory as playing a direct role in her experience of learning technology. In fact her major characteristic as “risk-taker” does not fit well in any of the main theories of learning styles discussed in this study. On the contrary, Kolb (1993) refers to risk-takers as an example of learners who are in the concrete-active quadrant of his diagram, which is not the case with Diana. This discrepancy in itself seems to imply that, in some cases, other characteristics may be more relevant to the experience of learning technology than those assessed through learning styles inventories. Although this particular case does not necessarily contradict the learning styles theory, it does not support it either. As a result, it seems more appropriate to look at Diana’s experience of learning technology as requiring a major characteristic or attitude of her personality, which is not necessarily her personal learning style in other areas. In other words, while the experience of learning technology sometimes may be explained by someone’s learning style, in some other cases it may be better explained by another major personality characteristic.

Case 3: Jennifer, the Visionary Learner

Envisioning Technology

A visionary of instructional technology, Jennifer started using glass slides 30 years ago, and has had all her lectures on overheads for more than 10

years. Although there was no technology department as she began, she took as much advantage as possible of the medical education resources group at her institution, which then was the department responsible for providing instructional resources for faculty members. Back in the 70s, Jennifer envisioned teaching some components of nursing skills in a video format, and started developing videotapes to be presented in the classroom. With little support, it was very difficult at the beginning, but in 1980, thanks to a research grant, she developed a series of teaching modules using video for classroom presentations.

The process of production, image-taking, editing, and selection of “actors and actresses” for her instructional “movies” was something totally unconventional and may resemble the early ages of the Hollywood industry. As unusual as it may seem, Jennifer was at the same time the producer, director, cameraperson, editor, and distributor of the movies. In addition, the site for recording her pictures was something much more “real” than any scene produced by Hollywood. This is how she describes the adventure of producing those videotapes:

We actually videotaped live surgery in the Emergency Room, and I did most of the editing in a very primitive way. We used to go at midnight to the Emergency Room (ER). We had one student as a cameraman on the ladder to shoot inside, and I also had a camera as I was standing down to shoot when the patient was coming. We didn't put over any sound track, so we had the actual sound of the patient and nurses' activities, and we really saw a lot of real blood!

Even using these primitive methods, Jennifer was always very careful with ethical concerns—asking permission before releasing a film. It was not easy, but she did respect the patient's privacy. She says, “We didn't really release it until after the patient was treated, and we would contact the family for release only for teaching purposes.”

The times have changed and Jennifer no longer produces instructional materials in the same way. One of the reasons is because the grant elapsed. Another major reason is that the curriculum has changed, and the school does not have the Emergency Nursing module anymore. She feels that she does not need those materials as much as she did in the past. She actually gave the tapes to a hospital, and they are using them for teaching purposes as well.

Today, Jennifer does not use the old movies, overheads, or 35 mm pictures anymore. She says that now everything is in the PowerPoint format. She is now equipped with a digital camera, which she bought with grant funds, and takes advantage of digital pictures for her presentations. And she is always looking for new advancements in instructional technology.

Learning Style Analysis

Jennifer was a visionary of technology more than 30 years ago, a time when most faculty and institutions had no concern at all with instructional technology. It seems that a visionary personality goes along with a visual style in Jennifer's case. Even at a moderate level, her higher scores were as a visual learner (5 out of 11) and also as a sequential learner (5 out of 11). Table 5 shows how Jennifer scored on the ILS inventory.

The sequential aspect does not appear to be much applicable in Jennifer's story, but commenting on her favorite learning style in technology, Jennifer refers to the multiple intelligences theory in the following words:

Table 5. ILS scores for Jennifer

Jennifer scores (11-point scale)			
Active		1	Reflective
Sensing	1		Intuitive
Visual	5		Verbal
Sequential	5		Global

The visual style appears to be most applicable as I reflect on my experiences and the learning path I took related to technology. I think the visual-spatial intelligence is my strongest intelligence related to instructional technology, especially in the development of course materials.

Jennifer's comments support the theoretical description of Gardner (2000), according to whom such learners develop the capacity to think in images and pictures, to visualize accurately and abstractly. Her comments also support Felder and Silverman (1988), as they state that visual learners get different information from visual images (pictures, diagrams, graphs, schematics, demonstrations) than from verbal material, which was very much the case in Jennifer's experience producing videotapes and pictures for her class presentations.

Case 4: Ellen, the Hard-working Learner

From the very beginning of her academic career, Ellen had to face a lot of hard work, as she began teaching a class with about 70 students, and had only one week for preparation after she knew she would teach that class. This is how she recalls the beginning of her teaching career:

I was a little bit intimidated, but I also had an extensive performance background, so I called on some of that performance background to help me at least get through the first two days, until the students realized that I was the teacher!

Hard Work in Technology

Before starting a new teaching assignment at another university, Ellen had a part-time job where she was asked to help maintain the company's website. She explains that she had no knowledge of HTML code at all, so she had three classes that lasted eight hours each, which was the full extent

of her knowledge of computers, other than using word processors and everyday software. At the university, her new boss found out that she had the 24-hour HTML training from the previous job, and he challenged her to be in charge of the Internet distance-based classroom for Music Appreciation. Not very much aware of the enormity and urgency of the task, Ellen agreed to teach the class, only to realize later that she was facing a huge problem. This is how she narrates the conversation with her boss:

The way this class started was somewhat humorous. The head of the School of Music came to me and said, "We think you can have an online Music Appreciation class." Then I said, all right. It was the end of June and beginning of July, and I was thinking that I would have the summer and at least a year to do it, but he said: "Oh no, we have offered it for starting this August, so you have until August to have it up and running. So I had about a month and a half to prepare.

Ellen had to work very hard to accomplish the task. She describes herself as typically a traditional in-front-of-the-classroom type of lecturer at that point in time, and the idea that she would not even see the students scared her, and she was not sure of what really she was going to do. So, she learned to use the course management system on the web, and had to handle all of this new technology plus teach four other classes at the same time. She says that the staff in the teaching center was very instrumental in supporting and helping her not to panic when something went wrong.

Recalling her experience, Ellen summarizes the hard work she had to face to learn and make progress in technology with a sense of pride, as follows:

I started with minimal knowledge, no confidence at all, and a feeling that the computer was a tool of terror. Now I realize it is simply a tool like a

pencil or a pen, the programs can or cannot work, depends on what I input.

Learning Styles Analysis

Ellen's scores on the learning styles test reflect her systematic way of doing things. She scored 9 out of 11 as a sequential learner, and 7 out of 11 as a sensing or concrete learner. Table 6 displays Ellen scores on the ILS inventory.

According to Gregorc (1985) this combination makes concrete-sequential learners prefer direct and hands-on experience. They like concrete and touchable tasks and step-by-step directions to follow. Felder (1993) refers to sensing learners as being very practical persons who don't mind detailed work and prefer to solve problems using well-established procedures. Supporting the same idea, Myers (1976) and Brightman (1998) describe sensing people as detail-oriented learners who focus on facts and practical solutions and prefer specific and orderly instructions.

Ellen's reflections about her personal style match the results of the learning styles inventory. This is how she describes herself:

I tend to learn more as a concrete, active, and reflective learner. I combine all these learning styles in my own approach to education, particularly instructional technology. I have used a hands-on approach with looking at a variety of possibilities and attempt to solve problems on my own.

This combination of learning styles supported by Ellen's self-analysis may explain her major

Table 6. ILS scores for Ellen

Ellen scores (11-point scale)			
Active		3	Reflective
Sensing	7		Intuitive
Visual		1	Verbal
Sequential	9		Global

characteristic of "hard work" when learning technology. As she says, she didn't mind staying long hours in the teaching center to learn how to set up an online class with just a month and a half of preparation. She had the task with a deadline, and she worked hard through all the steps to accomplish the task. And she did succeed in completing the work, which is very typical of a concrete-sequential learner.

Case 5: Karen, the Dependent Learner

As it seems natural and usual for someone in the areas of history and museums, Karen has a very conservative teaching background. The irony of this area though, is that history and technology are mixed together as part of the teaching style of Art History, although in a conservative way. This is how Karen explains the marriage between technology and Art History:

I just don't know how otherwise I would teach Art History without a visual image. It is just the standard in the discipline, so everybody does that, and I learned Art History with slides.

From Conventional to Digital Imagery

Willing to enter the digital era, Karen went to a technology workshop on PowerPoint in order to learn the basics. She says she can see that the future is going to be digital, so she decided to learn at any cost. But it was not easy. Although the instructors in the workshop did a great job trying to make it user-friendly, she felt overwhelmed as it just seemed like such a huge task for her. But Karen did not give up and found her own way to learn by hiring somebody else on whom she could depend while learning. She says: "I am not sure I would have gone any farther without having a teaching assistant who is pretty knowledgeable." Taking advantage of this new alternative, Karen

has regular appointments with her teaching assistant once a week to learn how to do PowerPoint.

Besides PowerPoint, Karen is also exploring the resources of the web and is now regularly using the course management system on the web, which she had never used before. At first she was simply posting pictures online. Now she has posted the syllabus, the study terms, and also study guides for tests. But again, she counts on her teaching assistant to scan the slides and post them on the web, so students can study for tests.

Learning Styles Analysis

Describing her personal approach to learning technology, Karen sees herself as dependent on someone else's help and support all the time. This major characteristic as a dependent learner makes all the difference for Karen. She says:

My feeling about the whole technology is that having one person sitting down just with me, so that whatever particular problem or questions I have, that person can be right there at my elbow to help me immediately.

Based on the learning styles inventory, Karen has a well balanced combination of learning styles, as she did not score high in any of the styles. In fact, she scored only 3 points out of 11 in three different styles: Active, sensing/concrete, and sequential, which is not enough to characterize one dominant style of learning. Table 7 shows Karen scores on the ILS inventory.

Table 7. ILS scores for Karen

Karen scores (11-point scale)			
Active		3	Reflective
Sensing		3	Intuitive
Visual		1	Verbal
Sequential	3		Global

According to Kolb (1993) and his theory, the concrete-active combination may explain her major characteristic as dependent on somebody else for learning technology, as this type of learner tends to rely on other people's analysis rather than on their own, and enjoy applying learning in real life situations. Also, they are primarily the "hands-on" type of learner (Algonquin, 1996). Karen's assessment of her own style of learning technology seems to agree with this explanation:

I learn the computer best by the hands-on use of it, even though this is not a kind of learning that comes easily to me. Besides, I learn instructional technology quite well if I have someone by my side who is articulate and knows the programs, who is willing to verbally walk me through it, and assist if I get stuck.

In other words, the inventory did not show a dominant learning style for Karen, therefore the connection between her personal characteristic and learning style offers little evidence to support the theory. Based on her own reflection, however, it seems that she has explored her personal learning characteristic as a dependent learner to learn what she needs in instructional technology.

Case 6: Roy, the Pragmatic Learner

Technology Expertise

Roy has had an easy time with technology since he has been a user. Even when using different technology applications, he didn't have problems, as he states: "I didn't have any difficult time actually. I am probably very technologically-minded, so I really didn't have major problems to do what I needed."

"Technologically-minded" is an apt self-description of Roy's experience using technology, since he started using web pages very extensively in 1994 and wrote a book on how to use the web

in practical social work. He also wrote a tool-book and designed a series of exercises on developing websites.

Learning instructional applications of technology was not hard for Roy either, as he has been basically self-taught. In summarizing his journey, Roy describes his attachment to technology as a lifelong experience in the following terms:

I have been interested forever. Actually I have been interested for fun. It was interesting and cutting edge, so I enjoyed it very much. There is the recreational dimension to it. Part of that too is that, in terms of Social Work, it is very easy to get behind the cutting edge, because Social Work is very reluctant to use technology.

Learning Styles Analysis

On the Learning Styles test, Roy had his higher scores both as a visual and as an intuitive/abstract learner (7 out of 11), and also scored 5 as an active learner. Table 8 presents the scores of Roy on the ILS inventory.

Roy does agree with the visual aspect of his style, and says that he has “the ability to grasp and understand very complex systems easily and visualize them in an effective way.” In addition, Kolb’s theory describes the abstract-active learners as people who like solving problems and finding practical solutions and uses for learning (Algonquin, 1996; Kolb, 2000; Kolb, 2007), which matches the pragmatic aspect of Roy’s personality. One difference, however, is that Roy thinks of himself as a concrete learner instead of the

intuitive one shown in the test result, but he admits that his combination of styles has some differences from the pattern stated by some theorists. This is how he analyzes his personal style:

I tend to be a concrete-active and reflective learner. The difference is that I usually take the hands-on approach when learning instructional technology and am prone to trust my own analysis rather than someone else’s.

In summary, although Roy’s combination of styles somewhat differs from the standard of the theories, which makes it difficult to establish a relationship between his personal characteristics and learning style, his major characteristic of being pragmatic and utilitarian in part supports the description of Kolb’s theory as addressed above (Algonquin, 1996).

Case 7: Steve, the Social Learner.

The Social Adventure of Learning Technology

Steve got involved in instructional technology early on, when he chaired a symposium on teaching excellence back in the 70s and 80s, and technology was one of the teaching strategies discussed in the symposium. Inspired by the idea of technology as a teaching strategy, Steve wrote a grant and got enough money to buy technology equipment for the Physical Education Performance Lab. Such technology would allow instructors to put markers on people and videotape them, so the software would track the markers and do all the compilation of the movements. This is how Steve describes his excitement with the new equipment:

When we got the equipment, and I could take my class and show them a device that would draw a picture to show the movement, store the data, measure the strength, resistance, and speed of

Table 8. ILS scores for Roy

Roy scores (11-point scale)			
Active	5		Reflective
Sensing		7	Intuitive
Visual	7		Verbal
Sequential		1	Global

movement, this suggested to me that there is a lot more about technology that we can use.

Steve always found encouragement in other people and their experiences. For instance, he refers to a book on successful stories of faculty members using technology, where people discuss methods and programs they are using in their classes. Steve also recalls that he had good mentorship from a very trusted colleague who was a role model for him and helped him understand more about technology in the classroom. As he says, “I am not as technologically savvy as some, so I like to hang around with people who are.”

Learning Style Analysis

On the learning styles inventory, Steve scored the maximum as an active learner (11 out of 11), and very high as a visual learner (9 out of 11). Table 9 displays the scores of Steve on the ILS inventory.

The visual aspect does not appear much when analyzing his style of learning technology, but the active component sounds like the perfect description of his style. According to Kolb’s theory, a high score in the active category indicates individuals who have an orientation to experimentation and who learn best when they can engage in such things as projects, group discussions, and peer feedback. Usually they tend to be extroverts. They are also described as “hands-on” learners who tend to rely on other people’s analysis rather than on their own and enjoy applying learning in real life situations (Algonquin, 1996;

Claxton and Murrell, 1987; Kolb, 2007). Steve says he has no doubt that this is his style:

Clearly this is how I learn. From an IT standpoint, I’ve spent too little time reading the manual and probably too much time with trial and error. I’ve enjoyed all that I’ve learned from my IT colleagues because I could let them do the analysis and then I could do the application.

In addition, Felder (1993) states that active learners tend to learn while doing something active, like trying things out, sharing ideas and working in groups, which may explain Steve’s major characteristic as a social learner. In fact, Steve agrees that his interpersonal intelligence plays a major role in his learning experience: “This is also something I’m good at. The IT application is that, when I’m really stuck on a problem, I can easily tap into the available human resources because I understand their motivations and desires.”

His active learning style makes Steve interact with many people and learn from his colleagues, which determines his major characteristic as a social learner.

Case 8: Nicole, the Skeptical Learner

Slow Involvement with Technology

Nicole started using technology in the classroom when she was teaching as a graduate student. She showed videos and used the overhead projector.

She recalls that one of her classrooms once had a multimedia tower with a VCR, a DVD, a computer, a cassette player, a CD player, and internet access. By having that in the classroom, she could easily do anything by just hitting a button and playing a CD, a DVD, or showing a video on the screen, and then turning it off. But, what really made a difference for her was that she could still use all her transparencies accumulated over the years, but instead of using the overhead projector, she used the document reader. Actually,

Table 9. ILS scores for Steve

Steve scores (11-point scale)			
Active	11		Reflective
Sensing	1		Intuitive
Visual	9		Verbal
Sequential	5		Global

she could bring in a book and just put the book on the document reader, or she could show a graph, a picture, or even an artifact.”

Most of the times, however, Nicole would prefer using real objects to illustrate her classes, rather than using technology devices. Usually she would try technology when artifacts were not available.

Nicole recognizes that her weak relationship with technology has been affected by her skepticism towards it. As she admits, she is not quite convinced about online education and of all its benefits. In addition, she says she is not sure if her students will have the equipment that will make it look great and work well, or if they will hate it like she did as a student, because students don’t have the access to the same level of technology as the faculty members do on campus. So she confesses being still a little bit hesitant and willing to let other people forge the pathway, and “when it becomes much smoother,” she says, “then I will go.”

In summary, Nicole can see the benefits and the potential, but technology has not attached itself to her in a way that she would go out and seek to learn and use it all the time.

Learning Styles Analysis

Nicole describes her experience of learning technology as a trial-and-error process, like setting up the computer and playing around. Except for one technology workshop, she had no other classes and no consultation at all. This is how she evaluates her learning process: “It was me sitting there by myself, trying something, and trying again, and when it didn’t work I would get frustrated and say, “What the hell is that?” So it was trial and error, very much. No textbooks, no how-to books, no *PowerPoint for Dummies*.”

Nicole’s selfanalysis totally matches the results of her learning styles test, as she scored higher both as an active and as a visual learner (7 out of

Table 10. ILS scores for Nicole

Nicole scores (11-point scale)			
Active	7		Reflective
Sensing		5	Intuitive
Visual	7		Verbal
Sequential		5	Global

11 in both styles). Table 10 shows the scores of Nicole on the ILS inventory.

Kolb (1993) states that active learners rely heavily on experimentation, and are primarily “hands-on” people who tend to rely on the ability to get things done, and usually use trial and error to solve problems (Algonquin, 1996; Claxton and Murrell, 1987), very much like Nicole described above. On the other hand, Felder (1993) refers to visual learners as people who get more information from visual images than from verbal material, while Gardner (1993) describes the visual-spatial intelligence as the capacity to think in images and pictures, and the ability to visualize accurately and abstractly. Referring to her experience in learning technology, that is precisely how Nicole describes the visual side of her learning style:

I am thinking that my experience with technology tends to be not so much text-based. I have to see it, I have to feel it, I have to feel what the key strokes are, and visualize what I have to do, where I have to click, where the button was, and in which side of the screen the menu was.

In short, while she is not very excited about technology, Nicole has a learning style that works best by visualizing things and doing something through a long trial and error process.

Case 9: Lisa, the “Watching” Learner

Enjoying Technology

Usually suspicious of technology, Lisa tended to always be afraid that things that she fears will not work. Therefore, when doing something on the laptop, for example, she would bring the laptop to project on the screen, but she would also make overheads too, just in case the projection would not work. She recalls that her first experiences with technology had to do with using an overhead projector and trying to figure it out how to turn it on and off.

Lisa describes her experience with technology as “exciting.” The more she found out about the variety of technology applications, the more she wanted to implement those different things in the classroom. As she says, “When I was able to take that technology and get the students excited, that made sense to me. I was dealing with this MTV generation and was able to make connections with them. That was when I got excited and when the big connection was for me.”

Lisa learned the very basics from her fellow faculty members. Usually she had someone in the department set up a manual that would explain step by step how to use a specific technology application. She also had other training opportunities such as classes or technology workshops taken through the teaching center. Other than that, she just experimented on her own and played around with different media.

Learning Style Analysis

Describing her learning process as a journey full of excitement and frustrations, Lisa stresses her preferred learning characteristic:

Watching other people use the technology was my favorite way of learning, and then seeing my instructors in the graduate school use the technology made me excited about it. Usually I had an

instructor who would demonstrate it first, but until I actually tried it on my own, at times frustrating, I would not feel safe using it.

The preference of Lisa to learn technology by watching other people may be explained by her results in the learning styles inventory, as her dominant learning preference is the visual style. In fact she scored very high in only this category (9 points out of 11), showing a low and balanced combination of all other categories. Table 11 presents Lisa scores on the ILS inventory.

Taking Gardner’s (1993) theory of visual-spatial intelligence as the capacity to think in images and pictures, and the ability to visualize accurately and abstractly, plus Felder’s (1993) concept that visual learners get more information from visual images, we would have a framework to understand Lisa’s learning preference. Commenting on her experience with technology, Lisa says that more than simply watching other people, she likes to visualize ideas:

The visual style relates to my learning experiences in IT in that I was able to picture and understand the overall process schemes and ideas, play with them mentally and apply them to the task. I like visualizing the background technical stuff as it helps me understand how the program works, and then manipulate it to meet my needs.

In addition, she says her visual style works best when assisted by continuous technical support, to deal with trouble and difficulties.

Table 11. ILS scores for Lisa

Lisa scores (11-point scale)			
Active		1	Reflective
Sensing		5	Intuitive
Visual	9		Verbal
Sequential		5	Global

Case 10: Bryan, the Self-Taught Learner

Teaching Himself

During his 13-year teaching career, Bryan had used overheads and video occasionally, but most of his teaching was the traditional “chalk on the chalkboard.” It was the use of a course management system on the web that really got him started with technology.

Bryan came up with the brilliant idea of putting partial notes online to be completed by students. He found that students responded very favorably to it, and they really appreciated having those online notes. So he got pretty positive feedback from students, both on the midterm and on the final course evaluation.

After one semester with this new experience, Bryan realized that he still had to write on the chalkboard a whole lot to help students get everything plugged in there. So in the next semester, Bryan came up with his brilliant solution number 2: He decided to convert his lectures into PowerPoint presentations. But not everything was in PowerPoint. Here is how Bryan describes the solution he found: “Sometimes I put questions and force them as a class to offer some examples.”

Gradually, Bryan kept adding new features every semester, such as putting up practice exams on the web, as well as students’ own notes on the web. As he explains, “students email their notes to me and I put it on the web. When the exam time goes around, every student should have their own notes from the discussion, but they also have their classmate’s notes.”

To make sure his methodology is effective, Bryan surveyed all his students at the end of the semester and found that 95% of the students strongly or greatly appreciated having the lecture notes available.

Learning Styles Analysis

It was hard to classify Bryan’s learning style, especially because the result of his Learning Styles test was a well-balanced combination of styles, with only a slight predominance of the intuitive/abstract style (5 out of 11, as compared to 3 points for the active and global/random categories). Table 12 presents Bryan scores on the ILS inventory.

Based on Bryan’s learning experience, however, it does make sense to apply the intuitive style to him. Kolb (1984) describes intuitive and abstract learners as concise and logical people, for whom abstract ideas and concepts are more important than people issues. They like to assimilate diverse data into an integrated whole, and they focus not so much on the practical application of ideas but on the soundness of ideas, and a good logical explanation is more important than practicality (Claxton and Murrell, 1987; Kolb, 2007). According to Myers (1976), intuitive people seek out patterns and relationships among the facts they have gathered. They trust their intuition and look for the big picture. They feel comfortable with ambiguous and imprecise data and with guessing their meaning (Brightman, 1998; Personality Pathways, 2003).

The experience of Bryan in surveying the students to gather facts and data, then his successive application of different teaching ideas, all reflect his concern with logical ideas and sound solutions for his teaching problems. In fact he sees himself related to this category, according to his self-analysis:

Table 12. ILS scores for Bryan

Bryan scores (11-point scale)			
Active	3		Reflective
Sensing		5	Intuitive
Visual	1		Verbal
Sequential		3	Global

I'm probably closest to the abstract-reflective learner. I don't know how this learning style impacted my use of learning technology. I had to stretch myself a bit to figure out how to use course management on the web, and I tried to think conceptually about how it might be used in my courses without creating too much work for myself.

Bryan also describes his learning process as being mostly a case of self-teaching with trial and error. This may relate to both the active and the random aspects of his learning style, although in low scale. According to Kolb (2000), active learners like experimentation, and Gregorc (1985) describes random learners as having an experimental trial and error attitude, as they like to find their own way in intuitive leaps and avoid step-by-step procedures. This description is close to the way Bryan analyzes his experience: "I taught myself to use PowerPoint and course management on the web. I had attended a couple of demonstrations of PowerPoint, but that was about it. It was a slow learning process of trial and error."

According to his comments, Bryan is always trying to find his own way of improving teaching and learning by testing different ideas and logical reasoning, which is typical of an intuitive learner, who tends to trust his intuition by teaching himself.

Faculty Struggles and Institutional Barriers

Most participants in this case felt that learning instructional technology has two opposite dimensions: the sense of accomplishment, and the sense of struggle and fear of failure. In fact, technology itself poses a lot of challenges for faculty who are not familiar with the technical details of computers and software. However, even worse than facing their own limitations is the frustration of missing the necessary support from the very institution they are willing to serve. Focusing on their personal learning experience with technology, participants

in this case describe their major struggles and difficulties with institutional barriers such as system failure, lack of technical structure, and lack of academic and administrative support.

Equipment and System Failure

Most participants pointed to equipment and system failure as their main source of trouble and fear when using instructional technology. Seven out of ten participants have had negative experiences and feel that failure seems to be usual when dealing with technology. Nicole says:

It breaks down, it fails. And then, what do we do? When we go to a committee and have to use a PowerPoint, it is always wise to bring transparencies as a backup. Or if we have transparencies, bring handouts as a backup. Any kind of technology and machinery is going to break down.

According to Nicole, even a small failure of the technology is enough to make people hate it. In her opinion, everybody knows technology will, at some point, break down and fail. As a result, technology can very easily get a bad reputation, and she thinks it is very hard to overcome that reputation once it is there.

Karen has the same struggle in her classes and feels like failure with equipment is pretty normal. This is how she describes her troubles when using slides projectors in her classes of Art History:

I am always afraid of technology. Even with the slide projector, like if the bulb burns out in the middle of a test, then we have to go back and change it, but we can't because it is too hot. Or when the slides get stuck in the projector, or things like that.

It took time for Karen to overcome the fear of failure, since she was always scared with the risk of failure. However, one positive thing about Karen's experience is that the equipment failure

does not decrease her willingness to use it. As she says, she never thinks of giving up.

Lisa feels frustrated when she has problems getting an image to show up on the screen, and setting up the hardware. And she remembers one of the most embarrassing situations in her technology adventure:

I had a guest speaker who came into my classroom, and I felt responsible because the equipment didn't work. Then I said to myself, let me go back to overheads and something like that.

Because she was afraid that things would not work, she always had an alternative, like bringing the laptop and also the overhead projector, in case something did not work.

The experience of Diana is a little different. In fact, teaching with technology does not bother her at all. She says that she likes to teach and she does it well. Although technology is challenging, she knows she has help available in the teaching center. One problem, though, does bother her. She says

The huge problem of failure, the things that terrify me more than even the technology, is having students not be able to access the medical library because the password does not work. They are registered for the course, but sometimes their password is not activated at a distance. I have been dealing with the registrar and the admissions office, and those are the tough parts, those are the things that keep me awake at night.

Those are the most difficult aspects of online education, from Diana's perspective. She thinks this is the real issue faculty have to be worried about. The technical support is no big deal, she says, because there is help available in the support center, and students are prepared to deal with that.

Bryan has had similar disappointments. He says that one thing that is really frustrating is when he goes to the classroom and the system is not working. This is his frustration: "When I try

to login and I cannot access the server on campus. It really annoys me."

Another frustration that Bryan mentions is that sometimes things are out of control. There have been semesters when the demands on the course management on the web overwhelmed the system, so students could not get on the system to print out lecture notes, and they were coming to class aggravated, and Bryan was annoyed as well. Bryan feels that when technology is not reliable and consistent, when it does not work well, it tends to make everybody bothered.

Roy stresses the fact that technology is never one hundred percent reliable, because something always goes wrong. And like Nicole and Lisa, he usually prevents himself from being stopped by those failures, as he says: "I always have a plan B. When I get students taking quizzes online, I always know that a small percentage of them will be shut out or drop out of the system. Anyway, it is getting more reliable."

In other words, system failure is a permanent threat to technology users. In fact, Ellen says that struggles and fears are a continuous source of worries for her. She thinks sometimes the problem may be beyond the local network system. There are problems with the web system as well, and she reports a frustrating example:

Couple of weeks ago, when a virus attacked the internet, I had an online test going, and we lost all of our sound and real media files that had all of our musical examples that were on the test.

There are moments when Ellen feels it is total failure, and sometimes she thinks she will never have another student in this class again. But she feels encouraged when she gets emails back from students saying things like, "I know you didn't cause it, as you are doing the best job you could." In other words, it seems that no faculty member is free of equipment or system failure, and if they want to keep using the resources of technology

they must be willing to deal with failures and frustrations.

Lack of Technical Support

But equipment or system failure is far from being the only source of disappointment when dealing with technology. For Roy, the problem was the lack of institutional interest and support. He says he had political struggles in his career because one institution where he worked did not want to invest in technology at all, so he could not do much at that time. Jennifer also reports her struggles because of the lack of equipment and support in her department. She says, "In my own unit in the school of Nursing, I did fear to fail, because we didn't have equipment and technology. We didn't have support for that, and it was very discouraging."

But Jennifer says it became very easy after she found support from the teaching center. She purchased a notebook with money from a grant, and used it in her school along with the few computers available there. However, she worried that after she discovered advanced ways of doing things in the teaching center, she would be unable to use the same methods in her department because of lack of support.

But this specific struggle is in the past already, as there is now equipment and support available. Jennifer explains that five years ago the department did not have any kind of help, not even a scanner to scan pictures for the web. She remembers that to get the school equipped was very hard. However, through this entire struggle, she says she never thought of giving up, because she was working in an area that she really likes.

Jennifer thinks that faculty in her institution now have reasons to celebrate, because everybody is encouraged to use technology throughout the campus system, and part of the excellence in teaching component for tenure and promotion is explaining how faculty incorporate technology in

their teaching. She says, "It is very new and has been done in the last two or three years."

Time Commitment

If there is any issue in which all the participants agreed one hundred percent it is that the time commitment is a major barrier that interferes in their process of learning instructional technology. In other words, ten out of ten participants unanimously said that this is a big issue for them. Bryan says there is a lot of frustration when he looks at how much time he needs to perform some basic tasks. For example, he reports:

It takes a lot of time to convert lectures to Power-Point, for example, particularly because I want to use some visual images. So we got to go hunting through the clipboard and on the web to find a picture of something. It is a time-consuming task.

Spending that much time with technology makes some faculty members worry about other roles they are neglecting in their career because of technology. Bryan says there were times when he was shaking his head thinking that he would not get any research done because he was spending so much time dealing with technology. He was worried that in some ways he would be penalized for doing it, because it was a time that he was not spending doing research. He thinks one reason is that he is not technologically savvy, as he does not know too much about computers and web pages. However, he says he is making progress, and eventually playing with PowerPoint gets easier the more he uses it. But using instructional technology has been very time-consuming because he had to figure out many things on his own.

Ellen has the same struggle with the time issue. She explains that there were brief moments when she thought the online class was not worth the amount of time it was taking, so she felt overwhelmed, as she describes:

I felt that was a failure on my part that I couldn't pick it up fast enough to know how to keep up with what I needed to do, because I have a lot of different ideas in my head, but I didn't know how to make them come to completion on a timely basis.

Sometimes Ellen wondered if she would even benefit the students enough to make it worth the effort. After a lot of frustration, however, she says she talked to the students, and they made her change her mind. As she says, suddenly she sees the light go on, as students get excited and involved in the learning process. Jennifer also struggles with the time issue. She says that sometimes she is scared because it takes a lot of time to learn something new, and she feels she does not have that much time available.

In turn, Nicole says she has a different problem about spending time. Because there were some students who refused to use the web to access course materials, she ended up having a two-way status among the students in class, those who used the web to a full degree, and those who refused to use it. That is how she describes her struggle:

I felt that I was doing double the work, because I had to do things on the web, but I still had to go back and do all the old way things on top of that to reach those students who didn't do it. And that is my hesitancy about technology.

Besides, Nicole thinks that for any faculty member it is going to be a matter of how many classes they teach and how much service they do. And she is very honest in addressing this issue:

Unless there is some reason why I have to know and do this, otherwise I would lose my job, so to speak, I would not spend much of my time on this. If I was a tenure track person, and my department chair told me that I should be spending my time on my research, and not playing around and putting up a nice website for my students, I

mean, the dilemma research versus teaching, I would not do it.

So, for Nicole, it is either a matter of being forced into it in some way or just a matter of personal interest. And as she says, it is not a personal interest for her. So she thinks it is easy to find an excuse not to do it because of the time commitment it requires.

Bryan thinks the time commitment is an issue not only in the creation of online materials, as there is also an ongoing time commitment. As he reports: "After every class, somebody is emailing me stuff that I have to take the time to put it on the web. So the time I spend on my teaching has increased with the use of instructional technology."

Ellen is convinced that learning technology is a matter of time management, and she says she has spent long hours and days to do what she has done with technology so far. This is the way she sees this issue:

I have found myself waking up in the middle of the night, thinking of new ideas, but I don't have time for doing that. So, the biggest barrier is time. There is never enough for me to either teach, to continue my own learning, to do my research, which is necessary, or to sit on the committees and do the committee work.

Ellen thinks faculty members willing to learn about technology have to face the dilemma of taking time from other activities and still keep up with all their responsibilities, which is not easy, she says.

In her experience, Lisa felt how hard this time management issue is, and she describes how she faced the time dilemma to produce only small pieces of course materials:

When I think about creating activities and including that technology in the classroom, I feel big time constraints. When I know it took me a long

time to edit a video and burn it on to a DVD, and produce only ten minutes of information . . .

Because it takes too much time, and it is not an essential responsibility, Karen says it is easy to keep doing things that are more “urgent,” thus relegating technology as a secondary task. Referring to the time required preparing PowerPoint presentations, this is what Karen says:

In my case I have to get the slides scanned and digitized, and it is either my time or somebody else's time. . . If it is my time, I always tend to give my time for things that are due tomorrow or the next day.

As the preparation of her classes is a top priority in her job, Karen says that the PowerPoint stuff becomes an extra task, therefore, secondary.

Diana has her own conclusion about why many faculty members never get involved with technology. She thinks the time commitment is the main reason why technology is not a priority for faculty. This is her opinion:

Most faculty resist because it is time consuming, and faculty time is precious. The institution loves technology and supports it, but time is still an issue. But personally, I don't let barriers get on my way. If I really want to do something, I just go ahead.

The attitude of Diana seems to be typical of those who are successful in using instructional technology. Like Diana, people willing to teach with technology do not let barriers get on their way. That is how Steve thinks about time commitment as well. He sees the barriers and time requirements, but he says everything depends upon the willingness of faculty, even if the schedule is tight.”

Jennifer and Roy agree with the others and refer to time as a big constraint. Jennifer mentions one example of how technology takes time from faculty and students: “Some students didn't have the latest version of the Real Player software to

play a video clip that I posted on the web. I had the same problem on my laptop, and I had to spend 45 minutes to download it from the web. It is free, but there is also the time constraint.”

Examples like this show that faculty must make it a priority in order to incorporate technology in their teaching routine. And that is exactly Carol's problem, as technology is not her high priority. In fact, she associates the time issue with her own reluctance to use technology. This is how she combines both things:

Time is the main thing. And so is my basic resistance to technology. I think that it slows down. If the time were available, I don't think I would pick it up as fast as I would like to believe I am capable of picking it up, because of this little resistance.

Despite her natural resistance, Carol wants to learn about technology, and she compensates her resistance by exploring an alternative learning method, which is having regular consultations in the teaching center. In short, she thinks that anybody who wants to use technology must be willing to spend enough time with it, as this is the only way to get proficiency and prepare consistent material.

The Rewards Issue

Another barrier addressed by the participants is the lack of rewards for faculty who spend time and effort dealing with instructional technology. Five participants mentioned that if institutions want faculty to use technology, they have to be rewarded in the promotion and tenure system. For Bryan, this is a basic concern, and this is his point of view:

I think many faculty worry that, if they spend a lot of time doing this, they will actually be punished for it, or that it may work against them when it comes to promotion and tenure, or when it comes to the annual review. And maybe the colleagues

in the department or the university will look at this and say that they should have done more in publishing articles. So there is a concern that this sort of effort is not rewarded within the system.

For Carol, this is a matter of institutional priority. She thinks that, if the university really believes that instruction can be improved by technology, the institution should encourage faculty members to use technology in their work by including this issue as a part of the annual review for promotion.

Nicole thinks time and rewards are related issues. She guesses that at least three quarters of all faculty would say that they don't have the time to learn and use instructional technology. Nicole thinks faculty should be guaranteed not only the time, but also the support, like not teaching a class for one semester but getting paid for that time, in order to develop new online courses or strategies.

Commenting on her experience, Jennifer feels lucky that her institution encourages the use of technology throughout the whole campus. She explains that part of the "excellence in teaching" component for tenure and promotion is achieved by reporting how faculty members incorporate technology in their teaching. As she clarifies, this is something very new that has been done in the last two or three years. Steve also refers to his experience to stress the fact that technology did help him to be rewarded with promotion and tenure. He thinks institutions should make it official to all faculty members.

The Cost Issue

Three participants referred to cost as another barrier for implementing instructional technology. Jennifer says that cost is a big institutional barrier. She points to the fact that some students do not have computers at home. And even when they do, they may not have the appropriate software. For Karen, the problem of cost has to do with paying additional people like her teaching assistant. Whenever she needs somebody else's

time, she has to pay the person. This of course is an institutional resources problem, but she has no choice but to hire knowledgeable people to help her continue using instructional technology.

Nicole also sees cost as a barrier, and she says that sometimes students complain about their computer at home, or they didn't have a computer at home, and this problem compromises student's access to the online environment. She thinks this will always be a problem in classes with diverse students, as some students will benefit from online materials while others will not. She thinks it gives an unfair advantage to some students over others who do not have a computer, or do not have the right program, or the right memory, or just are not familiar with the web environment.

The Technology Workshop Series

Willing to deal with their personal struggles and to develop their technology skills, all the participants in this case accepted the invitation to participate in a very innovative technology workshop series, as an initiative intended to foster faculty development in instructional technology and strengthen their motivation and technical skills. The workshop series called "Tech Camp," was designed in a creative way as intensive immersion experience to provide faculty with a rich technology environment supported by full technical and pedagogical assistance provided by faculty developers and technology expert. After the technology workshop series, participants were asked to share the impact of their learning experience described below.

More specifically, Tech Camp is a faculty development workshop series offered by the teaching center of a public university in the US and includes four different levels of seminars offered annually, ranging from basic to advanced content. Each level of seminar consists of a three-day workshop, in which the participants alternate training sessions in a computer lab with personal project presentations, exchange of personal experiences in using technology, and social interactions, including

having breakfast and lunch together every day. The first three levels of workshop are taught every year during the summer, and the fourth level is taught the following spring. In order to make them more attractive and enjoyable, each workshop is structured under an illustrative theme related to sports or adventure. The basic content and features of the workshop are summarized below.

Level 1: The Summer Scout Camp

The first level of the technology workshop series is structured under the theme of a summer camp, with the classroom decorated with trees, tents, and a campfire. The participants, called campers, are invited to spend time around the campfire while learning instructional technology techniques and resources to be used in the classroom. Each camper receives a “Camper Survival Kit,” which is the workshop handbook with printouts of all the lessons. This workshop is designed for faculty who are just beginning to work with online tools, have basic word processing skills, and are familiar with Internet browsing. The content of this workshop includes: Using course management system on the web and creating basic course materials online; creating basic PowerPoint slide shows; transferring files into an Internet server and linking them to a course environment; effective use of email, chat, and conferencing tools; linking electronic library resources; constructing an online quiz; and using the online grade book feature of the course management system.

Level 2: The Chateau Techneau Lodge

This level focuses on web page design, including planning and layout, along with basic creation, conversion, and enhancement of digital images for the web. The theme of this workshop is a winter ski resort called Chateau Techneau Lodge, where a series of exercises is designed to help participants to conquer the technology “slopes.” Every day, participants enjoy lunch and sip hot chocolate by

the “lodge” fire, and are challenged to experience the thrill of designing their very own course on the web. This workshop is designed for faculty members with intermediate technology skills.

Level 3: The Technology Cruise

Under the theme of a cruise, participants of this workshop “embark” as passengers aboard the S.S. Digital Divide with the mission of calming the stormy seas of technology by developing multimedia skills and navigating the basic technology tools for constructing online course materials. This level is designed to teach participants how to incorporate audio and video source material into web-based courses, which includes shooting, digitizing and editing audio and video media. Participants also get notions about the appropriate length of clips and on how to optimize media for better images.

Level 4: The Tech Olympics

Using the theme of the Olympic Games, campers are transformed into Olympians as they compete with themselves to achieve gold, silver, and bronze medals by finishing successive personal projects. In this workshop, the participants learn the basics of Web, CD-Rom authoring, DVD burning, and Flash web animation, using common authoring programs for each form of content distribution. This level is designed to build confidence in technological proficiency in an extremely hands-on learning environment.

General Workshop Structure

The workshop structure can be exemplified by the *Tech Olympics*, program. At the first day, participants entered the site to find a large painting of an Olympic stadium full of people on the front wall, while both an American flag and the five-intersecting-rings Olympic symbol were hanging from the ceiling. A table on the left-hand

side of the room displayed all sorts of balls and sporting gear for tennis, baseball, golf, basketball, volleyball, football, soccer, and so on. Numbered sprint tracks were designed on the floor, and another table at the back of the room covered with breakfast foods, such as fruit salad, orange juice, toast, cookies, coffee, milk, banana nut muffins, and chocolate chip muffins. Participants were sitting in groups around five tables dispersed in the middle of the room.

At the opening ceremony, after welcoming the participants, the coordinator of the workshop lighted an electronic simulation of the Olympic torch, thus officially starting the workshop. The coordinator introduced the “team” of instructors, dressed in athletic clothes, and made jokes with each of them. Then he asked the participants to introduce themselves in a very informal atmosphere. All participants received a folder with the schedule of activities and the workshop material, plus a badge on which they were to write their names using colorful markers. After receiving the instructions for the day, participants recited the tech pledge in unison. It reads as follows:

On my honor, I will try to incorporate technology wherever appropriate into my teaching, my presentations, and classroom discussions. I will post my syllabus online and will develop interactive strategies for my students as I pursue excellence while exploring technology resources.

After the pledge, participants went downstairs to the computer lab for technology exercises. In the lab, every participant sat in front of a computer previously set up with the required software, while one instructor walked the participants through the content in a step by step presentation. While one instructor was presenting, another three or four instructors were circulating the room to answer questions and help the participants.

Theme Strategy

The reaction of almost all participants to the technology workshop was highly positive. Six out of the ten participants referred to the workshop strategy as “relaxing,” and four of them found it “fun” and very attractive. Expressions like, “they made it very relaxing,” or “I knew soon it would be fun,” were repeated quite a few times by the participants during the interview. In fact, nine out of ten participants said they found the theme strategy a very powerful resource to make the workshop interesting and more attractive. Most of them said they enjoyed the different themes, which helped enhance their learning experience.

Some participants went to the workshop fearing that it would be very difficult, but the theme strategy made them feel comfortable at the very beginning. Jennifer says she was afraid: “I was pretty apprehensive that it would be so advanced. But in the first day, they made it very relaxing.” Lisa described her feelings like this: “No way will I be able to do this! I said, Oh my gosh, this is never going to make sense! So it was a little intimidating at first, but it was fun.”

A few comments by the participants are typical of their reaction to the theme strategy. Talking about their first impression of the workshop, some participants related the theme strategy to their learning experience. This is how Ellen reacted:

Oh my gosh! Things like fire and trees within this air conditioned environment, I think these people have lost their mind! But it added to the atmosphere and added relaxation because the first thing we all did was introducing ourselves and laughing.

After being afraid at the beginning, Lisa says the themes enhanced the peer interaction. She described her experience as a learning trip in the following words:

To me the cruise theme made all the difference. Each day we had a different work and a differ-

ent place to sail, and when I came back from the workshop, I asked the faculty member I worked with: Where did you cruise to today?

Nicole also felt that the relaxing sense of vacation was helpful to her learning process:

Even though we were still on campus, we had a sense of being removed on retreat, so we were not on campus because we were in Cancun, or in the Olympics, or in the forest, so themes helped us feel like we were on vacation. So it was relaxed, and not do or die, or so serious like another workshop might be.

Attitude of the Instructors

Eight out of ten participants referred to the attitude of the instructors as one of the most positive aspects of the workshop. Bryan has his own explanation for why the attitude of the instructors is crucial for the success of the workshop. This is his opinion:

I think faculty come to the workshop a little worried that they are going to feel stupid, as they don't know how to do things and the technology people will look down their noses at them because they are not as well versed in using this technology as they are, but I found that not be the case at all.

According to Bryan, the fact that faculty have prestige and expertise in many different areas makes them very sensitive, as they don't like feeling disadvantaged in a learning situation. That is why the role of the instructors is decisive in making faculty feel comfortable. Diana thinks the environment was comfortable and encouraging because the instructors were willing to help with deference and respect. This is how she addressed this point:

The instructors are wonderful and have a respect for faculty and faculty expertise. They also know that faculty who come for help are very vulner-

able, and they are supportive without being condescending and such. I think that the personnel are probably the strongest part of the workshop.

Impact on Learning

The impact of the workshop on the process of learning technology was different for each participant. They were asked to estimate which percentage of their learning of technology could be attributed to the workshop itself, and they came up with different levels of learning impact. Four out of ten participants estimated that 50% or more of their learning of technology could be attributed to the workshop, which means a very strong impact on their learning process. Three participants estimated that the impact on their learning of technology was between 25% and 50%, which could be considered a medium impact. Three other participants estimated the impact was less than 25%, meaning a low impact on their learning of technology.

Karen sounded very realistic describing how she felt about the impact of the workshop on her learning of technology, and this is her explanation:

For me it was a huge part. I would say that maybe 50% of my learning so far is due to the workshop, but I have a teaching assistant, and she may represent 40%, and I am only 10% of my improvement in technology.

Only Roy says the impact was as low as five percent. He is very experienced in technology, so the workshop was only an additional resource. But overall, the majority of the participants were very satisfied with their gains in learning technology through the workshop experience.

Regarding the way the workshop best facilitated their learning, six participants referred to the "hands-on" approach to learning as the most helpful methodology, as they appreciated the opportunity to watch the instructors and practice at the same time. To say that in the words of Roy, "the organizational pattern was pretty busy, transpar-

ent, so I understood what was going to happen. Methodology was good, mostly hands-on, quite professional.”

Both the hands-on approach and the time available to work on their personal projects helped the participants develop technical skills and produce useful material for their classes.

Impact on Teaching

Commenting on their teaching experience with technology as a result of the workshop, six out of ten participants stressed that the workshop had a strong positive impact on their teaching routine. They referred to this impact with expressions such as, “I had never used course management on the web before,” or “I had never done a full PowerPoint presentation before.” Some said things like, “it helped me a lot to use technology,” or “there was an immediate change when I took the workshop.” These participants sounded excited in describing some of their new experiences with technology.

Four participants said they didn’t use the technology applications that they learned about at the workshop much. Bryan says that he used very little of what he learned because he was already using it. The other three participants said that the workshop did not make any impact on their teaching as they didn’t change anything in the classroom. They have different reasons for that. Carol says she did not do anything different in part because of her subject area, which is Theater, and she feels that she does not have much to apply. Roy says he did not have time to produce the material he needs. This is how he analyzed it:

No changes. I haven’t produced any streaming video for teaching yet. As far as the use of Flash and animations, I have one animation distributed on the web, and that is probably the only one I generated so far. The same with Dreamweaver, as I am probably using only 15 percent of it.

In other words, the majority of the participants did feel a strong impact of the workshop on their teaching and applied a great deal, but some others did not make any significant change in implementing instructional technology after the workshop participation.

Overview of Findings and Conclusions

Based on the participants’ descriptions of their learning experiences with instructional technology, one major characteristic of each participant was identified and helped understand better how the learning process worked for each faculty member. In most cases, this dominant personal characteristic of the participants seemed to be consistent with the theoretical description of their learning styles, but in one specific case it was not consistent with the theory, and in three other cases there was little evidence to support the learning styles theories. Table 13 displays a comparison between the descriptions of the participants’ dominant characteristics and their learning styles, as well as the theoretical support found for each dominant characteristic. Columns two and three of the table describe the relationship found between the dominant characteristic of each participant and their personal learning style as assessed by the ILS instrument, and column four presents the learning style theory that offered support for such relationship.

The last column of Table 13 applies the adoption categories of Rogers’ (1995) diffusion of innovation theory to the participants in this study. Diana, Roy and Jennifer were classified as innovators, given their experience as risk takers willing to take the initiative and time to try something new and different. Ellen and Steve can be classified as early adopters since, to certain extent, they served as role models for their peers by being channels to help others to adopt innovations in instructional technology. Lisa and Karen fit in the early majority category, as they are careful, safe, deliberate, and do not want to risk much on

Table 13. A comparison of personal characteristics and learning styles

Participant	Dominant Characteristic	ILS Learning Style	Theoretical Support	Adoption Category
Carol	Emotional	Intuitive, Random	Gregorc, Felder	Late majority
Diana	Risk-Taker	Intuitive, Random	No theoretical support	Innovator
Jennifer	Visionary	Visual, Sequential	Gardner, Felder	Innovator
Ellen	Hard-worker	Concrete, Sequential	Gregorc, Myers, Brightman	Early adopter
Karen	Dependent	Concrete, Active, Sequential (low scores)	Kolb (little support)	Early majority
Roy	Pragmatic	Visual, Intuitive, Active	Kolb (little support)	Innovator
Steve	Social	Active (maximum score), Visual	Kolb	Early adopter
Nicole	Skeptical/Trial-and-Error	Visual, Active	Kolb, Gardner (little support)	Laggard
Lisa	Watching	Visual	Gardner, Felder	Early majority
Bryan	Self-taught	Intuitive	Kolb, Myers	Early adopter

the innovation process. Carol fits in the late majority because, even being suspicious of innovation and resistant to change, she keeps moving slowly influenced by peers and the environment. Nicole describes her experience as a laggard, since her skeptical attitude keeps her somewhat inflexible in resisting innovations in instructional technology.

From the data analysis, another theme that emerged was the positive impact of the technology workshop in the format it was presented. Faculty in this study identified seven major features of the workshop format that made a strong impact on their process of learning technology. These key features of the workshop were: (1) the theme strategy of illustrating the workshop as a sportive adventure; (2) the respectful and caring attitude of the instructors in making participants feel comfortable; (3) the “hands-on” approach in using a computer lab for the participants to apply the content of the workshop; (4) the peer interaction in the classroom and also in social opportunities; (5) the time available for practice after each lesson and presentation by the instructors; (6) the opportunity to develop their own projects during

the workshop; and (7) the continued assistance available to them as they worked for three days surrounded by instructors.

The way in which the technology workshop series was designed seems to include the concepts underlying the above approaches and strategies. Some functions such as modeling, skill training, intensive help, and a user-friendly environment, were mentioned by the participants as an effective part of the workshop format. In summary, participants approved the workshop format and they think faculty development programs should explore more the strategies used in this technology workshop series.

Based on the above discussion, the following conclusions seem to be evident:

1. In order to attract faculty members with different backgrounds, beliefs, and motivations, technology workshops need to be creative, dynamic, and involve participants in a presentation style that includes active learning strategies and a hands-on approach.
2. The theme strategy of illustrating the workshop as an adventure was found to be

a powerful resource to break the natural fear many faculty members feel towards technology, and made them feel comfortable and relaxed enough to enjoy a real learning experience.

3. A prolonged immersion approach is crucial to make participants “live” in a technology environment with full support and tutoring available, so no participant will get stuck without solving the common problems technology presents for beginners.
4. A friendly, respectful, and patient attitude on the part of the instructors is essential for making faculty feel encouraged to participate. Being experts in many different areas, faculty do not feel comfortable being treated as inferior for not knowing the basics of some programs or software.
5. The social interactions promoted by sharing food and participating in group discussion, as well as the peer teaching opportunities, are a powerful learning resource that make faculty encourage each other and exchange learning experiences.

The experience of the participants in this study provided helpful information on different aspects of the process of learning to use instructional technology. Putting together the relationship between the several different factors, the following findings and conclusions seem to be evident from this study:

1. From a practical perspective, this study found that the lack of time and rewards made it harder and more difficult for faculty to learn and use instructional technology. In other words, most faculty claim that they need more time and rewards from the institution.
2. From an institutional perspective, the study found that all the participants felt under stress because of the time commitment, since instructional technology was an addition to their already busy schedules. Therefore, most

participants claim that the preparation of instructional technology materials should be included and rewarded as part of the regular work load. Faculty also fear compromising the promotion and tenure process by spending time with IT.

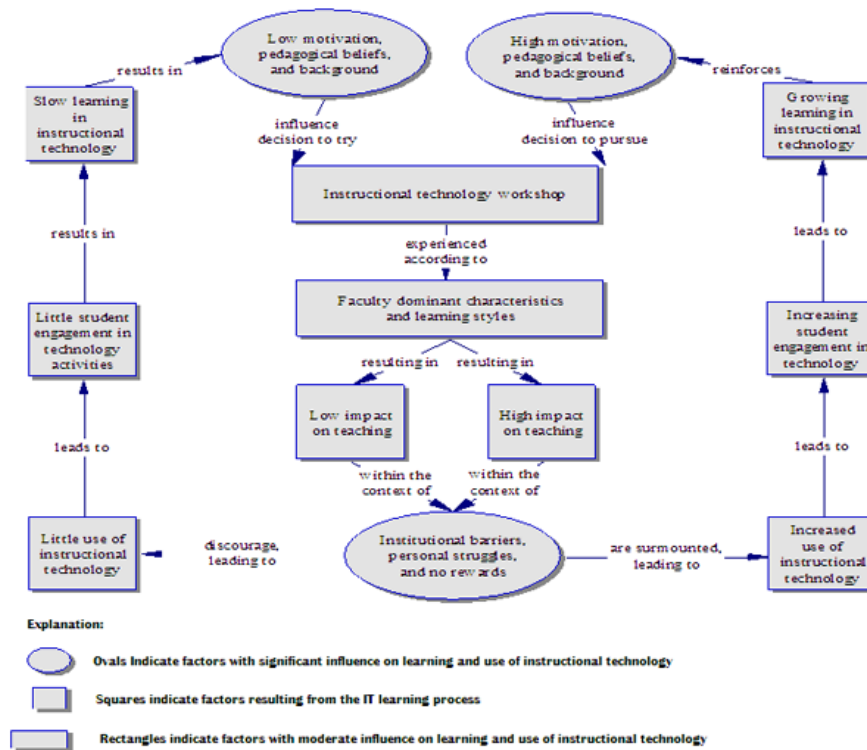
3. The participation of these faculty in professional development interventions such as the technology workshop series was very helpful to equip and develop faculty skills in instructional technology, thus enhancing the participants’ learning experience.

According to this study, the learning process in instructional technology works as a cycle in two opposite directions. Faculty who have high levels of motivation, positive beliefs, and some background in technology take the most advantage of professional development programs in instructional technology, have a growing learning experience, and are successful in developing teaching strategies that involve students in an active learning experience. The cycle is repeated as the more they learn, the more they increase the background, motivation, and positive beliefs. In the opposite direction, faculty who have low levels of motivation, negative attitudes, and no background in technology take less advantage of professional development programs, have a slow learning experience, and do not use much instructional technology in the classroom. Figure 1 displays this double cycle describing the relationship between the different factors influencing the learning process of faculty members in instructional technology based on the experiences of the participants in this study.

Practical Implications and Recommendations

The findings of this study present practical implications for faculty development in instructional technology, both from an institutional perspective related to policy issues and from the personal

Figure 1. Cycle of faculty learning experience in instructional technology



perspective of individual faculty members who want to learn from the experience of fellows who have struggled and walked the journey of learning instructional technology. Based on these findings, the following recommendations seem relevant to address the needs of the participants from an institutional perspective:

1. Institutions and departments should restructure their academic reward system to compensate faculty members who develop successful teaching activities and strategies using instructional technology and the online environment. The promotion and tenure process should include and consider instructional technology as a relevant part of the teaching excellence component of promotion and tenure.
2. Institutions and departments should restructure their financial reward system to

accommodate different criteria for assessing teaching load and instructional costs. The traditional model of measuring instructional costs based mostly on student/faculty ratio, average faculty salary, and student credit hours (Paulsen and Smart, 2001), must be reviewed to allow room for the time-consuming task of producing online courses and materials, thus providing a fair reward for faculty involved with instructional technology.

3. Institutions and departments should design both a short-term and a long-term pilot-plan for the implementation of faculty development programs in instructional technology, with a wide range of developmental interventions to reach faculty members at different levels of motivation and attitudes, as well as technology expertise and experience.

4. Based on the participants' descriptions of their dominant learning styles and characteristics, faculty development programs should address the needs of different types of learners and focus on different target audiences to reach faculty members with different profiles by promoting workshops with a wide variety of learning approaches including creative strategies like online games, instructional video clips, group discussions, and online case studies of pedagogical experiences using technology.

CONCLUSION

In summary, whether teaching instructional technology to an emotional learner, to a risk-taker or to a skeptical learner, it is always challenging to meet the needs and expectations of faculty with different learning styles, different technology backgrounds, different pedagogical beliefs, different attitudes towards technology, and who have their own pace and their own preferences in dealing with teaching and instruction.

Regarding the faculty development intervention, overall this innovative workshop series seems to have made a positive impact on the learning experience of most faculty members in instructional technology. However, even acknowledging the support of the institution in terms of providing faculty development opportunities, technical assistance and equipment available, one hundred percent of the participants agreed that institutional barriers such as time commitment and the lack of rewards are major barriers in terms of learning instructional technology. As a result, most participants tend to be under stress to accommodate all the demands of their professional appointment, such as teaching, research, service and participation in committees, and still be able to get involved with instructional technology. Many participants felt that instructional technology is an addition to their already heavy workload.

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KEY TERMS AND DEFINITIONS

Faculty Development: A wide range of interventions, programs and resources intended to support faculty in developing expertise in specific subject-areas, such as mastering technologies for learning.

Faculty Rewards: Academic and financial recognition of faculty work with technology for learning, including the promotion and tenure process.

Institutional Barriers: Lack of institutional support, resources or academic and financial rewards, thus discouraging faculty of learning and using instructional technology.

Instructional Technology: The art and science of designing, producing, and using solutions to instructional problems, using different media and systems that facilitate learning efficiently (Heinich, Molenda, Russell, and Smaldino, S., 2002)

Learning Styles: A generic term as an umbrella concept for recognizing individual learning differences and preferred ways of interacting or processing new information. No one has a monopoly on the term or can claim to represent learning style in its entirety (Butler, 1987; Kolb, 2000).

Pedagogical Attitudes: Faculty positive or negative reaction, including beliefs or disbeliefs regarding the benefits of technology applications for teaching and learning.

Teaching Strategies: A broad concept referring to the planning, implementation, assessment and management of educational activities, with the goal of producing learning.

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Chapter 7.9

On the Role of Learning Theories in Furthering Software Engineering Education

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ABSTRACT

Learning theories describe how people learn. There is a large body of work concerning learning theories on which to draw, a valuable resource of which the domain of software engineering educational research has thus far not taken full advantage. In this chapter, we explore what role learning theories could play in software engineering education. We propose that learning theories can move the field of software engineering education forward by helping us to categorize, design, evaluate, and communicate about software engineering educational approaches. We demonstrate this by: (1) surveying a set of relevant learning theories, (2) presenting a categorization of common software engineering educational approaches in terms of learning theories, and (3) using one such

approach (SimSE) as a case study to explore how learning theories can be used to improve existing approaches, design new approaches, and structure and guide the evaluation of an approach.

INTRODUCTION

Learning theories are attempts to describe and understand the various ways in which people learn. They are an important resource for educational research, as they can both guide us in creating new educational approaches, and help us analyze and improve existing approaches.

In this chapter, we propose that learning theories, which have thus far been explicitly leveraged in software engineering education in only a minimal way, can actually play quite a significant role in this domain. Specifically, we believe that learning theories can serve to move the field of

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software engineering education forward by helping us to categorize, design, evaluate, and communicate about software engineering educational approaches. Categorizing approaches in terms of learning theories can help us to understand the approaches in relation to each other, understand how they fit together, and point out areas of untapped potential. New approaches can be designed to leverage certain theories whose potential is unfulfilled or known to be especially valuable in our domain. Learning theories can be used to evaluate approaches by helping structure experiments to look for the presence of these and other theories in the processes of learners. And, we can use our newfound knowledge to communicate in a common language—that of learning theories—about different approaches and our experience with them.

This chapter details this vision of principally using learning theories in the domain of software engineering education. We first briefly present a set of well-known (mainly constructivist) learning theories that are especially applicable. We then introduce a categorization of the major software engineering educational approaches to date in terms of the learning theories that they appear to have been designed around. Following this, we discuss the role learning theories can play in analyzing and improving the design of a software engineering educational approach (and designing new approaches), and focus on the analysis of one such approach (SimSE) as a case study. We then discuss how software engineering educational approaches can be evaluated in terms of learning theories, again using SimSE as a case study. We conclude with a summary in the final section.

BACKGROUND: LEARNING THEORIES

To provide some background for our discussion on the role of learning theories in software engineering education, in this section we will briefly introduce the set of learning theories that we

surveyed for the purposes of our analysis. We do not include here an exhaustive list of all learning theories with significant detail. Instead, the purpose of this section is to simply introduce some of the ones we have seen software engineering educational approaches centered around most frequently, and provide pointers to where more information about each one can be found. In addition, we will also briefly touch on implications and typical or possible applications of each theory for software engineering education.

We chose the particular set of learning theories discussed here because of two criteria: relevancy to software engineering and orthogonality among the factors defining the theory. In other words, these theories are the ones we have seen to be most clearly and/or frequently embodied in the software engineering educational approaches that we surveyed. Furthermore, there exists a great deal of overlap among learning theories, and there are several learning theories that encompass a number of others. In these cases, we either group theories that have the same basic idea, and omit those that simply combine a number of theories.

We acknowledge that these theories fall mainly into the constructivist paradigm (rather than the behaviorist or cognitive categories), however, given that constructivism is the most recently-developed paradigm, and software engineering is a relatively new discipline, this is not surprising (it has been argued elsewhere, in fact, that the evolution of computer science education in the past decade or so has been significantly influenced by constructivism (Kolikant, 2001)). While it is certainly true that most delivery methods generally contain a mix of various theories that fall into each of the three camps (constructivist, behaviorist, and cognitive), because the constructivist aspects are the most focused on, we have chosen to scope this survey and analysis to focus primarily on these theories. Surely similar surveys and analyses could be done with cognitive and behaviorist theories that would yield interesting results, however, such exercises are outside the scope of the one presented here.

Nevertheless, some of the theories surveyed in this chapter do have elements of cognitive and/or behaviorist principles. For example, Learning through Failure involves a form of “punishment” (failure) meant to “extinguish” a certain behavior.

An additional issue that should be noted is the distinction between learning “theories,” learning “models,” and learning “methods,” as well as their counterparts in the domain of instructional design (instructional design theories, models, and methods). Because the lines between these are blurred and often used interchangeably, it should be noted that in this chapter several of the “learning theories” we refer to can also be called by some of these other terms. When this is the case, we will point it out in our discussion of those theories. However, as is frequently done in the literature, we use the term “learning theory” broadly, as a term that covers all of these categories.

One of best-known learning theories is *Learning by Doing*, a theory based upon the premise that people learn a task best not by hearing about it, but by actually *doing* it (Dewey, 1916). The implication of this theory for instructional design is the following: the learner should be provided with ample opportunity to actually perform the activities they are meant to learn, rather than using passive mediums such as lectures and readings. In software engineering education, this translates to going beyond just lectures and reading assignments (although, for most any domain, a certain amount of such scaffolding is necessary to provide the learner with the required background knowledge to effectively participate in the Learning by Doing). Software engineering educators have recognized this, and now a standard component of nearly all software engineering courses is the class project—a small software engineering project that students must develop using some of the techniques learned in class.

Situated Learning (Lave, 1988) is an educational theory that builds upon the Learning by Doing approach. While Learning by Doing focuses on the specific learning activities that the

student performs, the Situated Learning theory is concerned with the environment in which the Learning by Doing takes place. In particular, Situated Learning is based on the belief that knowledge is situated, being in large part a product of the activity, context, and culture in which it is developed and used. Therefore, the environment in which the student practices their newly learned knowledge should be “authentic”, resembling, as closely as possible, the environment in which the knowledge will be used in real life. A popular application of this theory in software engineering education focuses on incorporating aspects of realism (or “authenticity”) into the class project, such as using an industrial participant to play the role of the customer (Hayes, 2002), using maintenance- or evolution-based projects (McKim & Ellis, 2004), or using large teams of people that are distributed across geographical locations (Favela & Pena-Mora, 2001).

Like Situated Learning, *Keller’s ARCS Motivation Theory* (Keller, 1983) also focuses on motivating students to learn. However, rather than focusing on the physical environment in which they learn, Keller’s ARCS Motivation Theory concerns itself with producing certain feelings in the learner that are believed to promote learning. In particular, these feelings are attention, relevance, confidence, and satisfaction.

- **Attention:** The attention and interest of the learner must be engaged. Proposed methods for doing so are: introducing unique and unexpected events; varying aspects of instruction; and arousing information-seeking behavior by having the learner solve or generate questions or problems.
- **Relevance:** Learners must feel that the knowledge is relevant to their lives. The theory suggests that knowledge be presented and practiced using examples and concepts that are relevant to learners’ past, present, and future experiences.

- **Confidence:** Learners need to feel personal confidence in the learning material. This should be done by presenting a non-trivial challenge and enabling them to succeed at it, communicating positive expectations, and providing constructive feedback.
- **Satisfaction:** A feeling of satisfaction must be promoted in the learning experience. This can be done by providing students with opportunities to practice their newly learned knowledge or skills in a real or simulated setting, and providing positive reinforcements for success.

Keller's ARCS is technically considered an instructional design model that is rooted in various learning theories. Two of the most directly contributing theories are Andragogy (Knowles, 1984) and Expectancy-Value Theory (Fishbein & Ajzen, 1975). Andragogy concerns adult learners in particular, and focuses on their need for self-directed, relevant, hands-on learning. Expectancy-value theory states that in order for a learner to put forth the effort required to learn, they must both value the knowledge/task/exercise and expect that they can succeed at it. Because Keller's ARCS combines these theories and provides more hands-on applicability than either theory alone, we have chosen to include it (rather than the theories it is based on) in our survey and analysis.

While Keller's ARCS could be applied in a number of different ways in software engineering education, in general it entails providing the students with attention-grabbing, realistic, hands-on assignments that pose a significant, yet doable challenge. One class of approaches that explicitly sets out to accomplish such goals is that in which the class project is made purposely open-ended and/or vague. This is done in two main ways: either by allowing the students to define their own requirements (giving students the pseudo-experience of new product development based on market research) (Navarro & van der Hoek, 2005b), or by allowing them to define their own

process (giving students experience in not only following a process, but in designing the process that they follow) (Groth & Robertson, 2001). The stated purpose of these open-ended approaches is to mimic common, less-structured (authentic) real-world software engineering situations, giving the students more ownership of the project and therefore more interest in it, as well as a greater feeling of confidence and satisfaction when the project is completed.

Model-Centered Instruction (Gibbons, 2001) (which is also considered an instructional design theory) says educators should center all learning activities around models of three types: models of environments, models of cause-effect systems, and models of human performance. Presentation of general concepts and theories should be kept to a minimum. Instead, Model-Centered Instruction believes that knowledge is best learned by exploration of these models. In software engineering education, this translates to simulating realistic situations, presenting case studies, and assigning realistic problems for the students to solve. One software engineering educational approach that embodies this theory is the practice-driven one, in which the curriculum is largely lab- and project-based, and lectures are used only as supporting activities (Ohlsson & Johansson, 1995).

The Discovery Learning theory (Bruner, 1967) takes a similar approach to model-centered instruction in that it believes that an exploratory style of learning is best. Discovery Learning is based on the idea that an individual learns a piece of knowledge most effectively if they discover it on their own, rather than having it explicitly told to them. This theory encourages educational approaches that are rich in exploring, experimenting, doing research, asking questions, and seeking answers. Educational software engineering simulation approaches (Drappa & Ludewig, 2000; Navarro & van der Hoek, 2005a) are specifically designed to facilitate this type of learning—no knowledge is made explicit in the simulation, as it is rather discovered by students experimenting with dif-

ferent approaches and seeing the effects of their decisions on the outcome of the simulation. These types of approaches are generally given as structured exercises and combined with other teaching methods (such as lectures, readings, and projects). Including this type of scaffolding has been found to be crucial in making Discovery Learning maximally effective (Kirschner *et al.*, 2006; Roblyer, 2005).

Along the same lines as the Discovery Learning theory is the *Learning Through Failure* theory (Schank, 1997). This theory is based on the assumption that the most memorable lessons are those that are learned as a result of failure. The theory argues that: (1) Learning through failure provides more motivation for students to learn, so as to avoid the adverse consequences that they experience firsthand when they do not perform as taught, and (2) Failure engages students, as they are motivated to try again in order to succeed. Proponents of the theory argue that students should be allowed to (and even set up to) fail to encourage maximal learning. Although Learning through Failure is usually applied to the realm of e-learning, there have also been some non-e-learning software engineering educational approaches in which the main avenue of learning is through failure. In these “sabotage” approaches, the instructor purposely sets the students up for failure by introducing common real-world complications into projects (e.g., crashing hardware just before a deadline), the rationale being that students will then be prepared when these situations occur in their future careers (Dawson, 2000).

The theory of *Learning through Reflection* is primarily based on Donald Schön’s work suggesting the importance of reflection activities in the learning process (Schön, 1987). In particular, Learning through Reflection emphasizes the need for students to reflect on their learning experience in order to make the learning material more explicit, concrete, and memorable. Some common reflection activities include discussions, journaling, or dialogue with an instructor (Kolb, 1984).

One example of this in software engineering is (Tomayko, 1996), a practice-driven industrial partnership approach that incorporates weekly one-on-one mentoring sessions with a “coach” to discuss each student’s performance and help them reflect on their experience. The game-based simulation described in (Drappa & Ludewig, 2000) and the industrial simulation described in (Nulden & Scheepers, 2000) also incorporate dialogue and reflection as post-simulation activities in which students analyze and discuss their simulation experience with a tutor or instructor, and reflect on what they have learned.

Finally, the theory of *Elaboration* (Reigeluth & Rodgers, 1980) states that, for optimal learning, instruction should be organized in order of complexity, from least complex to most complex. Simplest versions of tasks should be taught first, followed by more complicated versions. This is a theory that is generally inherent to most curricula (as well as most other learning theories), as courses and topics are usually introduced in order of increasing complexity. In software engineering educational approaches, applying this theory can sometimes be difficult, as there is oftentimes no natural way to organize the information in terms of complexity (e.g., how can one do this for a class project?). One approach that has been able to do this is the industrial simulation approach described in (Collofello, 2000). In this approach, students are assigned very simple simulations to begin with, and the complexity of the simulations is incrementally increased as the students progress in their knowledge.

As mentioned previously, what has been presented in this section is only a brief introduction to the relevant learning theories. There is much more detail to these theories than what we have discussed, detail which must be looked into further before one can effectively apply these theories to their educational approaches. Typically, subtleties are involved in each one, and care must be taken to pay attention to these details.

LEARNING THEORY-BASED CATEGORIZATION OF EXISTING APPROACHES

One of the main ways that learning theories can be used in software engineering educational research is to provide the field with a way to analyze and categorize existing approaches, both independently and in relation to each other. Such a categorization can serve to help us understand how the different approaches fit together and create a picture of the field as a whole, so that areas of strengths, weaknesses, and untapped potentials can be unearthed. We have done such a categorization, which we will present in this section.

Before creating this categorization, in order to organize our analysis we first surveyed the major software engineering educational approaches published in the past several years and found that they can be lumped into three broad groupings: *realism*, *topical*, and *simulation* (these groupings can be broken down further into sub-groupings, as shown in Table 1). Realism approaches are those that focus on making various aspects of the students' project experience more closely resemble one they would encounter in the real world. Some of these have included industry participation (Beckman *et al.*, 1997; Kornecki *et al.*, 2003; Wohlin & Regnell, 1999), emphasizing non-technical skills such as marketing and project management (Gnatz *et al.*, 2003; Goold & Horan, 2002), and focusing on making the nature and composition of the student teams that work on the project more realistic (e.g., making them very large (Blake, 2003) or composed of several sub-teams (Navarro & van der Hoek, 2005b)). Topical approaches aim to educate students in detail about a topic generally not covered in depth in mainstream textbooks and lectures. These approaches do not focus on specific delivery methods, but instead focus on the mere addition of the topic as a crucial component of an effective and complete education in software engineering. Some examples of such topics are formal methods (Abernethy & Kelly,

2000), real-time software engineering (Kornecki, 2000), and specific software processes such as the Personal Software Process (Hilburn, 1999) or the Rational Unified Process (Halling *et al.*, 2002). Finally, simulation approaches are those that have students practice software engineering processes in a (usually) computer-based simulated environment. Within the realm of software engineering simulations, there are three main types: industrial simulations brought to the classroom (Collofello, 2000; Pfahl *et al.*, 2000), game-based simulations (Drappa & Ludewig, 2000; Navarro & van der Hoek, 2005a), and group process simulations (Nulden & Scheepers, 2000; Stevens, 1989).

To categorize these approaches in terms of learning theories, we carefully studied each one to determine which learning theories appear to have been applied (whether intentionally or unintentionally), and which learning theories have clear potential to be employed. The resulting categorization is presented in Table 2 as a matrix of approaches and the learning theories that they leverage. (For a complete discussion of this categorization, see (Navarro, 2005)—here we present only the highlights.) The presence of three stars in the table indicates that the approach embodies the particular theory, or is centered around it. The presence of two stars represents that the theory appears to be involved in the design of that type of approach, but is perhaps not an intrinsic part of it, and may not be involved in all approaches that fall within that type. The presence of one star indicates that there is an obvious potential for that particular type of approach to employ that learning theory, but there have been very few, or no known cases of it.

Example: Simulation and Learning Theories

As an example of how we analyzed each approach in terms of learning theories, in this section we will focus on the simulation category and walk through how we determined the applicability of each

Table 1. Grouping of software engineering educational approaches

Realism	53	Topical	48	Simulation	8
Industrial Partnerships	16	Formality	3	Industrial	2
- Modify real software	1	- Formal methods	2	Game-Based	4
- Industrial advisor	1	- Engineering	1	Group Process	2
- Industrial mentor/lecturer	2	Process (Specific)	21		
- Case study	5	- PSP	14		
- Real project / customer	7	- TSP	2		
Maintenance/Evolution	9	- RUP	3		
- Multi-semester	4	- XP	2		
- Single-semester	5	Process (General)	6		
Team Composition	13	- Process engineering	3		
- Long-term teams	1	- Project management	3		
- Large teams	3	Parts of Process	3		
- Different C.S. classes	1	- Scenario-based req. eng.	1		
- Different majors	2	- Code reviews	1		
- Different universities	2	- Usability testing	1		
- Different countries	1	Types of Software Eng.	8		
- Team structure	3	- Maintenance/Evolution	3		
Non-Technical Skills	2	- Component-based SE	2		
Open-Endedness	7	- Real-time SE	3		
- Requirements	2	Non-Technical Skills	7		
- Process	5	- Social/logistical skills	3		
Practice-Driven	3	- Interact w/ stakeholders	1		
Sabotage	3	- HCI	2		
		- Business aspects	1		

Table 2. Software engineering educational approaches and the learning theories they incorporate

	Learning by Doing	Situated Learning	Keller's ARCS	Model-Based Instruction	Discovery Learning	Learning Through Failure	Learning Through Reflection	Elaboration
Industrial Partnership – Real Project	**	***	**				*	
Maintenance/Evolution	**	***					*	**
Team Composition	**	***					*	
Open-Endedness	**	**	***		**	**	*	
Non-Technical Skills	**	**					*	
Practice-Driven	***			***	***	**	*	*
Sabotage	**	**				***	*	
Topical	**	*	*	*	*	*	*	*
Simulation	***	**	***	*	***	**	*	**

learning theory for these approaches. First of all, all aforementioned educational software engineering simulations allow students to learn software processes by participating in them (Learning by Doing), albeit virtually. This theory is central to the paradigm of educational simulations (hence, the three stars in the table). These simulations also employ Situated Learning by adding realism to the learning environment, although in different ways: Industrial simulations add realistic factors in the form of real project data in the simulation model; Game-based simulations add realism by immersing the student in the role of a participant in a realistic game scenario; Group process simulations inject realism through the simulated characters that behave similarly to real-world participants. Because these realistic factors are artificial in that they are virtual (rather than in a real-life setting), we put two stars in the table for this theory.

Simulation approaches strongly fit with the Keller's ARCS model of learning. In particular, they are specifically designed to promote attention, relevance, confidence, and satisfaction (and have been shown to do so in some cases) in the following ways:

- **Attention:** A number of studies done with educational software engineering simulations have repeatedly shown that students find these simulations enjoyable, engaging, and an interesting challenge they are happy to take on (Baker *et al.*, 2003; Dantas *et al.*, 2004; Navarro & van der Hoek, 2005a; Sharp & Hall, 2000; Stevens, 1989). This is particularly true for game-based simulations. Clearly this is the result of the elements of surprise, humor, challenge, and fun that are integral to many game-based simulations.
- **Relevance:** Because learners can experience firsthand how the knowledge they are learning is relevant in a real-world situation (the one that is portrayed in the simu-

lation), simulation promotes a feeling of relevance to students' future careers. This relevance can be enhanced by the usage of real-world data in the model to make the simulation more realistic. Furthermore, as the theory suggests, relevance is enhanced even further if the educational approach builds on previous and present knowledge. Simulations that are used to demonstrate concepts that have already been communicated to the students in another form (e.g., lecture or text) directly address this.

- **Confidence:** Simulations provide a non-trivial challenge that is also doable. As students are given the opportunity to succeed at a simulation, they will feel a sense of personal confidence in the learning material. This is especially true in game-based simulations, in which students have the additional benefit of feeling they have "won the game."
- **Satisfaction:** As students are able to practice their knowledge and skills in a realistic (yet simulated) setting, seeing the positive consequences of applying their knowledge correctly promotes a true feeling of satisfaction. Again, game-based simulations add to this if the student is also rewarded with a high score or some other game-relevant measure of success.

Model-based instruction has not been utilized at all in simulation, but has obvious potential to be. In particular, simulations could be used as the model (realistic situation, case study, *and* problem, simultaneously) that instruction is centered around. In such a case, students would practice a simulation (or series of simulations) for each concept (or set of concepts) being taught. Simulations would allow for ample exploration—one of the basic tenets of model-based instruction—as students could practice the same simulation multiple times, using a different approach each time, learning the consequences of various actions, and,

as a result, learning a great deal about the process and concepts being simulated.

The exploratory quality of simulation in and of itself directly implements the Discovery Learning theory. The nature of simulation is highly conducive to allowing students to discover knowledge on their own, as they see phenomena played out in a simulation, and are encouraged to explore, experiment, do research, ask questions, and seek answers.

This type of exploratory learning is also inherently related to the Learning through Failure theory. As students explore the simulation and try different approaches, they are likely to fail at least a few times. In fact, one of the basic purposes of simulations is to allow students to “push boundaries”, try different approaches, and fail without fear of the drastic and severe consequences that would occur in a real-world setting. For example, a student who fails in a simulated software project would only have to worry about getting a low game score or seeing an unhappy simulated customer, while in the real world such a failure could cost millions of dollars or have even more serious consequences.

Learning through Reflection has also been incorporated into simulation approach, although only limitedly: with the game-based simulation SESAM (Drappa & Ludewig, 2000), and the industrial simulation described in (Nulden & Scheepers, 2000). As mentioned previously, dialogue and reflection sessions have been incorporated into these learning processes as post-simulation activities. Some dialogue activity is also an inherent part of Problems and Programmers (Baker et al., 2003), the educational software engineering card game simulation. The face-to-face, competitive nature of this physical card game has been shown to promote rich and useful discussion between student opponents, regarding such topics as why they took the approach they did, the reasons behind one person’s win and another’s loss, and their reactions to unexpected events.

Finally, the Elaboration theory has also been only limitedly incorporated into simulation-based software engineering educational approaches. In particular, Elaboration has only been leveraged in the process used with the industrial simulation described in (Collofello, 2000). This process consists of assigning students very simple simulations to begin with, and incrementally increasing the complexity of the simulations as the students progress in their knowledge.

Categorization Highlights

The first thing to notice in general from Table 2 is that, although learning theories are not often explicitly discussed in software engineering education research, they are indeed applicable in our domain. Whether consciously or unconsciously, people have been building approaches toward them in various ways. If we look at how the different learning theories fare with respect to the number of approaches that incorporate them, we can clearly see that our domain has focused the most on Learning by Doing and Situated Learning. This is not a surprise, given the strong emphasis on preparing students for the “real world” that is intrinsic to the field. In contrast, Learning through Reflection is the most under-explored theory, but also has the most potential for greater use—every category of approach has the potential to leverage (or better leverage) this theory.

If we then look at each approach with respect to the learning theories they incorporate, we can see that most of them apply multiple theories at once. The “topical” category has one star for each theory because, since these approaches focus on the topic rather than on delivery methods, they theoretically have the potential to apply all of the theories, depending on the way that topic is taught. Simulation, on the other hand, directly incorporates, or has the potential to directly incorporate all of the theories considered in some way or another. While it certainly is not the case that any teaching method that addresses more learning theories than

another is better than that other method (consider a combination of strategies put together haphazardly in some teaching method versus one well-thought-out and tightly-focused method cleverly leveraging one very good strategy), an approach that naturally addresses factors and considerations of multiple learning theories is one that is most definitely worth exploring. Simulation is such an approach, but one that has been significantly underexplored in software engineering education (Navarro, 2005)—something that we are attempting to address with the approach described in the following section.

DETAILED ANALYSIS/DESIGN/DEVELOPMENT OF AN APPROACH IN TERMS OF LEARNING THEORIES

In addition to providing the field with a way to categorize and analyze existing software engineering educational approaches, learning theories can also help in developing new approaches and modifying existing approaches to be more effective. Categorizations such as the one presented in the previous section can help guide the design (or re-design) of such approaches, as areas for potential are highlighted.

Case Study: The Design of SimSE

In this section, we present a case study of a software engineering educational approach that was actually not explicitly designed with learning theories in mind. In looking back at our approach in light of learning theories, however, we can see that several of our key decisions made in its design are highly relevant to some of these theories. We can also see missed opportunities of ways we could have leveraged additional learning theories to make it more effective.

The approach is SimSE, an educational game-based software engineering simulation environment. SimSE is a computer-based environment that

facilitates the creation and simulation of realistic software process simulation models—models that involve real-world components not present in typical class projects, such as large teams of people, large-scale projects, critical decision-making, personnel issues, multiple stakeholders, budgets, planning, and random, unexpected events. In so doing, it aims to provide students with a platform through which they can experience many different aspects of the software process in a practical manner without the overarching emphasis on creating deliverables that is inherent in actual software development.

The graphical user interface of SimSE is shown in Figure 1. SimSE is a single-player game in which the player takes on the role of project manager and must manage a team of developers in order to successfully complete an assigned software engineering project or task. The player drives the process by, among other things, hiring and firing employees, assigning tasks, monitoring progress, and purchasing tools. At the end of the game, the player receives a score indicating how well they performed, and an explanatory tool provides them with a visual analysis of their game, including which rules were triggered when, a trace of events, and the “health” of various attributes (e.g., correctness of the code) over time (see Figure 2).

To date, six SimSE game models exist: a waterfall model, an inspection model, an incremental model, an Extreme Programming model, a rapid prototyping model, and a Rational Unified Process model. For more information on SimSE, including its design, game play, and simulation models, see (Navarro, 2006).

The idea of SimSE was originally motivated by the hypothesis that simulation can bring to software engineering education many of the same benefits it has brought to other educational domains. Specifically, we believed that software engineering *process* education could be improved by using simulation to allow students to practice managing different kinds of “realistic” software

Figure 1. SimSE graphical user interface

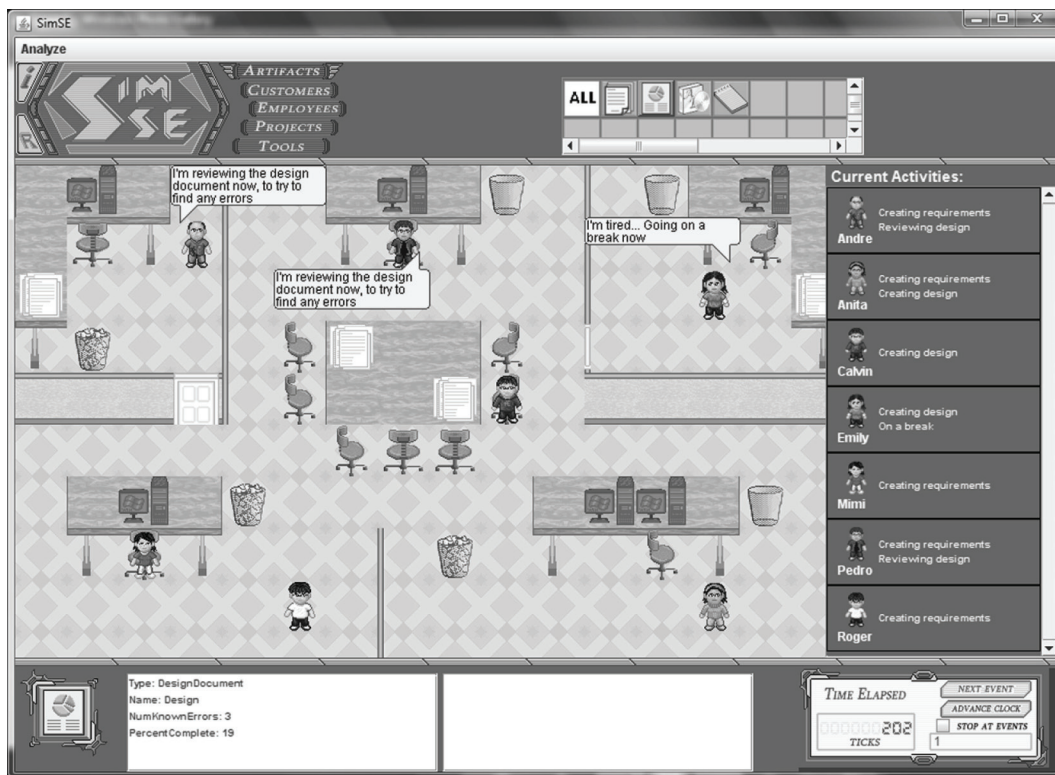
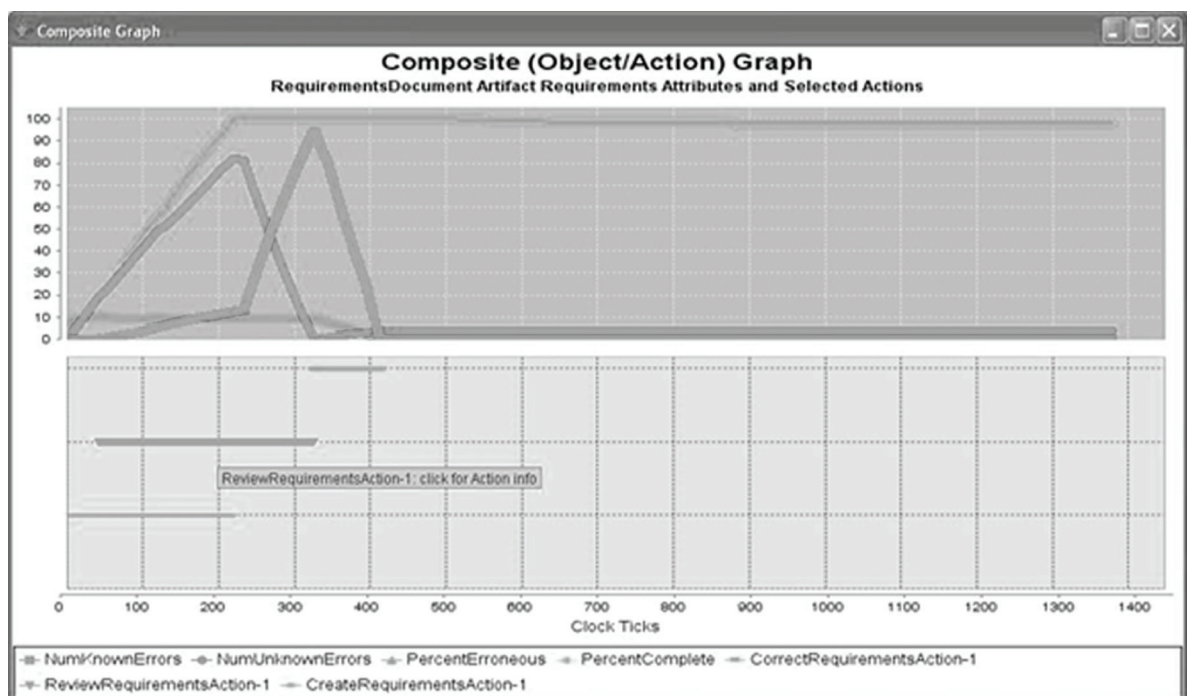


Figure 2. Graphical representation of a SimSE Game, generated by the explanatory tool



engineering processes. The constraints of the academic environment prevent students from having the opportunity to practice many issues surrounding the software engineering process in their course projects. Our approach therefore focused on providing this opportunity through the use of simulation.

To guide us in the design of SimSE, we performed two activities: (1) a study of the domain of software engineering education to discover what its unique needs are, and (2) a survey of well-known principles for successful educational simulations from the research literature. The result of this was a specific set of key decisions that are listed here and discussed in light of the learning theory (or theories) that we later discovered related directly to them:

1. **Use of the game paradigm.** We could have chosen to base our simulation approach on the industrial simulation or group process simulation paradigms mentioned previously, but instead we chose the game paradigm. It has been shown that game-like features such as graphics, interactivity, surprising random events, and interesting, life-like challenges are known to hold a student's attention and promote a feeling of confidence and satisfaction as they succeed in the game (Ferrari *et al.*, 1999). This directly corresponds to the Keller's ARCS theory, which suggests that such qualities promote a highly effective learning experience.
2. **A fully-graphical user interface.** To make SimSE maximally engaging and visually realistic, we chose to design a fully graphical, rather than textual interface. As was shown in Figure 1, the focal point of this interface is a typical office layout in which the simulated process is "taking place", including cubicles, desks, chairs, computers, and employees who "talk" to the player through pop-up speech bubbles over their heads. In addition, graphical representations of all artifacts,

tools, customers, and projects along with the status of each of these objects are visible. This decision to graphically portray simulated software engineering situations turned out to be strongly in line with the theory of Situated Learning—the learner is provided with a visual context that corresponds to the real world situations in which the learned knowledge would typically be used.

3. **A high level of interactivity.** Keeping the attention of the learner engaged is not only done by making a user interface visually appealing, but also by continuously involving the learner. Thus, rather than designing SimSE as a continuous simulation that simply takes an initial set of inputs and produces some predictive results, we designed it in such a way that the player must make decisions and steer the simulation accordingly throughout the entire process. SimSE operates on a step-by-step, clock tick basis, and every clock tick the player has the opportunity to perform actions that affect the simulation. Keeping the learner continuously engaged and giving them ample opportunity to practice their skills and tackle challenges are tactics suggested by the Keller's ARCS theory for promoting attention, relevance, confidence, and satisfaction.
4. **Customizable simulation models.** SimSE includes a model builder tool and associated modeling approach that allow an instructor to build simulation models and generate customized games based on these models. This feature adds the (unanticipated) potential for using SimSE in a way that follows the theory of Elaboration—instructors could build models of varying complexity and use them in order of increasing complexity with students. Although we have not yet built such models with SimSE, it is in our future plans to do so, as we now know that this potential for greater effectiveness is there.

5. **An explanatory tool.** An integral part of SimSE is its novel explanatory tool that provides players with a visual representation of how the simulated process progressed over time and explanations of the rules underlying the game. This feature promotes Learning through Reflection as it allows players to look back on their game and analyze their decisions and how those decisions affected the outcome. The explanatory tool output could also potentially be used as the focal point of a dialogue session between student and tutor/instructor.
6. **Complementary usage of SimSE.** Rather than design SimSE to be a standalone tool meant to replace standard course components such as lectures, readings, and projects, we instead designed it to be used complementary to them, and have used it in such a setting. The simulation models we have built require a basic set of knowledge and skills in order to play and learn from them effectively, knowledge that students conceivably obtain in lectures and readings. Thus, in essence, SimSE allows them to “Learn by Doing” by learning through experience the lessons communicated through reading and lectures, as well as other lessons that are simply not adequately teachable through passive means. Linking the knowledge learned in SimSE to existing knowledge also promotes the feeling that what a student is learning is of relevance to them, a major tenet of Keller’s ARCS.
7. **Simulation models that provide a clear goal.** SimSE allows the modeler to compose a “starting narrative” for the player that appears at the start of a game, and to which the player can refer back at any time during a game. In the models we have built, we have used this starting narrative to provide the player with the exact goals of the simulation, criteria for completion of these goals, and any hints or special notes that might

help them along the way. Precisely defined objectives not only guide students through a simulation, but also pose a challenge that many students find hard to resist. Achieving the goal becomes a priority and Discovery Learning is employed as creative thinking is sparked in coming to an approach that eventually achieves that goal.

8. **Simulation models that are adequately challenging.** We have built into our simulation models interesting situations that are adequately challenging (engaging students’ attention and making it likely that they learn through failure at times) but not impossible, promoting eventual success that leads to confidence in the learning material and satisfaction in the experience (central principles to Keller’s ARCS).

Looking back on the design of SimSE in light of learning theories served to link some of our intuition in the design of SimSE to these theories, thereby increasing our confidence of being on the right path with our approach. In addition to this, it also revealed some missed opportunities that we could have taken advantage of, had we originally designed SimSE with learning theories in mind. For example, we could have better taken advantage of the Elaboration theory by designing our models in incrementally complex versions, and introducing them to students in order of increasing complexity. In our usage of SimSE in courses and in out-of-class studies, we also could have made reflection a more central and structured part of the approach by providing the student with explicit explanatory tool exercises to complete, exercises that would encourage the type of reflection that would help solidify the lessons learned in the simulation (currently, the student is simply given the explanatory tool, and decisions about how to use it are left up to them). As another example, we could have better incorporated aspects of authenticity (promoting Situated Learning) by including more random events (a characterizing

feature of the real world) in our models. These types of events are only used sparingly in many of our models.

Like most software engineering educational approaches, SimSE was not designed with learning theories in mind. However, by looking back on its design in light of learning theories, we have learned a great deal about how SimSE promotes learning and how it can be improved to foster greater learning, as we have seen in this section.

LEARNING THEORY-CENTRIC EVALUATION

Although we did not explicitly use learning theories in SimSE's initial design, we did use them as a central guiding factor in designing a major part of its evaluation. Validating that the theories an approach was designed to employ (or appear to employ) are *actually* employed, as well as discovering if an approach incorporates aspects of any additional theories, can be highly useful exercises—such data can be used to make that and other similar approaches more effective as they are tailored to exploit the characteristics known to promote each theory (van Eck, 2006). Thus, as part of SimSE's evaluation, we performed an in-depth observational study that focused on investigating the learning processes of SimSE players to determine whether they exhibited behaviors indicative of various learning theories.

Case Study: SimSE Evaluation Setup

For this study, we used as subjects 11 undergraduate students who had passed the introductory software engineering course at the University of California, Irvine. This requirement was put in place so that they would have at least the basic understanding of software engineering concepts required to play SimSE. The study occurred in a one-on-one setting—one subject and one observer. Each subject was first given instruction on how

to play SimSE, and was then observed playing SimSE for about 2.5 hours. In order to evaluate how well the explanatory tool achieves its goal of aiding Learning through Reflection, we had eight students play SimSE with the explanatory tool and three without. (Differences in the behavior, attitudes, and opinions of each group could then be compared, though clearly, not to the extent of being statistically significant.) While subjects were playing, their game play and behavior were observed and noted. Following this, the subject was interviewed about their experience for about 30 minutes. In addition to any spontaneous questions the observer formulated based on a particular subject's actions or behavior during game play, all subjects were asked a set of standard questions. Several of these questions were designed to specifically detect the presence of one or more learning theories in the subject's learning process. Some questions did not target a particular theory or set of theories, but were instead meant to evoke insightful comments from the subject from which various learning theories could be inferred, and from which general insights into the learning process could be discovered. Some samples from the standard set of questions are listed here, with the targeted learning theory (or theories) listed in parentheses afterwards when applicable.

- *To what do you attribute the change (or lack of) (improvement, worsening, fluctuation, steady state) of your score with each game?* (Discovery Learning, Learning through Failure)
- *Do you feel you learned more when you “won” or when you “lost”? Why? What did you learn from each “win” or “loss”?* (Discovery Learning, Learning through Failure)
- *When you lost, did you feel motivated to try again or not? Why?* (Learning through Failure)

- *On a scale of 1 to 5, how much did playing SimSE engage your attention? Why? (Keller's ARCS)*
- *How much has your level of confidence changed in the learning material since completing this exercise? (Keller's ARCS)*
- *Did you feel that you learned any new software process concepts from playing SimSE that you did not know before? If so, which ones? (answer could be indicative of multiple theories)*
- *If you feel you learned from SimSE, what do you believe it is about SimSE that facilitated your learning? (answer could be indicative of multiple theories)*

There were also some questions primarily designed for comparison between the subjects who used the explanatory tool and those who did not. These questions were aimed at discovering how the player went about figuring out the reasoning behind their scores, as well as how well they understood this reasoning.

- *Where do you think you went wrong in game 1/2/x? (Learning through Reflection)*
- *Please describe the process that you followed to figure out the reasoning behind your score, or where you went wrong/right. (Learning through Reflection)*

Following the experiment, the interviewer's observations and interview notes were analyzed to try to discover which behaviors and comments were indicative of the various learning theories, and how, as well as to discover any other insights about SimSE as a teaching tool that could be gained from this data.

Evaluation Results

The learning theory that was most clearly involved in every subject's learning process was Discovery Learning. All subjects were able to recount at least

a few lessons they learned from SimSE, and none of these lessons were ever told to them explicitly during their experience. Rather, they discovered them independently through exploration and experimentation within the game. Interestingly, although all subjects that played a model seemed to discover the same lessons (for the most part), no two subjects discovered them in the same way. Every subject approached the game with a different strategy, but came away with similar new knowledge, suggesting that SimSE can be applicable to a wide range of students that come from different backgrounds with different ideas and possibly, different learning styles. This is a central aspect of a student-centered theory like Discovery Learning. Since learning depends primarily on the learner and not the instructor, the learner is free to use their own style and ideas in discovering the knowledge, rather than being forced to adhere to a rigid style of instruction.

Learning through Failure also seemed to be widely evident. Every subject seemed to take a "divide and conquer" approach to playing SimSE, isolating aspects of the model and tackling them individually (or a few at a time). When subjects described the progression of their games in the interviews, it was clear that the way they conquered each aspect was by going through at least one or two rounds of failure in which they discovered what *not* to do, and from this discovering a correct approach that lead to success. When asked explicitly about learning through failure, every subject stated that they learned when they failed, but the amount of learning they reported varied. Five subjects said they learned more from failure than success, two subjects said they learned more when they succeeded, and four subjects said they learned equally as much from failure and success. All but one subject said that they were motivated to try again after they failed. This motivation was also evident in the behavior of several subjects, as some, after the completion of one failed game, hurriedly and eagerly started a new one. One subject even tried to start a new game when the

time for the game play portion of the experiment was up and he was already informed that it would be the last game.

The Learning by Doing theory seemed to be involved in most of the subjects' learning experience. Eight out of the 11 subjects made comments about their experience playing SimSE that hinted at aspects of Learning by Doing. Some of their comments included:

- “[SimSE helped me learn because it] *puts you in charge of things. It's a good way of applying your knowledge.*”
- “[SimSE helped me learn because it is] *interactive, not just sitting down and listening to something.*”

Comments indicative of Situated Learning were also rather frequent, mentioned by seven out of the 11 subjects. Some of these included:

- “[SimSE helped me learn because] *it was very realistic and helped me learn a lot of realistic elements of software engineering, such as employees, budget, time, and surprising events.*”
- “[One of the learning-facilitating characteristics of SimSE was] *seeing a real-life project in action with realistic factors like employee backgrounds and dialogues.*”

Behaviors and comments suggestive of Keller's ARCS Motivation Theory were also evident, although certain aspects of the theory came out stronger than others. To explain, let us look at the four aspects of the theory (attention, relevance, confidence, and satisfaction) individually.

First, the attention of the subjects seemed to be quite engaged with SimSE. This was evident in their body language, the comments made both during game play and the interview, and their ratings of SimSE's level of engagement. Many of them spent the majority of their time during game play sitting on the edge of their seats, leaning forward

and fixing their eyes on the screen. There were head nods, chuckles in response to random events and character descriptions, shouts of “Woo hoo!” after achieving a high score in a game, shaking of the head when things were not going so well for a player, and requests of, “Can I try this one more time?” when the experiment's allotted time for game play was coming to an end. Words some subjects used to describe SimSE in the interview were “challenging”, “fun”, “interesting”, “addictive”, and “amusing.” When explicitly asked how much SimSE engaged their attention, the students rated it quite high—4.1 on average out of five.

Second, relevance was rated moderately high, but not as high as level of engagement. Five of the subjects rated SimSE's relevance to their future experiences as “pretty relevant” or “very relevant”, five described it as “somewhat” or “partially” relevant and one said it was not relevant at all. Although not explicitly asked about SimSE's relevance to their past experiences, nearly all of the subjects mentioned that they used some of the knowledge they had learned in software engineering courses to come up with their strategies for playing the game, suggesting that there is also a relevance between their past experiences (learning the concepts in class) and their learning experience with SimSE.

Third, most subjects felt their level of confidence in the learning material (the software process model simulated and software process in general) had increased at least somewhat since playing SimSE. Four subjects reported their level of confidence had changed “a lot” or “very much”, five said it had changed “somewhat”, and two said it had not changed at all.

Fourth, satisfaction was rated quite high by the subjects. Nine out of the 11 subjects reported that they were “quite satisfied”, “very satisfied”, “fully satisfied”, or “pretty satisfied”, and three subjects stated they were “somewhat satisfied.” Most of the reported factors that contributed to a feeling of satisfaction pertained to a subject's increasing success from game to game, although some also

mentioned that the sheer fun and challenge of SimSE contributed to their satisfaction as well.

The explanatory tool did seem to promote Learning through Reflection, to some extent. Most of the subjects that had access to the explanatory tool did make use of it, the duration of its use after most games ranging from five to 25 minutes. It was obvious that the subjects who did not have the explanatory tool (to whom we will henceforth refer as “non-explanatory subjects”) were significantly more confused and less confident about the reasoning behind their scores and how to improve than those who did have the explanatory tool (to whom we will henceforth refer as “explanatory subjects”). All of the non-explanatory subjects expressed this, while only one explanatory subject stated such an opinion. The following are some of the comments made by the non-explanatory subjects:

- *“I was trying to guess what I was doing wrong, so I probably chose the wrong areas that I was doing wrong, and then I tried to switch back to my original way and then I kind of forgot what that was and once I started trying to improve it, all of my little details started changing and I didn’t know what parts were causing my score to go lower.”*
- *“I felt like I knew, oh, that’s where I went wrong sometimes, like I should spend a little less time there, but a lot of times I was wrong about where it was I went wrong.”*

On the other hand, most of the explanatory subjects’ comments expressed that the explanatory tool did, indeed facilitate their learning:

- *“[The explanatory tool] showed me why I was doing poorly—because of certain events that were happening.”*
- *“The rules [described in the explanatory tool] are really helpful—even if someone doesn’t know anything about software en-*

gineering I think the rules can teach you how to play the game.”

Implications of Evaluation Results

Evaluating SimSE in terms of learning theories provided us with several valuable insights into how SimSE helps students learn. In addition, it also helped us to discover ways to potentially make SimSE more effective. In this subsection, we describe how focusing on some of the theories in our evaluation provided us with knowledge that will help us maximize SimSE’s effectiveness.

Learning through failure: Overall, the challenge of receiving a “failing” score and trying to improve it seemed to be a significant avenue of learning and a strong motivating factor of SimSE. This reinforced our notion that simulation models should be made challenging enough that students are set up to fail at times. It is these failures that provide some of the greatest opportunities for learning. By focusing on this aspect in our observations, we also discovered that one of our models (Rapid Prototyping) was not quite challenging enough, and students could sometimes get a good score without really learning the lessons. Thus, we have since added more challenges to this model, and will continue to build simulation models in the future that have an adequate level of challenge.

Learning by doing: Several of the subjects’ comments mentioned the ability to put previously learned knowledge into practice as a learning-facilitating characteristic of SimSE. This validates our choice to use SimSE complementary to other teaching methods, so that it can fulfill this important role of being an avenue through which students can employ Learning by Doing as they do the things they only heard about in class.

Situated learning: The realistic elements in SimSE seem to add significantly to its educational effectiveness. Thus, it is important that we continue to include elements of the real world in our models, in order to situate students’ knowledge in a realistic environment.

Elaboration: It became clear from our observations that one of our models (waterfall) is much too large and complex for a “SimSE beginner.” (Although the waterfall process is a simple one, the corresponding SimSE model is quite complicated, incorporating several non-technical, managerial aspects.) By giving such a complex model to a student who has never played SimSE before, we were clearly violating the principles of the elaboration theory. Thus, viewing this result in light of that theory taught us that such a model should not be introduced until the student has played other, simpler models first.

Keller’s ARCS: Through this study we were able to discover what elements of SimSE and its models best hold students’ attention by noting when students appeared to be most engaged, and what kinds of things they commented about favorably in the interviews. For example, several students mentioned that the random events in the models (e.g., the customer changing their mind and requiring the team to rework part of the code) added an element of surprise and realism that kept things entertaining. Thus, we will continue to build these elements into our future models, as well as try to maximize them in our current models. We also discovered which elements students found un-engaging. For instance, several subjects thought the inspection model was boring and repetitive. Through the interviews, we were able to detect exactly what it was about the inspection model that made it this way, and have recently implemented changes that we anticipate will make it more interesting for future SimSE players.

Learning through reflection: The explanatory tool partially fulfills its goal of facilitating reflection, but it is clear that it needs to be improved. In particular, more help needs to be given to the user in generating meaningful, useful graphs, and the rule descriptions need to be more easily accessible. We have recently addressed these issues in our development by adding attributes to each model that are meant specifically for explanatory

graphing purposes and by making the rule descriptions more accessible through the user interface.

Learning theories can help structure evaluations by providing ideas about what the researcher should be looking for in the learning processes of students. As we have seen with SimSE, this can be done even if the approach was not designed with learning theories in mind. A careful retro-analysis of the approach’s design in terms of learning theories can reveal the aspects that a learning theory-centric evaluation should focus on. Conducting such an evaluation has the potential to both reveal the effectiveness of an approach, as well as guide future work in the area.

Certainly, not every aspect of an approach can be evaluated this way—an evaluation focused on learning theories should only be one part of an evaluation plan. In addition to the evaluation described here, SimSE’s evaluation plan also included a pilot study, a comparative study, and in-class studies, each of which was designed to evaluate different aspects of SimSE to form a comprehensive picture of its ability as a teaching tool (see (Navarro & van der Hoek, 2007) for more information about these studies).

SUMMARY

Learning theories are an important educational resource of which the software engineering educational community has not yet taken full advantage. Learning theories can be used to categorize, design, evaluate, and communicate about software engineering educational approaches, providing a structured and informed way to move our domain forward with approaches that are effective and well-understood. We have shown one example of applying learning theories to software engineering education in our analysis and evaluation of SimSE. It is our hope that educators can take this example and apply it to other approaches and areas of software engineering education to create

more effective teaching strategies that are rooted in educational theory.

MORE INFORMATION

More information about SimSE, including downloads, evaluations, and publications, are available at <http://www.ics.uci.edu/~emilyo/SimSE/>.

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Chapter 7.10

Theoretical and Instructional Aspects of Learning with Visualizations

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ABSTRACT

Multimedia environments consist of verbal and visual representations that, if appropriately processed, allow for the construction of an integrated mental model of the content. Whereas much is known on how students learn from verbal representations, there are fewer insights regarding the processing of visual information, alone or in conjunction with text. This chapter uses a semiotics approach to provide a definition of visualizations as a specific form of external representation, and then discusses the differences between verbal and visual representations in how they represent information. Finally, it discusses how meaning is achieved when learning with them. The next section discusses basic perceptual and cognitive

processes relevant to learning with visualizations. This background is used to specify the instructional functions that visualizations have either as self-contained instructional messages or as text adjuncts. Moreover, the role of individual differences in processing visualizations is highlighted. The chapter ends with methodological suggestions concerning the important role of interdisciplinary research and assessment methods in this area.

INTRODUCTION

Visualizations constitute a key component in multimedia-based instruction, which can be defined as learning from text and pictures (e.g., Mayer, 2005). Despite the fact that visualizations are used more and more frequently in informal and formal educational settings, not much is

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understood about their semiotic properties, how humans process them, and how they can be best designed to learn from. In educational research, visualizations are often treated in a uniform manner, despite the fact that the visualizations might serve vastly different functions depending on the audience and goals. Just as bad, visualizations are treated as functionally equivalent to text. As a consequence, reviews on learning with visualizations are equivocal, with studies showing widely varying effects (negative to positive) on learning. In the current chapter, we will try to provide a more differentiated view by first reviewing the literature from different disciplinary perspectives (education, semiotics, perception, and cognition) to characterize different types of visualizations, to distinguish them from verbal representations, and to describe how information is derived from them. This approach will attempt to provide a unique approach to addressing the question of when and why visualizations are effective for learning. After some summarizing remarks, directions for future research will be outlined in the final section of this chapter. It is important to note, however, that we will not review the more mainstream literature on the effectiveness of learning with visualizations, as comprehensive reviews can be found elsewhere (e.g., Anglin, Vaez, & Cunningham, 2004; Rieber, 1994).

BACKGROUND

What are Visualizations?

Visualizations are a specific form of external representation that are intended to communicate information by using a visuo-spatial layout of this information and that are processed in the visual sensory system. According to Rieber (1990, p. 45) “visualization is defined as representations of information consisting of spatial, nonarbitrary (i.e. “picture-like” qualities resembling actual objects or events), and continuous (i.e., an “all-in-

oneness” quality) characteristics”. Visualizations are often best understood through the context of their use (MacEachren & Kraak, 1997). In as much as visualizations are created to communicate in a learning or problem-solving context, these visualizations are typically based on models and leverage human perceptual and cognitive abilities to efficiently and effectively convey information (Gilbert, 2005). The model and its use in the context of the visualization then drive particulars of the visualization—from the visual metaphors employed to the dynamic characteristics of elements (Bertoline & Wiebe, 2003).

External representations such as visualizations are defined with regard to their relation to the real world. “The nature of representation is that there exists a correspondence (mapping) from objects in the represented world to objects in the representing world such that at least some relations in the represented world are structurally preserved in the representing world” (Palmer, 1978, p. 266). Thus, a representation is defined through its structural correspondence to what it stands for (i.e., the referent) and is hence analogical to the referent. By means of this analogy, representations can act as a substitute for the referent and evoke similar responses as the real-world referent. Semiotics is an approach that can be used to more rigorously analyze the relationship between the signs that make up a visualization, the underlying intended instructional message of the visualization, and the learning task context in which the visualizations are being employed.

Using semiotics as a methodology, visualizations can be understood and organized in ways that better guides their creation and intended use. Peirce (1960) identified three forms of relations between the representation and the represented object: an *icon* resembles the object it depicts in terms of its criterial attributes in a given context. Criterial attributes are properties of the object that “act as discriminanda for sorting and resorting the objects in the perceptual world” (Knowlton, 1966, p. 162). An *index* refers to its object by

means of a physical connection to it (e.g., a footprint as a representation of a bear). A *symbol* (or digital sign, according to Knowlton, 1966) bears no resemblance to what it stands for and is thus arbitrary (e.g., words, numbers). Knowlton (1966) further distinguishes between realistic pictures, analogical pictures, and logical pictures.

Realistic pictures resemble their referents by means of physical similarity (e.g., a picture of a tree looks like a tree we see with our eyes). This similarity is achieved by copying the real-world referent with respect to shape, details, color, or motion. From a semiotics perspective, there are at least three problems associated with the labeling of this category of visualizations. First, constructivists like Gombrich (1969) have proposed that what people perceive as being realistic in a picture is strongly affected by their preconceptions of how a representation of the real-world object should look like. Second, realistic pictures may vary largely with regard to the level of realistic detail, which is why Alessandrini (1987) suggested calling this type of pictures ‘representational’ rather than ‘realistic’. The third problem with this labeling is that it does not help distinguishing the first from the second visualization category, namely analogical pictures.

Analogical pictures may seem realistic in the sense that the depicted objects look alike to something known from the phenomenal world. However, analogical pictures “make reference to something else – something that is in some way analogous to the portrayed object or to its manner of functioning” (Knowlton, 1966, p. 176). Thus, the objects depicted in the visualization refer to entities that are different from entities that they resemble (e.g., two lumberjacks moving a felled tree as an analogous picture for muscles moving a bone). Resemblance to the referent is established solely through functional similarity or structural correspondence. Whereas realistic pictures can be used to represent the phenomenal world only, “analogical pictures can represent either the phenomenal or nonphenomenal world.

In both cases, this is done through the bridge of the ‘visual’ phenomenal world” (Knowlton, 1966, p. 177). Accordingly, these pictures can represent abstract concepts, albeit not directly; rather, “they can be illustrated indirectly by showing their effects on visible objects, tangible results, specific instances, or concrete exemplars” (Alessandrini, 1987, p. 176).

Logical pictures can be thought of as highly schematized pictures, where the elements of the picture do not bear any physical resemblance to objects in the phenomenal world and are thus arbitrary (*cf.* arbitrary pictures, Alessandrini, 1987; Rieber, 1994). Accordingly, one might argue that logical pictures are symbols rather than icons. On the other hand, logical pictures, like analogical pictures, preserve the structural interrelations between these referents. Examples of logical pictures are depictions of things that are potentially visible, but where we do not know how they look like (e.g., atoms) or of things that do not exist in any tangible way (e.g., a mathematical proof). Moreover, the term logical (or arbitrary) picture is used to describe charts, diagrams, and graphs, because here the spatial layout is used to convey information on conceptual relationships. Logical may be the better term in this case since conventions for the design and layout of charts, diagrams, and graphs are often far from what would typically be considered arbitrary (Bertin, 1983).

Semiotic taxonomies like the one by Knowlton (1966) have been largely neglected in educational research (Anglin et al., 2004), although they may be very relevant to the research and development of visualizations. Research on learning with visualizations has often made generalizations across a wide range of types, which have led to the misuse of multimedia principles (Mayer, 2005). Moreover, visualizations have been incorporated in instruction with the assumption that they behave the same as verbal representations. While both text and graphics can be scrutinized through semiotic analysis, they are truly unique sign systems with

differing strengths and weaknesses in communicating referents.

How Do Visual Representations Differ from Verbal Representations?

The properties that make visualizations different from verbal representations have been discussed in various disciplines. Differences between the two representational formats pertain to three aspects: (1) the features of the external representation, (2) the external representation's relation to the represented world, and (3) the relation between the external and the internal representation (i.e., the representation's meaning).

Features of the Representational Formats

Modularity. Kosslyn (1994) has suggested that verbal and pictorial representations differ with regard to their modularity. Verbal representations can be broken down in small, discrete symbols (i.e., letters), however breaking down letters into even smaller parts will not yield meaningful pieces. On the other hand, there is no discrete unit for visualizations, because they can be arbitrarily broken down in multiple ways and still yield potentially meaningful patterns.

Sequentiality. Visualizations comprise spatial relations to represent information in a two- or three-dimensional structure. Linguistic information, on the other hand, is presented in a purely sequential manner (Larkin & Simon, 1987).

Modality. Verbal representations are amodal, in that information extraction is not linked to a specific perceptual modality. That is, verbal information can be processed by the auditory system, the visual system, or even by the haptic system. On the other hand, the processing of visual representations is strongly associated with the visual modality.

The Relation between the External Representation and the Represented World

Arbitrariness. Verbal representations are said to be arbitrary in the sense that there is no inherent reason for why the word “house” denotes the thing we live in, for instance. Rather, the object could be represented by any given arrangement of letters or phonemes if a culture agreed on this. On the other hand, most visualizations are non-arbitrary in that the representation and the represented world are linked to each other by means of inherent structural correspondences or even by physical resemblance.

Notationality. In verbal representations, distinct elements are linked to real-world elements in an unambiguous and explicit way, thereby determining the semantics of the representational elements (Goodman, 1976). Moreover, for every language there are explicit rules telling us how to combine words to sentences or how to express temporal relationships, thereby determining the syntax of the representation. Goodman calls this the notationality of a representational system, which denotes the “degree to which the elements of a symbol system are distinct and are combined according to precise rules” (Anglin et al., 2004, p. 870). Visual representations are far less explicit in terms of their semantics, whereby these elements can be represented in many different ways and still be recognized, as long as the structural relations are preserved. Nevertheless, in semiotic theory there have been attempts to determine the regularities of visualizations and, therefore, to identify their underlying syntax (Kress & van Leeuwen, 1996). Logical pictures may lend themselves best to this approach since they are often notational in that there are distinct elements arranged according to specific rules or conventions (Tversky, 2003).

Parsimony. The famous saying “a picture may be sometimes worth 10,000 words” suggests that it sometimes takes 10,000 words to express

what can be depicted in a picture with markedly fewer symbols. One reason for this parsimony is that spatial relations of objects are automatically implied in a picture and thus do not require any additional symbols, whereas in verbal representations spatial arrangements need to be made explicit (e.g., x is positioned above and to the right of y). According to Kosslyn (1994) visualizations are more complete than verbal representations in that they deliver information on all possible details of the object (e.g., its shape, size etc.) that is being represented through them.

Expressiveness. Contrary to verbal expressions, visualizations have limited power for expressing logical and temporal relations as well as abstractions (Maybury, 1995). For instance, to represent the concept “animal” it would not be very helpful to show a dog or a cat, as these would be interpreted as standing for the concrete animal, but not for the superordinate category. Knowlton (1966), however, notes “that it may be possible to suggest a concept with an iconic sign, depending, in part, on its level of realism” (p. 167). Accordingly, Schwartz (1995) demonstrated that realistic visualizations made people think more about the concrete referent of the depiction. On the other hand, schematized visualizations facilitated abstract reasoning and symbolic interpretations of the represented objects (DeLoache, 1995; Goldstone & Son, 2005; Schwartz, 1995).

Specificity. According to Stenning and Oberlander (1994) and Bernsen (1994), visualizations can be characterized by their higher specificity compared to verbal representations. That is, while language can be interpreted in multiple ways, thereby corresponding to multiple possible represented worlds, visualizations are often more constrained in that respect and reduce the number of possible worlds that can be represented through them (*cf.* graphical constraining, Scaife & Rogers, 1996).

The Relationship between Internal and External Representations

Conventionalism. The meaning of a verbal representation (i.e., what it stands for or what it signifies) is established through convention or cultural agreement. This is why Palmer (1978) referred to verbal representations as extrinsic representations, where meaning is imposed onto the representation from the outside. The meaning of the visualization is intrinsic to the representation as it is constructed based on the properties of the objects that it represents; thus, its meaning is derived from these inherent characteristics. Whereas these structural correspondences can potentially be expressed in very many ways, for some visualization forms there are established cultural rules as to how to represent the structural features of the real world, thereby constraining the multitude of options (*cf.* Gombrich, 1969; Kosslyn, 1994). As outlined before, this is particularly true for logical pictures (Tversky, 2003).

Interpretation and Reasoning. When being confronted with a verbal expression for the first time (e.g., as a child or as a second-language learner) we will not understand this expression unless we are explicitly told its meaning. Realistic visualizations, on the other hand, can be intuitively understood without making the link to the real-world referent explicit. This is even true for babies who lack experience with external representations (DeLoache, 1995; Hochberg & Brooks, 1962). Gibson (1979) has argued that this is because realistic visualizations result in optical arrays similar to those when looking at their real-world referents. Hence, information “can be directly picked up without the mediation of memory, inference, deliberation, or any other mental processes that involve internal representation” (Zhang, 1997, p. 181). Similarly, other researchers have suggested that visualizations may support inference and reasoning processes grounded in perception (Goldstone & Son, 2005;

Schwartz, 1995; Stenning & Oberlander, 1994), allowing perceptual judgments to substitute for more demanding logical inferences. While these arguments are evident for realistic or representational visualizations (Alessandrini, 1987; Knowlton, 1966), logical pictures may also have specific cognitive processing benefits compared to verbal representations. Larkin and Simon (1987) have suggested that diagrammatic visualizations are often more computationally efficient for accomplishing tasks that require the processing of visuo-spatial properties (*cf.* cognitive offloading, Scaife & Rogers, 1996). In particular, visualizations reduce the need of searching for multiple information elements related to a single idea because this information is grouped (chunked) in visualizations. Thus, in visualizations related information can be processed in parallel (to a certain extent), rather than sequentially.

Internal representation. Verbal and visual representations differ in their dominant internal representation formed in long-term memory. Whereas verbal descriptions are associated with the construction of a propositional representation, non-verbal formats like visualizations are more likely to be encoded and stored as analogical representations (Kosslyn, 1994; Paivio, 1991). According to Paivio, these two internal representations are interconnected by referential links so that they can activate each other (e.g., the word “apple” activating the mental image of an apple tree). It is important to note that words and visualizations may, in principle, both yield a propositional representation as well as an analogical representation (e.g., through construction of a mental image for concrete words). The so called picture-superiority effect (i.e., better recall for pictorial than verbal information) is explained by assuming that this dual coding of information based on a single input representation is more likely to occur for pictures than for words. The picture-superiority effect can also be explained by Baggett’s *bushiness hypothesis* (e.g., Baggett, 1984). It states that knowledge acquired from

visual rather than verbal external representations will be better accessible in memory because the respective nodes in memory share more associations with other nodes in the semantic network. Thus, visual concepts are assumed to be “bushier” than verbal concepts and, therefore, more salient in memory.

Bernsen (1994) mentions a number of mechanisms that help to overcome inherent weaknesses of the two representational formats, such as *focusing mechanisms* in graphics and *specificity mechanisms* in language. Thanks to focusing mechanisms (e.g., selective removal of specificity, highlighting, selective enlargement), analogous visualizations come closer to the strengths of a natural language. Thanks to specificity mechanisms in language (summaries, key points, usage of metaphor and analogy), language comes closer to the strengths of an analogous representation. Even with these mechanisms being present, visual and verbal representations will differ on a variety of dimensions, which naturally affects the way they are processed during multimedia learning. While there are elaborated models of text comprehension, no comprehensive models exist for the processing of complex visual information. In the following section, some pivotal concepts of visual perception are described as they are relevant to multimedia instruction.

Processing of Visualizations

While the research traditions in understanding text and graphic representations are equally rich, visual perception has been less well represented in educational research. Understanding the perceptual and cognitive processing of graphics is crucial to understanding the differences between text and graphic representations and how to most effectively design visualizations.

The processing of visualizations for learning and problem-solving can be understood in the context of information processing theory and, more specifically, multiple resource theory (Wickens,

2002). Using this approach, the processing of visual images contains both perceptual and cognitive elements, each of which require their own resources. In addition, there will also be resources dedicated to overarching, executive functions, guided by both short-term and long-term goals (i.e., the task). While earlier information processing models were often depicted as consisting of a number of distinct stages and functions, multiple resource theory recognizes that mental functions differ both in terms of the amount of resources required and the degree of resource overlap with other functions. Common to information processing theory, resources related to both sensory buffers and short term memory are finite while long term memory resources can be considered essentially infinite. It is the resource-limiting nature of sensory and short term memory and the ability (or lack thereof) to access relevant long term memory resources that informs much of the research in multimedia instructional design (Mayer, 2005; Sweller, van Merriënboer, & Paas, 1998).

It is useful to think of perception unique from cognition (Hochberg, 1978; Zhang, 1997). Perception can be operationally defined as those (visual) mental functions that do not require access to long-term memory. These, then, are abilities common to the normal adult and adolescent population and can be assumed when designing visual representations. Perception, therefore, involves basic processes such as discrimination based on visual properties of color, shape, texture, and orientation, form recognition and spatial arrangement.

Within perception, there is both ambient and focal vision, with the difference largely based on attention (Wickens, 2002). In terms of resources, attention is an executive function that allocates resources to processing information received by the sensory buffers. Some perceptual functions—including peripheral vision—make use of low-level processing capabilities in the brain that require little or no resources (i.e., pre-attentive or automatic processes). These ambient perceptual capabilities include supporting much of everyday

functions such as basic hand-eye motor skills or locomotion through space. All perceptual processes are actively involved in sense-making. These low level ambient functions will attempt to organize a scene as three-dimensional space, segregating foreground and background elements and determining whether these elements lie in discrete locations in depth (e.g., a planar surface) or as a continuous three-dimensional form. Elements will be grouped based on visual properties and their spatial relation to each other. While some of these properties, such as color, are pre-attentive, others (e.g., shape) may require additional attentive processing (Treisman & Gelade, 1980). The Gestalt principles of configuration are some the best known examples of active perceptual organization of a scene (Rock & Palmer, 1990). These ambient processes can be seen at work initially organizing visual information used in multimedia instruction.

Focal vision requires attention and thus more resources than ambient vision. Focal vision will make use of both bottom-up information gathered from ambient vision and top-down information provided by both ongoing focal viewing and higher level cognitive processing. Ambient visual function may provide the “gist” of a scene whereby focal vision then attends to elements initially deemed as interesting, unusual or important. Ongoing processing of this scene then guides focused vision. In addition to information being passed from ambient vision to focused vision functions, information processed at this next level may be processed further and passed to long term memory. Eye movement research informs our understanding of this ongoing process (*cf.* Henderson, 1992). While our conscious perception of a scene is of a single, unified, stable image, the underlying eye movements reveal constant saccadic movement, sampling various portions of the scene to varying degrees. The brain, employing both ambient and focal vision, engages in both real-time, transient and longer-term meaning making of what is re-

ceived in the sensory buffers and creates the sense of a stable, meaningful scene.

Cognition, in this context, can be thought of those resource-driven processes that require long-term memory. For example, viewing a photograph of a lion, perception would be able to separate the lion from the surrounding background, use shading and perspective convergence to mentally orient it's three-dimensional shape in space. Prior knowledge would, however, be needed to know that this form was a lion. Further knowledge would be needed to know whether this lion was male or female, and still further specialized knowledge might allow you to use visual cues to discern the approximate age of the lion. In the context of learning, the difference between perceptual and cognitive functions becomes very important. While most perceptual capabilities can be assumed to be universally present in a population, cognitive capabilities may be much more varied (Mayer & Massa, 2003; Siegler & Alibali, 2005). While all of the students in a sixth grade classroom may know that the photograph is of a lion, they may not all know its sex or approximate age. What is important is which of these elements of prior knowledge is important for the learning task and/or whether these elements are what you hope the student will learn about. Prior knowledge is equally important with analogical or logical images, where the visual sign element must be mapped to its referent in memory. Improper scaffolding may leave a student at a lower level of processing, where the image seen is just a "red triangle" and not, say, a representation of a key biological molecule used in DNA replication (Patrick, Carter, & Wiebe, 2006).

The movement of visual information from sensory buffers to short term memory and then possibly to long term memory establishes a number of points of possible failure to encode into schemas information necessary for a learning task. Low level visual information that cannot be apprehended because it is too small or does not possess enough contrast to be segregated

from surrounding elements cannot be used as part of higher level visual processing. Similarly, elements that meet the requirements of low level apprehension may still not be further processed because attention has not directed the necessary resources to this visual information; the information is not rehearsed in short term memory and not integrated into long-term memory. Finally, visual information in long term memory may not be retrieved because it is not recognized as related to the current visual processing task.

It is important not to think of these processes as rigid and linear, as there is an ongoing flow of information between all levels in both directions, with some of it happening in parallel while other elements happening in a more serial fashion. In addition, it is equally important to not make assumptions about the structure of visual information as it is stored or processed. There is no reason to believe that there is a direct, homologous relationship between the distal visualization (whether it be a physical three-dimensional object, printed graphic, or computer display) and the internally coded visual information (Scaife & Rogers, 1996). That is, that one's internal mental images, no matter how they might "look" like their corresponding real world objects, can be composed of information from multiple sources, including both real-time sensory streams and long-term memory traces of previous experiences. Ongoing cognitive and neuroscience research is continuing to unravel both the physiological and psychological basis for visual information processing and storage.

LEARNING WITH VISUALIZATIONS

If visualizations are going to be optimally deployed in instructional materials, their semiotic, perceptual, and cognitive characteristics and their relationship to textual elements need to be synthesized and operationalized. In the following sections, two issues will be addressed that are relevant to learning with visualizations. The first

section aims at specifying the conditions under which visualizations will contribute to learning. The second section addresses the role of learner characteristics in visualization research.

When Do Visualizations Aid Learning?

A main issue in designing instructional materials pertains to the questions of when and how to use visualizations for conveying knowledge in a particular domain. To find an answer to these questions, one has to ask what information is to be conveyed, what the users' physical and cognitive abilities, preferences, and intentions are, and what the communicative situation is where the instruction will be used (Maybury, 1995). In the following section, we will highlight the function a visualization may have for learning and whether this function is relevant to achieving a particular learning objective. Hence, visualizations are supposed to be effective for learning only if they fulfill functions relevant to achieving a particular learning objective. In the following, we will distinguish instructional functions that visualizations may have if presented as self-contained messages (i.e., regardless of verbal information) or if they accompany verbal explanations. We will end this section with a discussion on whether visualizations can aid learning even if they are redundant to other representations.

Instructional Functions of Visualizations as Self-Contained Messages

The design of the visualization, of course, has to take the instructional context into consideration. There are several instructional functions that visualizations may have—irrespective of whether they are accompanied by verbal explanations or not.

Affect. Visualizations are often said to be motivating for students, because they can make a subject matter more interesting and appealing to students. Moreover, they can trigger specific

emotions or lead to a change in learners' attitudes (Levie & Lentz, 1982). However, there is a danger that visualizations that do not convey any information relevant to the learning objective will distract learners (*cf.* seductive details effect, Harp & Mayer, 1998).

Replace and augment real-world experience. Visualizations as instructional materials can act as a substitute to direct experience by offering highly realistic impressions of real-world objects and events, which might otherwise be too small, too large, too fast, too far away, or too dangerous to observe in reality. In that respect, visualizations do not replace real-world experience, but they may even improve this experience by providing information that would not have been accessible in the real world (i.e., 'better than reality').

Visuo-spatial reasoning. As has been outlined in the section on differences between verbal and visual representations the latter provide direct and parsimonious access to visuo-spatial information and, in case of dynamic visualizations, temporal properties of objects and events (Larkin & Simon, 1987; Rieber, 1990; Tversky, Bauer Morrison, & Betrancourt, 2002). This visuo-spatial information can also be directly used for inferences and reasoning (Goldstone & Son, 2005; Schwartz, 1995). With verbal representations, the sequential information would not only require cognitively demanding processes of searching related information, but also it would need to be internally transformed into a form more appropriate for spatial reasoning. Thus, for visuo-spatial reasoning tasks visualizations are more computationally efficient and allow for cognitive offloading (Larkin & Simon, 1987; Scaife & Rogers, 1996). This function is important in that it does not limit a visualization's capabilities to act as a memory aid; rather, it suggests that reasoning based on visualizations is a way of extending the boundaries of cognition to external representations (Zhang, 1997). External visualizations enable cognitive operations that would otherwise have to be conducted internally (e.g., mental imagery)

and thereby require more cognitive effort (*cf.* supplantation, Salomon, 1979).

Instructional Functions of Visualizations as Text Adjuncts

Most often, visualizations are used in conjunction with verbal instructional materials rather than acting as self-contained messages. Analyzing the combination of text and pictures has a long tradition within semiotics and sociosemiotics (Eco, 1976; Kress & van Leeuwen, 1996), in interface design (Bernsen, 1994; Mullet & Sano, 1995) and in human–computer interaction (Maybury, 1995) and textlinguistics. The perspectives in these works differ; while some stress the differences between text and pictures with regard to their suitability for expressing specific information (Bernsen, 1994; Mullet & Sano 1995), others are more interested in the interplay between them. The latter perspective is also taken here in this section, where it is emphasized that when visualizations accompany text they have functions in addition to those mentioned before, because they interact with the verbal information in specific ways. The most prominent analysis of the instructional functions associated with such a use of visualizations as text-adjuncts in the education literature has been conducted by Levin, Anglin, and Carney (1987). In their review, the authors described five functions of visualizations as text adjuncts: decorative, representation, organization, interpretation, and transformation.

Visualizations with a *decoration function* are not related to the verbal information and are introduced only to make a text more appealing and interesting for learners. However, while they are supposed to motivate learners, the meta-analysis by Levin et al. (1987) actually revealed a negative effect of decorative visualizations (*cf.* seductive details effect, Harp & Mayer, 1998). Presenting irrelevant additional information may distract learners from processing the pivotal learning contents or it may trigger inappropriate schemas for encoding the relevant content.

Visualizations in their *representational function* depict objects and relations mentioned in a text in a way that the meaning of the text more accessible for learners by making a text more concrete. Visualizations with an *organization function* provide an organizational framework for a text (e.g., how-to-do-it diagrams) and thereby make the content more coherent by highlighting the argumentative or organizational structure of the text (Verdi, Kulhavy, Stock, Rittschof, & Johnson, 1996). According to Levin et al. (1987) this function refers to comprehensible texts, whereas the *interpretation function* of visualizations is to make texts understandable for learners that would otherwise be incomprehensible. Accordingly, these visualizations are often introduced in textbooks and multimedia instructions to clarify difficult-to-understand passages and abstract concepts within passages (e.g., pictorial analogies).

The rarest function that visualizations are used for pertains to the *transformation function*. Visualizations that follow this function are designed to improve memory performance directly “by targeting the critical information to be learned, and then (a) *recoding* it into a more concrete and memorable form, (b) *relating* in a well-organized content the separate pieces for that information and (c) providing the student with a systematic means of *retrieving* the critical information when later asked for it.” (Levin et al., 1987, p. 61). Visualizations with a transformation function showed the strongest positive effects on learning outcomes in the meta-analysis conducted by the authors.

It is important to note that Levin’s review is limited to prose learning, whereas most multimedia materials are concerned with a broader and deeper understanding that can be transferred to novel situations. It is thus questionable whether these recommendations can be simply applied to the design of multimedia materials. There is at least one recommendation where research seems to disagree: informational equivalence of verbal and visual representations. According to Levin et al. (1987), students who use redundant informa-

tion to acquire content knowledge benefit from visualizations if these show a large information overlap with the verbally presented information. In fact, the representational, organizational, and interpretational function of visualizations presuppose that text and picture are at least partially redundant. On the other hand, multimedia learning research, has suggested to not present redundant information to learners, because this may require additional cognitive resources for comparing and integrating the information, which are then no longer available for learning (redundancy effect; e.g., Bobis, Sweller, & Cooper, 1993).

There are at least three things that are usually ignored in this discussion in the literature on multimedia learning: First, a certain degree of overlap is necessary to allow for a coherent mental representation, where learners can draw connections between the two sources of information. Second, what is redundant information is often impossible to say. Even when deliberately trying to construct informationally equivalent (and thus fully redundant) representations, it is almost impossible to counteract the fact that visualizations often “unintentionally” convey more, albeit potentially irrelevant information than do verbal descriptions due to their higher specificity or completeness (Kosslyn, 1994; Stenning & Oberlander, 1994). Third, as has been emphasized by Ainsworth (1999, 2006) in her functional taxonomy of multiple external representations (MERs), even informationally equivalent representations may have different functional roles for learning and thus support knowledge acquisition differently. She categorizes these roles into three groups: First, visual and verbal representations may fulfill *complementary roles* in instruction by facilitating different cognitive processes, serving different learning objectives, or addressing the individual representational preferences of different learners. Second, they can *constrain interpretation* and guide learners’ reasoning about a domain. Third, visual and verbal representations together might be suited to foster a *deeper understanding* than could

be achieved by using just one representational format. Thus, whenever any of these functional roles can contribute to learning, representing redundant information visually as well as verbally may be advised according to Ainsworth’s taxonomy. On the other hand, if one of the representations does not contribute to learning on a functional level, it should be deleted from the instruction.

Hence, when designing multimedia materials special attention has to be paid to how to distribute information across text and graphic representations by maximizing the representations’ strengths and reducing their potential weaknesses for delivering specific information aspects. This pertains to the notion of Palmer (1978) that the represented world can be depicted in many different ways and the decision about which constitutes the most appropriate representation depends on the operations that need to be performed with it and the questions that should be answered with it.

The Role of Individual Learner Characteristics in Learning with Visualizations

In order to be effective for learning, visualizations need to be designed in a way that they can be “readily and accurately perceived and comprehended” (Tversky et al., 2002, p. 258). Moreover, the effectiveness of visualizations is affected by what the learner brings to the learning task as another crucial component of the instructional context. Visualization design needs to recognize that there is no homogenous response to graphic or textual representations and how they are, or are not, used in learning. Several learner characteristics have been suggested that may affect learning with visualizations. We will follow a suggestion by Mayer and Massa (2003), who tried to disentangle cognitive abilities, cognitive style, and learning preference along the visualizer-verbalizer dimension. These dimensions account for the fact that “some people are better at processing words and

some people are better at processing pictures” (Mayer & Massa, 2003, p. 833).

Cognitive Abilities

Cognitive abilities related to the processing of visualizations comprise a wide range of constructs that differ not only with regard to their specificity, but also with regard to their empirical foundations. Some constructs like pictorial competence or visual literacy are rather general, whereas the impact of visuo-spatial abilities clearly depends on the type of learning tasks students are confronted with. For the former constructs, to our knowledge, no straightforward measures exist to assess them other than by observing a person performing a task that either requires or does not require this specific ability. On the other hand, there have been many different attempts to assess visuo-spatial abilities, though their literature is still equivocal (see Carroll, 1993; Hegarty & Waller, 2005 for overviews). Thus, at the current moment it is unclear how the concepts are related to each other and how they contribute to learning with visualizations independently as well as in interaction with each other. For these reasons, we will refrain from providing a comprehensive overview and instead sketch some of concepts that are relevant in the current context. The general notion is that learners who lack the abilities to process visualizations will benefit from them to a lesser extent, demonstrated, for example, in a study of science textbook instruction by Hannus and Hyönä (1999).

Pictorial competence. DeLoache, Pierroutsakos, and Uttal (2003) discuss the ability to use pictures from a developmental psychology perspective. According to their view, pictorial competence encompasses “the many factors that are involved in perceiving, interpreting, understanding and using pictures, ranging from the straightforward perception and recognition of simple pictures to the most sophisticated understanding of the conventions and techniques of

highly complex ones” (DeLoache et al., 2003, p. 115). While basic elements of pictorial competence exist already in newborns, more complex skills are characterized by strong developmental shifts. In particular, the ability to understand the relationship between the representation and the referent; that is, to become symbol-minded, is clearly age-dependent (DeLoache, 1995). DeLoache’s research suggests that pictorial competence develops during the daily interactions with pictures and their real-world referents. However, it is unclear whether this kind of familiarity is sufficient to use pictures in academic contexts. According to Pozzer and Roth (2003), “most students are familiar with photographs in general; however, appropriate instructions for how to read and analyze photographs currently are not provided to them.” (p. 1092). While the concept of pictorial competency mostly refers to the interpretation of realistic visualizations, the term visual literacy denotes a more general ability of dealing with visual media of all types (e.g., video, graphics, diagrams, animation, etc.).

Visual literacy. According to Nöth (2003) this concept refers to the “the ability to decode the pictorial repertoire of the media without indexical or iconic support” (p. 186). Messaris (1994) calls it “the familiarity with visual conventions that a person acquires through cumulative exposure to visual media” (p. 3). The “visual literacy” model defined by Messaris (1994) specifies different levels of visual communication that range from simple understanding to aesthetic appreciation of visual media. Despite its popularity in discussions on computer-based instruction, there is no objective assessment tool that would allow measuring the visual literacy of students. While in reading research, illiteracy can be conceptualized as the lack of knowledge on the syntax, semantics, and pragmatics of language, there is nothing comparable in non-notational representational systems, where the interpretation of visualizations is often subjective and context-dependent. Because of this, it has also been suggested to refrain from using

the term literacy and replace it with graphicacy instead (Roth, Pozzer-Ardenghi, & Han, 2005) to get rid of the strong association between literacy and reading. The term literacy may however be adequate for logical pictures, where it can be defined as the knowledge of notational rules, allowing mapping visual features of a representation to an interpretation of the depicted part (Pinker, 1990; Shah & Hoeffner, 2002).

Domain-specific prior knowledge. There is increasing evidence that students' level of domain-specific prior knowledge moderates learning from visualizations. For instance, learners with a high level of prior knowledge are better able to direct their visual attention towards relevant information (Lowe, 2003) and are less affected by a high visual complexity of the display (Lee, Plass, & Homer, 2006). Both findings support the notion that extracting information from a visualization is both a bottom-up as well as a top-down process. In the latter case, existing mental representation guide the lower-level perceptual processes and the interpretation of information acquired through them.

Visuo-spatial abilities. According to Carroll (1993), visuo-spatial ability is not a unitary construct; rather, it comprises five different dimensions that all make up abilities in the perception of visual input: (1) Spatial visualization is "the ability to mentally rotate or fold objects in two or three dimensions and to imagine the changing of configurations of objects that would result from such manipulations" (Mayer & Sims, 1994, p. 392) without referring to one's self, (2) spatial orientation is the ability to imagine an object's appearance from different view points as the observer's body orientation changes, (3) closure speed is the ability to access representations quickly from long-term memory, (4) flexibility of closure, and (5) perceptual speed is involved in the processing of simple visual displays (e.g., quick scanning). Prior findings from other researchers have likewise established evidence for the first two dimensions (spatial visualization and orientation),

while they failed to find consistent evidence for the latter three (Hegarty & Waller, 2005).

Research on spatial visualization suggests that "high- and low-spatial abilities individuals differ in the quality of the spatial representations that they construct and their ability to maintain its quality after transforming the representations in different ways" (Hegarty & Waller, 2005, p. 141). Accordingly, spatial visualization differences have been successfully conceptualized against the background of differences in working memory resources (Shah & Miyake, 1996). The role of visuo-spatial abilities has mostly been investigated in mental animation, where learners have to infer the motion of a mechanical system from a static picture. Here it has been demonstrated that learners with high abilities perform better in this task than low-ability students (e.g., Hegarty & Sims, 1994). It seems very plausible to assume that visuo-spatial abilities will show a strong influence in other tasks involving learning with visualizations. For instance, Plass, Chun, Mayer, and Leutner (2003) demonstrated that either students with low verbal or spatial abilities showed worse performance in multimedia learning than their higher-ability counterparts when receiving visual annotations, whereas abilities played no role when students were given verbal annotations.

Cognitive Styles: Visualizers versus Verbalizers

"A cognitive style is a psychological dimension that represents consistencies in how an individual acquires and processes information" (Kozhevnikov, Kosslyn, & Shepard, 2005, p. 710). The visualizer-verbalizer dimension (Richardson, 1977) characterizes students as verbalizers, if they rely on verbal-analytical strategies when performing a task, whereas visualizers use imagery as a predominant strategy of task accomplishment. Kozhevnikov, Hegarty and Mayer (2002) revised the visualizer-verbalizer dimension and suggest a more fine-grained distinction between spatial and

iconic visualizers (object visualizers according to Kozhevnikov et al., 2005). In a problem-solving task, they collected evidence for these two types of visualizers. Spatial visualizers, in a schematic interpretation, focused on the location of objects and on spatial relations between objects. This group also used “imagery to represent and transform spatial relations” (Kozhevnikov et al., 2005, p. 722), where images were processed analytically to infer their spatial interrelations. Iconic visualizers, on the other hand, in a pictorial interpretation, focused on vivid visual details like shape, size, colour and brightness, thereby processing these objects as a single perceptual unit. Interestingly, this distinction between the two groups fits nicely with research that focuses on dissociating the ways in which visual information is processed. This work shows that there are brain areas that either focus on processing shape and color information to determine an object’s identity (what-system) or on processing spatial and dynamic input (where-system). Moreover, current theories of visuo-spatial working memory (Logie, 1995) make a similar distinction by relating the function of the inner scribe – as one component of visuo-spatial working memory – to the processing of spatial and movement information, whereas the other part is responsible for the processing of color and shape information (i.e., the visual cache). At this moment, however, it is highly speculative if the cognitive styles identified by Kozhevnikov et al. (2002; 2005) could be linked to a different use of these brain areas or working memory systems.

Preferences for Visual versus Verbal Information

Leutner and Plass (1998) developed a method to assess preferences for verbal or visual materials by analyzing the students’ information-selection behavior. The VV-BOS (Visualizer/Verbalizer Choice Behavior Observation Scale) showed very promising psychometric properties as well as a superior validity with regard to the differ-

ential prediction of learning outcomes. Plass, Chun, Mayer, and Leutner (1998) demonstrated that students with visual preferences as assessed by the VV-BOS benefited predominantly from visual annotations, whereas students with verbal preferences gained most from verbal annotations.

Taken together, there is evidence that suggests that when investigating learning with visualizations, the students’ individual differences in terms of cognitive abilities, cognitive styles, and learning preferences need to be considered. With the current state of research, it is impossible to tell their relative influence and direction, but first studies show promising results in this respect.

CONCLUSION

When developing multimedia materials, instructional designers are faced with a multitude of decisions as to which contents should be part of the instruction, which representational format to use for these contents, and how to design these contents. For improving multimedia instructions, two conclusions can be drawn from the current paper.

First, one needs to clearly understand the learning task and relevant individual differences of the learner. From this, the relative strengths and weaknesses of different representational formats can be considered and information visually encoded in accordance with the results of this analysis. Visualizations should be used whenever their instructional functions are assumed to add considerably to the effectiveness of the multimedia instruction.

Second, the use of visualizations often seems to suffer from the *resemblance fallacy* (Scaife & Rogers, 1996). While it is seductive to assume that mental imagery and distal visualizations are homologous and that processing these visualizations only involve low level perceptual processing innate to all humans, this is a grave error in instructional strategy. While perceptual processes are naturally

involved in learning from visualizations, only seldom are the visualizations supposed to be taken literally. Rather, they have to be taken as representations standing for something else than what is being depicted. Identifying what is being represented based on the structural correspondences (rather than physical similarity) may cause severe difficulties for learners when studying visualizations. Thus, it should not be taken for granted that learners will extract the information from a visualization that was intended by an instructor. Rather, students need to be supported in extracting the relevant information from the visualization and guided as to how to best deploy their limited perceptual and cognitive resources. This support can be provided either by guiding learners' attention towards its relevant aspects (e.g., highlighting) or by improving students' competencies in dealing with visualizations. The latter comprises teaching to students existing conventions underlying these (logical) visualizations (e.g., how to read a graph, Pinker, 1990) or training them in developing graphacy (Roth et al., 2005).

FUTURE DIRECTIONS

The final section of this paper is devoted to future directions in research on learning from visualizations. In particular, we wish to emphasize that more in-depth analyses are needed that shed light on the process of perceiving and interpreting instructional visualizations and on the visualization's impact on performance in a variety of tasks. We believe that respective analyses would benefit from an interdisciplinary perspective, where insights from different areas (e.g., cognitive science, education, semiotics, visual perception, human-computer-interaction, human factors) could be united.

Integrating models of visual perception and cognition. Most researchers argue for visualization's instructional effectiveness by referring to its relative ability to support higher-level cognitive

processes. Accordingly, pictorial representations may support a dual coding of the information (Paivio, 1991), the construction of a mental model (e.g., Mayer, 2005), or cognitive offloading (Scaife & Rogers, 1996). These approaches pay considerably less attention to perceptual processes, thereby ignoring that these processes need to take place before higher-level cognitive processes can act upon the information that has been attended to. As a consequence, the vast literature on visual perception is largely neglected in the educational literature, even though it may provide important and novel insights into the design of effective visualizations (e.g., MacEachren, 1995). According to Anglin et al. (2004), "theory-based studies that are informed by both memory research and theories of picture perception are lacking" (p. 876).

Taxonomy research. Currently, visualizations are mostly treated as a unitary construct without taking into account the differences among them. These differences may pertain to their appearance, content, or instructional functions. Future research should attempt to develop taxonomies that will allow classifying visualizations according to these different dimensions. There have been morphological approaches that classify visualizations according to their appearance (e.g., Lohse, Biolsi, Walker, & Rueter, 1994; Twyman, 1985) however, we do not think that these taxonomies will help explaining much of the variance with regard to the instructional effectiveness of visualizations. Rather, content-oriented classifications (Bieger & Glock, 1984) or more systematic approaches to instructional functions like the one by Levin et al. (1987) seem to be more promising in this respect. The availability of such taxonomies would allow greater generalization of findings across studies than what is currently possible.

Analyzing processes and learning outcomes in parallel. While there are some theoretical assumptions on how pictorial representations are processed, most of the existing studies have refrained from empirically investigating these pro-

cesses. Knowledge on how students use pictorial representations is, however, not only necessary for theory development, it is also relevant for practical reasons. For instance, for logical pictures it is often not clear whether these representations sometimes fail to improve learning because they are designed in a bad way or because students did not understand the underlying conventions. Process-oriented data may allow identifying possible misconceptions students have regarding the meaning of the visualizations and assist in developing effective teaching strategies for using them. Despite these promises of analyzing the processes of learning from visualizations, most of the studies until now have only looked at learning outcomes in isolation. Some noteworthy exceptions to this situation come from research that has applied eye tracking methodologies (e.g., Cook, Carter, & Wiebe, 2008; Lowe, 1999). This methodology provides information on the temporal and spatial resolution of visual attention by tracking the location of the eye as a person watches a visual display. It thus offers a good starting point to analyze perceptual and possibly cognitive processes when learning with visualizations. In particular, its combination with think aloud data has been shown to be very informative (van Gog, Paas, & van Merriënboer, 2005). Hence, we suggest combining the predominant outcome-oriented research strategy with a more process-oriented strategy (*cf.* Peeck, 1987).

Assessment of learning outcomes. Despite the fact that core information is often conveyed by means of visualizations in multimedia instruction, most test items are presented in words only. Moreover, in class students are typically required to provide their answers verbally. Thus, most ways of assessing what has been learned from a visualization potentially requires multiple recodings of this information by the learner to accomplish a task. In particular, non-sequential information needs to be transformed into a sequential format to provide a verbal answer (speaker's linearization problem; Levelt, 1981). Moreover, according to the verbal

overshadowing effect (Melcher & Schooler, 1996) it may well be that asking learners to provide verbal answers when assessing their learning outcomes may interfere with the "visual" knowledge stored in memory and make this information less accessible. Hence, verbal tests may inadequately reflect students' acquired knowledge. Moreover, interactions between the instructional format and the learning objective should be considered more thoroughly in future research. A larger variety of test formats might be more apt to account for the complexities underlying learning with visualizations. Accordingly, Joseph and Dwyer (1984) found positive effects for illustrated text compared to text-only versions only in a drawing test, but not in a comprehension test, suggesting that the type of test moderates the effectiveness of instruction. Furthermore, Levie and Lentz (1982) showed in their review on learning with visualizations that visualizations improved recall more in delayed tests than in immediate tests. It might be that the advantages of visualizations relate to dual coding in memory and creating more associations to other long term memory content—a pay off only seen in situations that impose higher demands on memory and understanding.

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Chapter 7.11

Teaching Social Skills: Integrating an Online Learning System into Traditional Curriculum

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ABSTRACT

The ubiquity of instructional technology necessitates a more critical look at the theories that drive adoption and the practical implications of its usage. Blended learning has been offered as one compromise to fully online learning or strict adherence to traditional lecture-based instruction that seems outdated. A particular approach to blended learning is examined in the present chapter through the use of an online learning system. Concept Keys was developed to assist instructors of social skills in breaking down these abstract concepts into manageable units of information appropriate for daily delivery via e-mail. This program is shown to be easily integrated into existing curriculum through two studies. A

concluding section attempts to tie these studies together and suggests potential limitations and avenues for future research.

CHAPTER OBJECTIVES

The reader will be able to:

- Understand the pedagogical goals driving the development of Concept Keys (CK)
- Understand the key elements of the CK system
- Identify two specific ways in which CK can aid in the teaching of specific social skills
- Determine the usefulness of the CK approach to his or her pedagogical needs

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INTRODUCTION

Institutions of higher education continue to face challenges posed by online education and the ubiquitous nature of technology in the classroom. The concept of blended learning—the use of two or more complementary approaches when teaching the same material—has seen heightened attention in literature in the past decade and offers a unique approach to merging the availability of technology with traditional and tested pedagogical approaches. Examples of blended learning include using textbook supplements, peer-to-peer learning, and/or online modules while maintaining aspects of a more traditional, lecture-style format. The purpose of the present chapter is to outline the development, implementation, and effectiveness of one online learning system, Concept Keys (CK), that takes a blended learning approach to teaching social skills (see also Bodie, Powers, & Fitch-Hauser, 2006; Powers, Bodie, & Fitch-Hauser, 2005). In service of these aims, a brief background is offered that situates CK into the larger category of e-learning and examines its core components. Then, two studies are used to illustrate how the system is easily integrated into an existing curriculum and can be custom fit to address specific pedagogical goals. Finally, a concluding section ties these two studies together and offers insights for future research and exploration using the CK system.

BACKGROUND: E-LEARNING, SOCIAL SKILLS, AND CONCEPT KEYS

E-learning can refer to a wide range of online learning protocol. Systems can be created that allow individuals to self-manage their learning or that blend online and face-to-face instruction to greater or lesser degrees. Datamonitor (2004, July 14) predicts the global e-learning market for higher education to grow at a rate of

12% between 2004 and 2008. This growth has necessitated a more critical look at the theories that drive technology adoption and the practical implications of instructional technology usage. Intuitively, technology should not be utilized for its own sake; instead usage should be grounded in specific goals and objectives (see Moore, 2005). This translates to practical considerations of which types, how, and how often specific technologies will be used and in what combinations. Backing such claims, research suggests that, when grounded in pedagogical goals and objectives, technology has the potential to enhance learning outcomes (e.g., Dean, Stahl, Sylwester, & Pear, 2001; DeLacey & Leonard, 2002; Rainbow & Sadler-Smith, 2003). Conversely, using technology can impede the learning process if used poorly (Derntl & Motschnig-Pitrik, 2005; Sellnow, Child, & Ahlfeldt, 2005). Still other studies have found that students have certain expectations of instructor use of technology prior to the first day of class; violating these expectations can have deleterious effects on student learning (e.g., Witt & Schrod, 2006).

Thus, it follows that instructors who teach social skills—communication-related skills such as listening and critical thinking (Leigh, Lee, & Lindquist, 1999)—are likely to benefit from the use of online learning systems; however, the adoption of a given system should be guided by specific curricular goals. Concept Keys (CK) is an online, empty engine approach that allows instructors who teach what are generally categorized as social skills the opportunity to offer students a blended learning approach to obtaining these skills. In other words, CK enables the educator an opportunity to define social skills as broadly or narrowly as needed for a particular application (e.g., how to communicate effectively or how to give meaningful presentations). The system can accommodate educators interested in, for instance, enhancing sales-related communication skills as well as educators interested in teaching engineers how to present complex material or medical

students how to be more patient-centered. Most importantly, the system is customizable based on pedagogical goals and objectives.

The Concept Keys Approach to Blended Learning

The CK system is a focused approach to classroom interaction grounded in educational theory (i.e., chunking, priming, and active learning) that blends Web-based education with face-to-face instructor direction and support. Concept Keys provides students with small bits of information over a long period of time culminating in an integrated store of knowledge about a set of skills and how to perform these skills in specified contexts. Along with daily commentary, or fundamental keys, this method has students rate these keys according to personal relevance. Additional classroom activities are also available, which add to the student-teacher interaction and

increase the chances of information retention and skill acquisition (see Table 1 for a brief overview of program elements). Defining some key terminology within the system will aid in describing its basic components. Once key terms are explained, the CK process will be outlined.

Keys

Keys are very brief statements reflecting small bits of information that make up some larger concept (hence, Concept Keys). This system is based on the notion that the best way to teach complex material is to break it into small, manageable units or bits of information that are systematically delivered over an extended timeframe. This organizational framework mirrors textbook and lecture organization in which students are taught steps, guidelines, and strategies that aid in the successful implementation of a competency (e.g., how to deliver bad news). As noted by Bodie et al.

Table 1. Concept keys online learning system components: Traditional integration options

Each Student in a Concept Keys Certification Achievement Program receives:
• 1 Personal CK website account
• 2 Certification Examination attempts at program conclusion
• 50 Daily “Gentle Reminder” emails
• 50 Daily Keys
• 50 Daily Micro-lessons; each micro-lesson has four paragraphs
• 50 Daily Food For Thought Segments (four questions and responses)
• 10 Weekly quizzes over previous 5 Keys
• 10 Weekly self-selections of the Most Important Key
• 10 Weekly self-determinations of what to do about the Most Important Key
• 70+ Days of availability to download all personal program material
• 70+ Days of Engagement Index Metric (degree of participation in the program)
• 700+ Cognitive engagements in learning and improvement activities
Each Teacher (or designate) in a Certification Achievement Program will receive the following:
• A free copy of the <i>Student Learning Instructor’s Manual</i>
• Daily access to all student’s program activity
• Daily opportunity to obtain detailed metrics for documentation, assessment, and accountability
• Daily option to download metric data for group comparative purposes
• Daily opportunity to provide immediate feedback to students regarding their progress

(2006), “information is more easily remembered (Cowan, Chen, & Rouder, 2004; Miller, 1956) and strategic choices more easily made (Gobet & Simon, 1996, 1998) if small bits of information are built into larger stores or chunks of information that can be recalled in necessary situations” (p. 121).

For example, if you were trying to teach a group of students how to deliver an effective presentation you might start with the necessity of audience analysis followed by appropriate topic selection, writing general and specific purposes and thesis statements, and so forth. These smaller components, if segmented even more, might result in the generation of hundreds or thousands of keys to successful presentational speaking (the concept). One such key might be “Walk a Mile in the Audience’s Shoes.” This key should elicit thoughts concerning the importance of audience characteristics and/or experiences that might differ from one’s own.

Micro-Lessons

A micro-lesson is an extension of the key whereby specific elements of the short statement (e.g., Walk a Mile in the Audience’s Shoes) are elaborated upon. Specifically, each micro-lesson contains 3 elements: the key, three to four bullet points expanding upon the core components of the key, and food-for-thought (FFT) questions (see Figure 1). The paragraphs that follow the key are a combination of explanation and motivation.

Explanation refers to bullet points with the main purpose of explaining what the key means in ordinary language. In the example presented in Figure 1, the first three bullet points explain that “Walking a Mile in the Audience’s Shoes” refers to taking the audience’s perspective into consideration during the speech preparation and presentation process. They also provide specific examples of how to do this (e.g., use words and concepts the audience knows and is concerned

about) in order to give students practical examples of recommended behavior. Motivation refers to the bullet points designed to include both the appropriate behaviors and an example of at least one situation in which the set of behaviors should be used. As seen in Figure 1, each bullet point attempts to provide motivation to utilize the key by suggesting positive outcomes of key use (e.g., increased audience interest) and ramifications for non-use (e.g., not achieving goals, audience not attentive).

In sum, this explanation-motivation sequence provides examples of what can happen when the key is used successfully and the possible negative consequences when the key is misused or not used. These examples are written to resonate with students insofar as they are likely to recall at least one instance in which miscommunication occurred in this particular context; the assumption is that students will connect the mishap with misuse of communication processes thus motivating behavior change. Such suggestions are also likely found in textbook treatments of public speaking; by presenting material in multiple ways and through multiple channels, likelihood of retention is increased (see Bodie et al., 2006).

Each micro-lesson also contains four FFT questions that act to encourage the learner to make a decision about how to increase his or her use of that day’s key. Those questions are also presented in Figure 1. Questions build upon each other allowing the student to reflect on the present use of the key and how this aspect of the social phenomenon might be improved. The final question, especially, places the responsibility for learning on the student.

The Process

Once a student is signed up for a CK program, he or she goes to the CK Website, creates a unique username and password, and submits a working e-mail address.² This e-mail address is used to

Figure 1. An example of a CK micro-lesson

Concept Keys -- Unlocking Knowledge, One Key at a Time
Effective Presentational Speaking
Key #1: Walk a Mile in the Audience's Shoes.

- ☐ Your audience will be better able to comprehend and understand your topic if they are able to relate it to their unique lives and experiences. So to have the attention of your audience, approach your topic from the audience's perspective, not your own. This will assist you in bridging the gap between you and your audience, making your presentation more effective.
- ☐ The audience will trust you more if you show that you can relate to them. This includes using words and concepts the audience knows and is concerned about. This breeds interest and an interested audience will allow for a better presentation.
- ☐ Make sure to incorporate ways in which your audience can benefit from the topic of your presentation. Explain to them how they would benefit if the problem you're addressing in your presentation could benefit them in some way. The audience will have a better understanding of your presentation if it involves something they are concerned about.
- ☐ A presentation that an audience views as not related to them will not succeed in winning attention or achieving its goals. Use words and concepts that your audience will perceive as effective yet understandable and you'll have no choice but to succeed.

Food For Thought!
Now you want to make a decision about how to increase your use of this Key. Answering the following questions should point you in the right direction. Be sure to click on the Finish button below once you have answered all the questions.

1) How would you evaluate your use of this Key in your current work environment?

- A) Not Effective
- B) Slightly Effective
- C) Moderately Effective
- D) Very Effective
- E) Extremely Effective

2) To what extent would increasing your effective use of this Key help you achieve your short-term or your long-term goals?

- A) Not Helpful
- B) Slightly Helpful
- C) Moderately Helpful
- D) Strongly Helpful
- E) Extremely Helpful

3) To what extent do you plan to develop your ability to effectively use this Key?

- A) Not a Priority
- B) Slight Priority
- C) Moderate Priority
- D) Strong Priority
- E) Extremely High Priority

4) What are you actually going to do to improve your effective use of this Key? (Maximum: 360 characters)

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send the student daily reminders that a particular key is ready to be viewed (see Figure 2). Once the student clicks on the Web address located in the e-mail, he or she is sent to the login page. Once logged in, the student will be able to access the daily micro-lesson and answer daily FFT questions; past micro-lessons, quizzes, and so forth, not yet completed are also made available.

Summary

CK allows abstract and complex social skills that are otherwise ambiguous, vague, and/or vast in scope to be presented in manageable and meaningful units of information that can be tailored to course goals and individual learners. This information is presented to the learner though daily

Figure 2. An example of a daily reminder e-mail

Greetings, John!

This is your daily reminder that a key is ready for you to read! Today's key is:

Key #1: Take personal responsibility for quality communication!
<http://www.conceptkeys.com/program.php?keyId=1&progId=99>

If the above URL is 'clickable', simply click it to go to the key. You might need to log into your account as well. If you do need to log in, you will be directed to your participant page immediately upon successful log in where you will find the above key in your 'To Do List'.

If the URL is *not* clickable, simply copy and paste it into your web browser.

In addition, the following item has not yet been completed:

Key #1: Food for Thought Questions
<http://www.conceptkeys.com/program.php?progId=99&keyId=1&fft=1>

If you have any questions, comments, or suggestions, please feel free to reply to this message and one of our customer support agents will respond to you shortly.

Sincerely,
 Dr. Will Powers
 CEO Concept Keys, Inc.
wpowers@conceptkeys.com

micro-lessons over a predetermined period of time. Each micro-lesson consists of (a) the daily key, (b) the cognitive and behavioral components of that key, and (c) "food for thought" questions. CK achieves the objective of breaking down a complex concept like presentational speaking into manageable units of information for increased retention as well as increases the amount of time the student is likely to remain engaged with course material (small bits of information are delivered daily). This is enabled by the empty engine capabilities of the system—individual lessons can be customized as broadly or narrowly as desired. Components of this system, such as FFT questions and motivation-based behavioral examples, aid in student engagement and a sequentially-based learning approach that has been shown to be effective in several classrooms. The next section explores two such applications of the system.

CURRICULUM INTEGRATION

Concept Keys has been successfully implemented in several classrooms at three different universities. Initially, the system was built to provide instructors with 10-week programs that cover a wide variety of areas relevant to social skills. This has been the most widely used component of the system. Study One addresses this traditional integration. In this model teachers serve as *learning system coordinator* to students who are assigned, as one component of a larger class, one of eight e-books each with 50 micro-lessons. Typically, the teacher assigns CK as a supplemental text in a class that is largely focused on some large area of social interaction (e.g., business communication, listening). There are many options available to the teacher, some more appropriate in one level of learning than another (e.g., College students relate to some learning activities differently than would Junior High School students). A complete

Table 2. Two example activities for use with CK modules

Personal Improvement Plan Development Once students identify a particular Key as having some level of special value for themselves as they look at their relationships and career aspirations, the first learning element has to be to get that Key into long-term memory. Thus, the emphasis in so many activities upon repetition leading to enhanced memory. But, memory without use is of value only at some future time—and then, the actual skill may not be as practiced or smooth as one would desire. So, at the same time that memory is being developed, we may wish to ask the students to develop a plan that each student believes will lead to their personal improvement with specific Keys. You could review the plan and have the student implement the final improvement plan and report their progress after a specified time period. You could have Buddies or Teammates select a Key, develop a two-week personal improvement plan for each other, negotiate the plan to each person's satisfaction (you would want to review all plans to assure appropriateness), implement the plan, and have each partner report the progress of the other person. The number of times you use this activity is optional. You could have students develop such a plan for the Most Important Key each week, thus producing 10 personal improvement plans. Or, you could use this activity on the basis of the Most Important Key each 25 Keys leading to two personal improvement plans. Communication Cartoon of the Week Newspapers, magazines and books are filled with cartoons that often have direct relationship to communication or to specific Tips. Students can clip these out and post them on bulletin boards or include them in the newsletter, along with how they relate to Concept Keys content. Or, Teams can present them in class along with their rationale. The best (or most relevant cartoon) can be identified by a vote, and the person/team contributing the cartoon can be recognized. These cartoons can be collected and saved in a photo album with the related Key itself and used later as a resource. A unique twist to this idea could be having a cartoon posted in a central place and having other students figure out which Key(s) it applies to and why. The group or student with the most relevant Keys and explanations can be rewarded. Also, a cartoon can be displayed without the caption, allowing students to write their own caption. Using cartoons allows a humorous look at how things can sometimes occur and also foster some learning.
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Instructor Manual detailing multiple options is available on the CK Website (see Table 2 for a sample of activities).

Thus, in study one we discuss the ways in which online material was blended into the classroom experience through particular assignments in one classroom; however, it should be noted that this is merely an example of traditional integration (for additional case studies see Bodie et al., 2006; Cook & Powers, in press; Powers et al., 2005). Although the class was small, the results from the study are useful in illustrating points about CK as well as elements of the system that seem to work as they were theoretically grounded.

More recently, the system has been modified to allow students or instructors to author e-books of varying lengths, thus taking full advantage of the empty engine application. Study two describes a student authorship approach that was recently incorporated into an introductory interpersonal communication course. This class was largely focused on theories and approaches to the study of interpersonal communication; therefore, the CK

program was used as a supplement to provide a focus on basic communication skills that students often do not receive when taking such a class. The particular course represented in study two is required or offered as an elective for a wide range of student majors. Since this class is taught in multiple sections each semester, it is necessary to streamline material and textbooks as much as possible. CK offered a non-intrusive supplement that allowed one section to receive CK materials and still be exposed to the same concepts and theories as the other sections of the course. In other words, this context allows for exploring and illustrating a second specific case of integration made possible by the CK learning system.³

Study One: Traditional Integration

The first study looks at the traditional use of a CK e-book and subsequent exercises that are integrated into the requirements of a semester-long course on listening. Eleven students enrolled in a five-week mini-mester at a large southeastern

university during the summer of 2006 subscribed to the *Listening Effectively* e-book which consists of 50 micro-lessons and ten retention quizzes—each quiz tests the retention of five keys. Time constraints of a five-week course altered normal key distribution. Instead of receiving one key per day for 10 weeks, students received three keys each day for three-and-a-half weeks. On day 17, students received the final two keys. Students received retention quizzes at the end of every five keys. These quizzes motivate students to remember each key and to think about the key they find to be most meaningful out of each set by having each student establish his or her most important key (this culminates in each student having ten most important keys with a rationale of why this key is the most important to his or her unique situation). To further motivate students to remember the keys, students were encouraged to take a certification exam at the end of the term that tested overall retention and understanding. Students who correctly answer the questions at a 90% or better accuracy rate are certified at the highest level; those who score in the 80% range receive regular certification. Each student had two opportunities to take the certification test. All 11 students received certification. Two additional assignments designed to integrate the keys into the fabric of the class were used as pedagogical tools.

CK-Related Assignments

The first assignment was used to increase student engagement in classroom discussion by enhancing active learning. This group project had students get into pairs (there was one triad) and write a skit that illustrated two keys which both students agreed were important for social interaction. In addition to writing the skit, the groups had to perform it in front of the class. To increase the number of keys covered, groups were told no keys could be repeated in the class; 10 of the 50 keys to effective listening were represented by this activity.⁴ This activity provides a fun, but challenging op-

portunity for the students to translate the key into an active skill. For example, one skit illustrated the key “stop talking” by featuring an individual missing important instructions for a task because she continued to talk over her supervisor. The skit clearly demonstrated what the key means in a life-like situation and illustrated the importance of the skill. The clarity and creativity of the skits provided useful measures of how students interpreted and integrated the keys into their way of thinking about potential listening situations.

The second assignment required students to turn in, on a weekly basis, a two-page essay focused on how they had incorporated their two favorite keys (out of the previous nine) in their daily lives. The exercise was designed to keep students engaged in the program and provided one more means of getting them to think about the importance of the particular skill or suggestion. By getting them to focus specifically on how they were using a particular key, the students found they either already used a skill or explored how a new approach (as suggested by the key) could help them manage a situation more effectively.

At the end of the semester, the instructor asked volunteers to return copies of their individual CK reports for use in writing the present manuscript. A total of 15 out of a possible 55 reports were returned representing nine out of the 11 enrolled students. Most students returned their last one or two reports. A theme analysis was conducted on the returned essays to determine whether or not they truly integrated the keys into everyday thinking. To show integration, the report should not only discuss the meaningfulness of the key itself, but it should also clearly relate the key to some area of the student’s life. Common themes across essays included relating keys to personal experience, relating keys to relevant prior coursework, and applying the keys. Table 3 provides relevant excerpts for each theme.

Several essays were representative of students focusing on the impact certain keys have on their unique lives and personal experiences when en-

Table 3. Study one: Essay excerpts

<i>Relating Keys to Personal Experience.</i>	
Key(s)	Excerpt
"Take the Time to Respond"	Instead of hollering at one another, [my parents] took their time and came up with a good calm response. This is probably why they have been married so long. So I am going to try to emulate them in my listening behavior and always take my time to respond. From doing so, I can avoid situations where I say something I regret.
"Control Your Feelings About the Task" "Listen with Optimism"	...when it comes to doing certain things [at work], I tend to have a pessimistic attitude. Sometimes, I haven't heard the complete details of the task but I tend to block out the rest of the information being delivered to me. I catch myself doing this at work ... when someone has an idea that I don't particularly like, I tend to focus on how it will not work as opposed to making the idea more effective. ... I think it's important to listen with optimism because if you don't, you may miss details that could lead to mistakes that will be hard to fix. I realize that this pessimism will not get me far, especially when I get a real job and will probably have to work with a group of people for a common goal. I have found that listening with optimism is also a great way to improve relationships among coworkers. . .
<i>Relating Keys to relevant prior course work.</i>	
Key(s)	Excerpt
"Be Aware of Nonverbal Messages while Listening"	Concept Key 48 is something I studied during the last mini-semester in nonverbal communication, Oculistics, or eye behavior, is one of the most important nonverbal behaviors to observe. Deception can be very easily detected by eye behavior. If the speaker avoids eye contact or has trouble maintaining eye contact it could be a sign that the truth is not being told. Kinesics or body language is very important for the listener as well as the speaker.
<i>Applying the Keys</i>	
Key(s)	Excerpt
"Reduce Distractions when Listening,"	I attend a devotional each week ... After the devotional is over, we use the time together to catch up with friends and meet new people. The problem is we are still gathered in a large room with several people. There are a lot of conversations going on.... This is where I have been trying to practice this skill. I have found communication more successful when I try to block out all the noise and everything going on around me.

gaged in interaction with others or when observing good and poor examples of listening behaviors. By personalizing the keys, students took the abstract skill of listening and its component parts, as presented by relevant micro-lessons, and added concrete and applicable dimensions to it. That is, rather than simply drawing general conclusions and applications, which may be equally accomplished by reading a chapter in a textbook, students focused on the actual use or observation of the key and the resulting impact. By ending with a listening lesson, they showed their ability to generalize from their own experience and integrate the concept into their daily behaviors.

Another focus in some reports was to write about how the keys fit with concepts learned in previous communication classes. This provides

support for the notion that chunking helps increase one's knowledge base by allowing individuals to layer relevant information into proper mental category or schema. A core assumption of the CK system is that micro-lessons operate most effectively when students are not only able to relate to presented material but are also able to build mental stores of core concepts that can be recalled when certain aspects of the environment prime relevant information from long-term memory (see Bodie et al., 2006). The more students are able to do this, the more effective learning from such a system should be. This blending and combining of small bits of information is also facilitated by the way in which current e-books are constructed and how authors are encouraged to write new material.

First, programs have been designed to include micro-lessons that are repetitive and cross over potential applications. For instance, the keys “Control Your Feelings about the Task” and “Listen with Optimism” share common aspects (this is also evident in the bullet points following the keys). Thus, the student who wrote about both keys in the same report also illustrated how students are relating previously learned information within the program to build larger stores (chunking) about the core concept (i.e., effective listening). Second, the micro-lessons are designed to reflect an explanation-motivation sequence which should resonate with students. This resonance should call forth life experiences from long-term memory (as illustrated by students who related keys to personal experiences) and further the chunking process.

A final way student’s showed how thoughtful they were about the keys was experimenting with and practicing their application. The segment of one report presented in Table 3 clearly shows the student has used the key and has noticed an appreciable difference in his ability to listen. This application of course material is often what is sought as we teach social skills. The fact that student essays were illustrative of this goal is encouraging.

Discussion

While these results are only anecdotal, they do suggest that CK can be integrated into a traditional course with positive results. By providing students with the opportunity to link basic concepts and elements of a skill to their own lives in small, regular increments, educators can help students incorporate important skills into daily practice. As discussed previously, students related keys to their personal experiences and prior coursework, and experimented with keys to improve their listening ability.

These themes are also useful to illustrate the pedagogical goals to which a “traditional integration” is suited. One of the most important goals

of the original CK system is to assist education in teaching basic social skills. Unfortunately, students not only place barriers to learning these skills, but by the time students get to college many of their inappropriate communication behaviors are ingrained. To “unlearn bad habits” and to simplify the presentation of large amounts of information, CK presents students with small bits of information on a daily basis that takes approximately five minutes to complete. Even this short amount of time can produce considerable reflection, sparked by FFT questions and application. This positive finding suggests that more extensive and statistically reliable research needs to be done in the future on the impact of this type of instructional tool.

Likewise, a five-week mini-mester places constraints on the ability for the system to be implemented as intended. However, it should be noted that results from the present case study do not deviate from those presented elsewhere (Bodie et al., 2006; Powers, Bodie, & Fitch-Hauser, 2006). It would also have been useful to obtain pre- and post-test measures from students related to listening habits and biases to assess change over time. Two reasons are offered for why these data were not collected. First, the small number of students limits statistical power needed to detect even large effects. Second, the length of the course places into question the amount of absolute change that is likely. The results of study two offer some appeasement to such concerns. It is to that integration method we now turn.

Study Two: Student Authorship Project

In the spring semester of 2006, 20 students enrolled in an upper-level interpersonal communication course at a large mid-western university took part in a group project that involved researching and authoring a skills training program, as well as acting as participants for a similar program authored by classmates. Specifically, students

self-selected five-person groups then chose a general skill set on which to focus: intercultural communication competence, effective public speaking, effective parent-child communication, and effective employment interviewing. Students were responsible for two main tasks. First, groups developed a three-week CK program to enhance the skills of their chosen competency. Second, students were randomly assigned to take one of the four three-week programs near the end of the semester; the program ended one week before the final day of class and was scheduled to run Wednesday through Sunday with Monday and Tuesday as “off days.”⁵

A series of smaller steps was employed to better facilitate the project. After students formed groups, they were required to turn in an initial bibliography consisting of journal articles, book chapters, books, and other sources. After this bibliography was approved by the instructor, the students developed a list of 50 keys to their chosen competency. These 50 keys were refined and reduced to 15 and approved by the instructor. It was at this point that the groups began work on their series of micro-lessons. Five different micro-lessons were due at three different points in the semester. After all micro-lessons received final approval by the course instructor, the instructor put them into the CK template and randomly assigned individuals to take a program that they did not create. Students were graded on the quality of their authored programs as well as their participation in the three-week program as participants. In all, this project counted for 40% of the total course grade.

Several different measurement instruments were employed to test the effectiveness of the different project stages. A series of self-report scales were employed after the completion of this class project to assess different learning-related outcomes. In addition, a pre-post design (week three and week 16) was used to test knowledge relevant to the four competencies represented in the CK programs.

Self-Report Learning and Knowledge Outcomes

Concept Keys Assessment Instrument

To assess student perceptions of the utility of the CK program a 21-item scale was implemented (see Table 4 for all items). The scale is a modified version of the ART-Q (MacGeorge et al., in press) and asks students to report on their experience using the CK system without regard to any other element of the course, the group to which they were assigned, or other elements of the classroom. The scale was originally intended to measure seven areas relevant to the CK experience: time, interest (in the course), motivation, self-perceived learning, ease of use, fun, and liking. When submitted to a principle components factor analysis with Varimax rotation, a two factor solution that explained 57.6% of the item variance was found. These two factors were interpreted as CK enjoyment ($\alpha = .922$), how much the students enjoyed using the system, and CK knowledge ($\alpha = .871$), how much the students reported learning as a result of using the system (see Table 4 for items corresponding to these components).

Self-Reported Improvement

To assess student perceptions of learning several items were written that asked respondents to “refer to how much you think you learned as a result of the Concept Keys system.” A principle components factor analysis with Varimax rotation indicated a three factor solution that explained 77.8% of the item variance. However, after inspecting the rotated factor structure and the corresponding reliability analyses, the following items seemed to comprise the only interpretable and reliable scale: “How well do you think you have comprehended the content of the CK system?”; “How much improvement have you noticed in your ability to communicate since you started the CK program?”; and “How much has your level of anxiety about communication decreased due to the CK program?” Thus the variable perceived communication improvement was calculated

Table 4. Factor analysis for concept keys assessment scale

Scale Items	Component				
	1	2	3	4	5
CK boost my enthusiasm for studying the material we covered in this course.	.887	.272	.153	-.116	.088
CK helped me learn course material better.	.583	.186	.323	.168	.605
I did not like using CK. (R)	.847	.061	.182	.253	.078
I enjoyed using the CK system.	.629	.359	-.177	.463	-.119
I felt more engaged with the class because we used CK.	.812	.285	.339	-.154	.146
I had a good experience with CK.	.848	-.019	-.023	.174	.017
I had no problems using the CK system.	.191	.158	-.410	-.351	.521
I understood more in this class because we used CK.	.244	.838	.023	.092	.182
If we didn't use CK, I would have been less interested in the topics we covered in this course.	-.054	.834	.021	-.011	.206
Investing time in the CK program was a worthwhile use of class time.	.518	.461	.417	.476	.026
It was exciting to get daily e-mails from the CK system.	.540	.078	.721	-.061	.228
My knowledge of course material was improved by using CK.	.200	.832	.159	-.247	-.079
The CK project was good use of class time.	.356	.349	.554	.239	-.059
Using CK did NOT get me any more involved in the class. (R)	.101	-.026	.058	.882	.005
Using CK heightened my interest in other aspects of the class.	.750	.386	.350	-.258	-.107
Using CK made me more motivated to learn in this course.	.203	.873	.154	.149	-.025
Using the CK system was a waste of class time. (R)	.510	.516	.220	.250	-.433
Using the CK system was boring. (R)	.835	.071	.199	.150	.397
Using the CK system was easy.	-.032	.012	-.939	-.058	.107
Using the CK system was fun.	.678	.285	.031	.152	.569
Using the CK system was pretty hard. (R)	-.154	-.199	-.889	.020	-.043

from the means of these three items ($\alpha = .757$).
Affective Learning

Affective learning is defined as “an increasing internalization of positive attitudes toward the content or subject matter” and “is viewed typically as an important motivator of students’ willingness to learn, use, and generalize information and skills beyond the traditional classroom” (Rubin, Plamgreen, & Sypher, 1994, p. 81). To assess student affect toward learning with respect to the CK project, students completed a slightly modified version of Affective Learning Scale (Kearney, Plax, & Wendt-Wasco, 1985); they were instructed to “respond about how you perceived your learning as related to the CK system and not to other elements of the course.” Responses

were recorded on a series of semantic differential scales (1 to 5) with respect to three areas of the CK program: behaviors recommended by the CK program (good/bad, worthless/valuable, fair/unfair, and positive/negative), content/subject matter of the CK program (bad/good, valuable/worthless, unfair/fair, negative/positive), and in “real life” situations, your likelihood of actually attempting to engage in behaviors recommended in the program (likely/unlikely, impossible/possible, probable/improbable, would not/would). Affective learning with respect to the CK project was calculated by taking the mean of all items. Internal consistency for this scale as measured by Cronbach’s alpha was .921.

Pre-Post Design Measures

Intercultural Communication

Three measures were used to assess pre- and post-intervention knowledge of intercultural communication: the generalized ethnocentrism scale, the personal report of intercultural communication apprehension, and the uncertainty when communication with strangers scale. The generalized ethnocentrism scale (Neuliep, 2002; Neuliep & McCroskey, 1997a) consists of 22 items, only 15 of which are used, that assess the general tendency to see the world from one's own cultural perspective. The 15-item scale achieved excellent reliability both pre- ($\alpha = .908$) and post-test ($\alpha = .939$).

The Personal Report of Intercultural Communication Apprehension (PRICA) (Neuliep & McCroskey, 1997b) assesses anxiety within intercultural communication exchanges. This 14-item measure ($\alpha_{pre} = .881$; $\alpha_{pst} = .959$) produces scores between 14 and 70, with scores below 32 indicating low intercultural communication apprehension (ICA), scores above 52 indicating high ICA, and scores ranging between 32 and 52 indicating a moderate level of ICA.

Items from the Uncertainty When Communicating with Strangers Scale (Gudykunst, 1998) were modified slightly to measure confidence/uncertainty when engaged in cross-cultural communication. For example, the item "I am not confident when I communicate with strangers" was reworded to read "I am not confident when I communicate with members of other cultures." Alpha reliability for this scale was .830 pre-test and .520 post-test.⁶Public Speaking

One measure was used to assess levels of competence with public speaking. The Personal Report of Public Speaking Anxiety (PRPSA) (McCroskey, 1970) consists of 34 items that are added to form a composite score between 34 and 170. Given excellent reliability estimates ($\alpha_{pre} = .962$; $\alpha_{pst} = .965$), scores could be interpreted as consistent with prior research: highly apprehen-

sive (scores above 131), moderately apprehensive (scores between 98 and 131), and low apprehensive (scores below 98).Parent-Child Communication

Self-reported competence when communicating with one's parents was assessed in two primary ways. First, eight questions were written and embedded in the interpersonal competence questionnaire (Buhrmester, Furman, Wittenberg, & Reis, 1988), a 40-item scale that assesses five social competencies. Four items concerned how comfortably respondents handled situations with their father (e.g., talking to your father about personal problems or issues.) and the same four items concerned how comfortably respondents handled situations with their mother (e.g., handling a conflict with your mother.). Responses were recorded using a 5-point scale: 1 = I'm poor at this; I'd be so uncomfortable and unable to handle this situation that I'd avoid it if possible; 2 = I'm only fair at this; I'd feel very uncomfortable and would have lots of difficulty handling this situation; 3 = I'm okay at this; I'd feel somewhat uncomfortable and have some difficulty handling this situation; 4 = I'm good at this; I'd feel quite comfortable and able to handle this situation. 5 = I'm EXTREMELY good at this; I'd feel very comfortable and could handle this situation very well. Internal consistency was as follows: father and mother combined ($\alpha_{pre} = .858$; $\alpha_{pst} = .773$), father ($\alpha_{pre} = .920$; $\alpha_{pst} = .895$), mother ($\alpha_{pre} = .735$; $\alpha_{pst} = .855$).

Second, a family communication questionnaire was written to assess how likely a respondent is to talk with his or her father/mother about several situations. Those situations were as follows: (a) "If you are having problems with your homework," (b) "If you are trying to find a good book to read or a movie to watch," (c) "If you are thinking about your plans for the future," (d) "If you have had a quarrel with your best friend," (e) "If you want to know something about alcohol or other drugs," (f) "If you are really angry or upset about something," and (g) "If you feel bad or guilty about something you have done." Respondents

recorded responses on a 5-point scale from Almost Never (1) to Almost Always (5) with the midpoint indicating Sometimes (3). The scale achieved excellent reliability for father-oriented responses ($\alpha_{\text{pre}} = .929$; $\alpha_{\text{pst}} = .895$). After removing one item (If you are thinking about your plans for the future), the mother-oriented scale also achieved excellent reliability ($\alpha_{\text{pre}} = .907$; $\alpha_{\text{pst}} = .906$). The combined scale achieved adequate reliability ($\alpha_{\text{pre}} = .823$; $\alpha_{\text{pst}} = .833$) after the removal of the same item. Interviewing

Self-reported interviewing competence was assessed in two distinct ways. First, four interview competence questions were written and embedded in the Interpersonal Competence Questionnaire (Buhrmester et al., 1988). Those items were: (a) "During an interview, telling a potential employer my strengths," (b) "During an interview, telling a potential employer my weaknesses," (c) "Asking relevant questions at the end of an employment interview," and (d) "In a job interview, responding quickly and comfortably to questions." Response choices were the same as indicated in the previous section. Since alpha reliabilities did not indicate an internally consistent scale at either pre- ($\alpha = .381$) or post-test ($\alpha = .591$) this measure was not included in further analyses.

Second, a more objective measure of job interview knowledge was created which included both general (e.g., what is the purpose of the job interview?) and more applied questions (e.g., what is the best way to respond to the request, "Tell me about yourself?"). Respondents were given three answers in a multiple choice format. Questions had one correct and two incorrect answers, thus scores could range between 0 and 10.

Results

Self-Report Learning and Knowledge

To assess student self-perceived learning, a series of single sample t-tests were conducted with a value of 3 (the mean of all three variable scales) as the test value. Results showed statisti-

cally significant differences (90% CI) for CK knowledge, $t(17) = -2.05$, $p = .057$, $M = 2.63$, $SD = .778$, affective learning, $t(16) = 2.57$, $p = .021$, $M = 3.56$, $SD = .894$, and perceived communication improvement, $t(17) = 2.68$, $p = .016$, $M = 3.51$, $SD = .805$; there was a non-significant difference for CK enjoyment, $t(17) = .091$, $p = .929$, $M = 2.98$, $SD = .740$. An additional analysis was run to assess the utility of the CK project beyond simple classroom purposes. As previously mentioned, one subscale within the affective learning scale refers to the "likelihood of actually attempting to engage in behaviors recommended in the program" in "real life situations." This composite subscale achieved excellent reliability at .90. A one-sample t-test with 3 as the test value produced a marginally significant and positive result, $t(16) = 1.99$, $p = .063$, $M = 3.59$, $SD = 1.22$.

Thus, students seemed to enjoy the CK program an average amount but perceived the program to aid in their comprehension and improvement of key communicative behaviors. Moreover, their affect toward learning material related to the programs as well as their likelihood of engaging in relevant behaviors was also above the mean. The negative result with respect to CK Knowledge can be explained with respect to the specific items. As compared to the Perceived Communication Improvement and Affective Learning items, the CK Knowledge items seem to measure the CK program as assisting in learning course material. The course material was more theoretical than applied and exams were focused on this theoretical material. The CK program was highly applied and not tested explicitly on examinations. Thus, although the students did not feel as if the CK project heightened their understanding of course material per se, they still felt as if the project aided in their understanding of a core social skill and in the improvement of this skill. Pre-Post Design Measures

After the four programs were finalized, students were randomly assigned to take a program they had not authored. Thus, all students fell into

one of three groups for all programs: program author, program taker, or control group.⁷ To control for possible differences in pre-test scores a series of one-way ANCOVAs were run to test the expectations that, within each context, the author group would achieve the greatest improvement from pre- to post-test, the taker group would achieve the second greatest improvement from pre- to post-test, and the control group would achieve the least improvement from pre- to post-test.⁸ The rationale behind this hypothesized pattern of results is the time spent with the material. Individuals who engaged in the authoring process spent eight weeks engaged in researching and thinking about the concept under question. Meetings between group members and the instructor indicated the depth in which students were exploring the material and the exponential growth in their understanding as they attempted to translate scholarly research into real-life suggestions (in the form of micro-lessons) that took no more than five minutes for an individual to comprehend.

The dependent variable was always the post-test score, the fixed factor was group membership (author, taker, control), and the covariate was always the pre-test score. Given the small sample size, power analyses indicated that even a 90% level of statistical significance would be difficult to achieve: large effect (power = .40), medium effect (power = .20), small effect (power = .10) (Cohen, Cohen, West, & Aiken, 2003). Means, standard deviations, standard errors, and group sample sizes for all variables of interest are presented in Table 5. Table 6 presents the results of a series of ANCOVA analyses. As indicated in the table, the only significant result found was for public speaking anxiety. A series of simple contrasts showed that, as predicted, those students who authored the program had a lower level of public speaking anxiety post-test than did controls, Contrast Estimate = -27.2, $SE = 11.9$; however, authors did not differ significantly from takers, Contrast Estimate = -12.8, $SE = 13.7$, and takers did not differ significantly from controls, Contrast

Estimate = -14.5, $SE = 12.4$. Given the power to detect significant effects and the exploratory nature of the present study, the discussion section presents explanations for all findings in light of inherent limitations.

Discussion

Adding to the descriptions of how students incorporate CK material into their personal and professional lives obtained in study one, the present investigation allows for a slightly more rigorous test of the assumptions that the CK system provides students with a meaningful learning experience. Although the sample size in this study warrants caution be taken when extrapolating the results to a larger population, this study does provide evidence that students in the present study felt as if the system aids in their understanding of a particular social skill (at least within the confines of a typical semester project). Moreover, they report that engaging in behaviors recommended by the system is likely. Insofar as the behaviors recommended are appropriate for the skill in question, the system shows promise in allowing instructors to engage in a blended learning approach to teaching skills that may otherwise be overlooked, ignored, or given peripheral treatment in a more theoretically-driven classroom. As mentioned previously, the course in study two is largely theoretical with little emphasis on skills training. Incorporating CK in this manner increased student engagement with both scholarly literature and application potential of this material.

In terms of the pre- and post-test knowledge assessment, power to detect significant differences between groups was dismally low. Nevertheless, several results are worth extended discussion. First, the public speaking program produced the only statistically significant result with program authors achieving lower public speaking anxiety scores post-test than controls; no differences were found between program takers and program controls. In addition, as indicated in Table 5,

Table 5. Part one: Group size, means, standard deviations, and standard errors of cross cultural and public speaking measures

Cross Cultural Communication					
	Program	N	Mean	SD	SE
Ethnocentrism Pre Test	Author	5	25.40	6.02	2.69
	Taker	5	32.60	8.62	3.85
	Neither	10	34.30	6.63	2.10
	Total	20	31.65	7.64	1.71
Ethnocentrism Post Test	Author	5	25.20	5.45	2.44
	Taker	5	32.60	7.80	3.49
	Neither	8	36.00	13.67	4.83
	Total	18	32.06	10.93	2.58
Intercultural Communication Apprehension Pre Test	Author	4	30.75	7.54	3.77
	Taker	4	32.00	1.63	0.82
	Neither	10	34.90	8.88	2.81
	Total	18	33.33	7.46	1.76
Intercultural Communication Apprehension Post Test	Author	5	28.40	12.52	5.60
	Taker	5	30.80	4.76	2.13
	Neither	8	34.13	11.56	4.09
	Total	18	31.61	10.17	2.40
Public Speaking					
Personal Report of Public Speaking Anxiety Pre Test					
Personal Report of Public Speaking Anxiety Pre Test	Author	6	107.83	26.71	10.90
	Taker	5	107.60	20.89	9.34
	Neither	9	95.78	21.55	7.18
	Total	20	102.35	22.63	5.06
Personal Report of Public Speaking Anxiety Post Test	Author	5	99.40	35.66	15.95
	Taker	4	108.00	26.92	13.46
	Neither	9	115.11	20.07	6.69
	Total	18	109.17	25.76	6.07

program authors seemed to decrease and controls seemed to increase their anxiety while program takers seemed to stay relatively stable. The fact that a significant result was found with respect with the public speaking program may reflect the fact that all students in the present class had been exposed to similar instruction prior to the class in

the form of the basic speaking course (a course that is required for most students at this particular university). Thus, additional reinforcement may have triggered cognitive stores of information (i.e., chunks) and strengthened the links between this information (see Bodie et al., 2006).

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Table 5. Part two: Group size, means, standard deviations, and standard errors of parent-child and interviewing measures

Parent-Child Communication					
	Program	N	Mean	SD	SE
Family Communication Competence Pre Test	Author	4	4.06	0.63	0.31
	Taker	5	3.63	0.99	0.44
	Neither	11	3.46	0.66	0.20
	Total	20	3.62	0.74	0.17
Family Communication Competence Post Test	Author	4	3.78	0.28	0.14
	Taker	4	3.25	0.92	0.46
	Neither	10	3.45	0.65	0.21
	Total	18	3.48	0.65	0.15
Family Communication Questionnaire Pre Test	Author	4	3.85	0.57	0.29
	Taker	5	3.05	1.46	0.65
	Neither	11	2.73	0.62	0.19
	Total	20	3.03	0.95	0.21
Family Communication Questionnaire Post	Author	4	3.35	0.28	0.14
	Taker	4	3.02	1.24	0.62
	Neither	10	2.85	0.86	0.27
	Total	18	3.00	0.84	0.20
Interviewing					
Job Interview Knowledge Pre Test	Author	5	5.20	2.59	1.16
	Taker	5	6.20	1.30	0.58
	Neither	10	5.10	0.57	0.18
	Total	20	5.40	1.47	0.33
Job Interview Knowledge Post Test	Author	4	5.25	1.71	0.85
	Taker	5	6.40	1.52	0.68
	Neither	9	6.00	1.00	0.33
	Total	18	5.94	1.30	0.31

Table 6. Results of the ANCOVA analyses

	<i>F</i>	<i>df</i>	<i>p</i>	Partial η^2	Post-Test M in Predicted Direction?
Cross Cultural Communication — Ethnocentrism	.824	2,18	.459	.105	Yes
Cross Cultural Communication — PRICA	.104	2,16	.902	.017	Yes
Public Speaking — PRPSA	2.69	2,18	.103	.278	See contrast results
Parent-Child Communication — Family Communication Competence	.451	2,18	.646	.061	No
Parent-Child Communication — Family Communication Questionnaire	.072	2,18	.931	.010	Yes
Interviewing — Job Interview Knowledge	.136	2,18	.874	.019	No

One aspect of the class that may have influenced this result is the fact that all students were required to present an abstracted version of a scholarly article as a course requirement. Presentations were 15 to 20 minutes in length and basic public speaking criteria were used as a part of the grading rubric. This was done throughout the semester with approximately one student presenting per class period. It is possible that program authors, with an extended and in-depth exploration of this subject, felt better about this particular experience as a result of their research and program writing while the program takers did not have the opportunity in a three-week program to obtain all the positive benefits of such instruction. Those that neither authored nor took the public speaking program were not only exposed to an anxiety producing speaking event, but they had no further instruction as to how to manage their anxiety or how to improve their skills; they also lacked the potential additional feedback that such instruction may have afforded the other two groups. In other words, this recent public speaking event may have served as a reference point to all students as they answered the post-test questionnaire.

A second set of results that supports the utility of the CK system are those non-significant results that met expectations in terms of patterns of group means. Within the cross cultural communication program, program controls had the highest and authors had the lowest post-test ethnocentrism scores with the mean for program takers falling between. It is also notable that only the program controls exhibited a change of over .20 between pre- and post-test scores going from an average of 34 to an average of 36 on ethnocentrism over the course of the semester. Similarly, program controls had the highest and program authors had the lowest anxiety levels related to cross cultural communication with program takers falling in between. As with the ethnocentrism variable, pre- to post-test change for each group was also in line with expectations; control participants showed the smallest decrease in cross cultural communica-

tion anxiety (.77) and program authors showed the greatest decrease in this variable (2.35), with program takers falling between these two (1.2). Given that cross-cultural communication is likely a new topic, especially in relation to the other programs, it is possible that none of the students had much prior exposure. Thus, there may be little information stored in long-term memory to which students can incorporate new bits of information to form larger chunks. With increased exposure, we would expect this mechanism to begin operating and for the observed mean pattern to remain. This also points to a potential limitation of the CK system, namely, some material may need to be presented in longer or shorter sessions with more or less repetition and cross application depending on the nature of the material and the individual learner.

Finally, the results related to parent-child communication showed some awkward patterns (and they were not statistically significant). This, along with the job interview results, may suggest that certain topics are not as productively taught in the present format. In the case of parent-child communication, it may be that some individuals were raised and continue to communicate in single- or split-parent households; even those whose parents are still married may experience more or less productive talk in this context. In the case of some students it might be irrelevant to discuss strategies in terms of parents or of specific recommendations related to one or the other parent. Likewise, when responding to questionnaire items individuals from "non-traditional" family structures may interpret items differently. For instance, for those with step parents to whom should the student refer when answering about conflict?

For the job interview results, it might be that students, most of whom were in their junior year, were not particularly motivated to engage with material so seemingly distant. Moreover, as with the intercultural communication material, students taking the job interview program may have had little prior knowledge from which to build large

schema needed to fully become competent in this area. Alternatively, the material presented in the job interview program may have been at odds with previously learned tidbits about the job interview process. Investigation of, and comparison with, other material may be warranted with this and similar skills. It is possible that the CK system could also be used to integrate relevant opposing opinions and suggestions; however, the format of such a protocol would differ in substantial ways to that presented.

Overall, the student-authorship integration addressed goals similar to traditional integration (e.g., break down complex topics into small, manageable bits of information), but also dealt with the confines of a common service course. Theory and practice are inherently intertwined but semester time constraints often restrict serious focus on both. Incorporating CK as the skills-based component and using the online system as a group project allowed for the integration of theory, scholarly research pertinent to four areas of social skill, and direct hands-on application. The project was not without flaws, however. Limiting programs meant teaching social skills that have accumulated vast amounts of research to 15 keys. This poses problems of comprehensiveness and accuracy. It also limits repetition which can enhance code building and cross application which can help to build needed stores in long-term memory. Similarly, the programs contained material only as good as its authors. The potential downfalls of teaching either inappropriate or controversial information in a format meant to build mental stores that rest in a relatively stable long-term memory structure should not be overlooked and is one area in need of added attention if this integration is used in the future. Finally, multiple measures of similar constructs were used thus necessitating alpha correction for t-tests and multivariate statistics for the pre-post design. Thus, appropriate statistical tests were not run in many instances and assumptions related to other tests were certainly violated. Thus, results

should be replicated with larger samples in future research. Nevertheless, a second application was presented and seems to aid in achieving particular pedagogical goals.

CONCLUSION

Given the prevalence of technology for use in higher education, it is important for instructors to be informed of the ways in which different technology options can aid in or detract from achieving specific pedagogical goals and objectives. Concept Keys offers one way to break down complex topics into smaller, more manageable bits of information. This system is based on how students learn (see Bodie et al., 2006) and is easily integrated into existing curriculum. Two ways in which integration is possible were explored and data was presented that shows how students perceive the system and how learning may be affected. Although future research is needed, CK should be considered a viable alternative to traditional, lecture-based formats. This system provides instructors with an easy way to supplement textbook treatments of material or to offer an additional skills-based component to a more theoretically oriented class. Other integration strategies are also possible. For instance, basic communication course textbooks often do not treat listening in a thorough manner (Janusik & Wolvin, 2002). The CK program on effective listening might be used as a supplement for this lack of focus in such a course as opposed to a supplemental text in a course on listening. The sections below explore some reflections on why CK is likely to produce results seen thus far in our research.

Active Learning and Reflexive Thinking

Oftentimes lecture-based instruction does not allow for students to interact and wrestle with course material. Thus, good teachers structure the

classroom in a way that promotes active learning. Active learning is seen most directly in the skit activity from study one and the overall implementation of a student authored e-book in study two. Each of these learning centered approaches allowed students to become involved in the learning experience. The second integration strategy furthermore allowed students to have a voice in the production of course material. In groups, students selected material that they wanted to engage with and present in a skills training program. This may be an even more productive form of active learning than producing skits about mandated material.

An additional way to foster such an environment is by allowing students to self-manage their learning by increasing the responsibility of the learner to think critically about course material (Thomas & Busby, 2003). When teaching listening, Cost, Bishop, and Anderson (1992) “encouraged [students] to explore and understand what words, phrases, or topics get them emotionally involved; what their listening strengths and weaknesses are; and how to recognize what motivates other people to speak and behave as they do” (p. 42). In this way, the student is actively engaged with course material, reflexively thinking about that material, more likely to relate the material to his or her circumstances, and able to incorporate what it means to be socially competent within in his or her unique frame of reference.

CK encourages reflexive thinking on a daily basis through the use of the FFT questions; reflexive thinking was also explored through weekly essay assignments used in study one. Similarly, each week, after all five keys were presented, instructors can have students prompted by the question, “Of the five (5) most recent Keys you have received, which one is most important to your (career, personal, social) success?”⁹ After choosing this most important key students are asked, “How will you apply this most important Key in your everyday interaction?” In addition to these built-in personal relevance motivators (i.e., integrating, self-selection and self-determination)

the expected success of the CK system is also contingent upon the instructor taking on the role of program leader and providing motivational leadership in the form of high student involvement in program decision-making and assisting in making the learning process enjoyable and individualized (see Powers et al., 2005). This was accomplished in the first study by a written essay assignment and a group skit activity. In the student-authored integration students were actively involved in both creating a unique e-book and taking an online course that was created by classmates. On course evaluations, students in study two wrote most extensively about CK and how “cool” it was to be a published author as an undergraduate. Although not conclusive, this at least suggests students took learning into “their own hands.”

Our Continuing Challenge

It is not uncommon to hear students complain about taking courses on presentational speaking, listening, interpersonal communication, and other related topics because “I already know how to speak” or “I listen all the time.” However, as one of the authors explains to his students: simply because an individual possesses a car and drives daily does not mean he or she is a skilled driver. Social skills, like driving, can be performed more or less successfully. Social skills, like driving, also have many manifestations—communicating interpersonally is qualitatively different from public speaking which is different from effective group interaction or handling conflict.

The challenge then becomes not only how to engage the students with learning social skills, but also how to change thoroughly ingrained (and oftentimes bad) habits. In other words, the educator’s challenge is how to re-teach practices that are ingrained in the student’s way of thinking and way of interacting in a social environment. CK approaches this by engaging the student in his or her learning environment via daily e-mails that

incorporate elements of explanation and motivation. Given the likelihood of learning incorrect behavioral sequences related to social skills, CK attempts to aid the learning of correct behavioral and cognitive records to be recalled in the correct context in three distinct ways.

First, programs have been designed and future authors are encouraged to include micro-lessons that are repetitive and cross over potential applications. Not only will students attach different meanings to keys but the contexts in which the keys can be applied are inherently different. Thus, “repetition allows the student to build larger chunks of information based on similarities between Keys and allows for extended priming opportunities across contexts” (Bodie et al, 2006, p. 125). This motivation is furthered by the use of FFT questions which virtually force students to attach keys to personal experience. As mentioned above, the lack of such repetition in the form of repetitive keys was a main limitation of the student-authored study. Similarly, in study one learning was somewhat restricted to a three-and-a-half week delivery of material as opposed to the traditional 10 week structure. Even so, incorporating keys into personal experience was one of the three main themes found in study one.

Within the first study, the traditional 50 key sequence utilized the above components (explanation-motivation, repetition, etc.) in a way that was set previously by book authors. However, this same model was utilized when students authored their own e-books. Students were instructed that keys must be brief and clearly communicate the overall purpose for a particular day. It was also explained that the paragraphs constituting the remainder of the micro-lesson should both explain and motivate proper key usage. This model can be used or other protocol developed to more easily fit instructor goals. For instance, instructors who want to author unique e-books for specific classes can begin to blend current materials with the CK system in order to produce a third type of integration similar to but not isomorphic with

the authorship study. The point is that CK offers the hardware and online support some suggest (Bonk, 2001) as the primary obstacle for secondary educators instituting Web-based blended learning.

In sum, the CK system was built to teach social skills that are broad, ubiquitous, and often difficult to teach due to lack of student engagement and prior habits that are brought into the learning environment. Although the above studies do not cover the entire gamut of possibilities, we feel that what has been presented offers those who teach social skills the tools necessary to institute a fun and effective way to blend traditional instructional practices with Web-based learning. CK can be tailored to fit specific pedagogical objectives which is a mark of a useful instructional technology. Moreover, students appear to learn from the program in theoretically driven ways. The need for future research should not halt the extended use of this blended learning approach to social skill development.

FUTURE RESEARCH DIRECTIONS

The rapid rate at which technology is available to instructors presents a number of questions for future research. Questions specifically raised by this study include issues of online learning protocol in general and the CK system in particular. First, more research is needed that helps specify the boundary conditions for e-learning technology. For example, are some learning objectives, although possible to achieve online, better achieved in more traditional or blended classroom environments? If so, why? Is it because the classroom can foster active and peer learning, whereas online systems often stifle such learning potential? Are efforts to enable active learning and peer learning online effective and seen as productive? The answers to questions such as these should be based on sound theory. As previously discussed, the limitations of our research prevent us from making broad generalizations. Our findings do,

however, provide a foundation for testing existing and yet-to-be-developed learning systems that are similarly based on theories of learning, memory, and information processing.

The research that has been conducted with the CK system has been small-scale and mainly presented in the form of case studies. Experimental studies that randomly assign participants to engage or not engage with the CK program would be an ideal next step for research to progress. If truly experimental studies are not possible due to the design of the system (designed for use in a classroom setting), research needs to examine the effects of variables that exist on multiple levels within the same study. Building and testing multilevel models that enable the simultaneous inclusion of aggregate, group-level, and individual variables are needed to test such effects. Likewise, research should address the longitudinal effects of empty engines such as CK. Specifically, issues such as the extent to which CK enables students to build large chunks of information that can be recalled from long-term memory with appropriate priming stimuli and the identification of those primes should be addressed. Future researchers will also need to refine measurement devices needed to test such propositions.

A second set of questions addresses whether students learn differently when material is presented online versus offline. Future research in this area should examine the impact of presenting online information in its entirety as opposed to presenting it gradually and sequentially. In addition, given some of the results from study two, we should address whether the CK approach of breaking down complex ideas into small, manageable units of information is a better approach for all learners and for all subject matter. In other words, will online systems such as CK be able to provide more advanced learners with a meaningful learning experience? What about students who do not possess characteristics of self-motivated and self-managed learners? If not, how will it need to be modified to be the most effective?

Finally, future research should be conducted on potential additions and alterations to the CK learning system that are either currently unavailable or have the potential to evolve as technology itself evolves. For example, as video-conferencing capabilities develop for use in truly distance education contexts wherein teacher and student interactions will approximate the personal atmosphere found in the face-to-face traditional classroom and office environment, will increased or different learning outcomes be enhanced or comparable to the in-classroom or office face-to-face tradition?

Ultimately, the possibilities of research that are generated by the introduction of the CK and similar learning systems are limitless. Not only do we need to modify existing theories within education and learning, but we also need to build sound, novel theories that help explain the phenomena germane to online learning specifically. CK was developed from sound theories of education, and research is needed to support many of the assumptions underlying this approach. Further research and theory from the areas of technology acquisition, teacher immediacy, student-teacher interaction, learning and memory, and information processing, just to name a few, are also likely to prove fruitful for incorporation into and expansion of CK and similar learning systems.

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ENDNOTES

- ¹ The authors would like to thank Dr. Steven Wilson and Dr. John Greene for their insights and help with various stages of the project reported in study two of this chapter. All correspondence regarding this chapter should be directed to the first author. Address: Department of Communication, Purdue University, 100 N. University Ave., Beering Hall 2114, West Lafayette, IN 47907-2098; Phone: 765-494-3429 E-mail: gbodie@purdue.edu.
- ² A space is created for this student that stores information relevant to programs in which he or she is enrolled, the number of keys completed and the number yet to be completed; answers to FFT questions, and the amount of time spent on each key. Other options available on the system include weekly retention quizzes and a final certification exam; all of this information is likewise stored in the student's individual database. Teachers or others in supervisory roles also have access to this information through the use of an administrative login. Readers are encouraged to visit www.conceptkeys.com, explore the options, and sign up for a trial program.
- ³ Syllabi and other instructional material for either application will be made available upon request.
- ⁴ This is a common practice when using the traditional CK system but is only one of several options included in the Student Learning Instructor's Manual (see also Table 2).

- ⁵ Technical difficulties (the beta version of the CK template software) and time constraints imposed by the semester format made Monday through Friday delivery impossible to implement. Participation indices obtained by the CK system indicated that this alternative delivery was not a problem for the majority of students. At most, students skipped one day, usually on the weekend, and completed two keys in one day in order to catch up.
- ⁶ Given the low reliability post-test, the measure of cross cultural uncertainty was excluded from further analyses.
- ⁷ Since all data are not independent, a main assumption of ANOVA has been violated. In addition, equal sample sizes were not achieved. Similarly, in most cases multiple dependent variables were used to measure pre-post differences. Thus, MANOVA and MANCOVA are arguably the more appropriate techniques (small sample sizes precluded a full multivariate form to be utilized). Thus, all results should be tempered by these limitations. However, given the primary goal of the project was for students to become “communication trainers” within an interpersonal

communication course, this limitation was disregarded and considered less important than the pedagogical objective. Thus, the analyses presented show preliminary evidence of the success of this project based on previously validated measures of the constructs in which students attempted to train their classmates.

- ⁸ Although only one of the DVs showed a significant difference between pre-test scores based on group membership in a series of oneway ANOVAs (data not presented but available from first author upon request), the lack of power to detect even large effect sizes seemed to warrant controlling for these pre-intervention assessments. Nevertheless, a series of 3 X 2 mixed model ANOVAs were also run with repeated measures on the last factor (pre-test, post-test scores). The between-subjects factor was always group membership (author, taker, control). The results from these analyses produced results comparable to the oneway analyses and are not reported but are available from the first author upon request.

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Chapter 7.12

Conversation Design in the Electronic Discussion Age

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ABSTRACT

The electronic age offers technologies that have great potential to empower conversation. The following chapter introduces a model for coding electronic discussion. Inherently the use of the so-called “cognotes” has been shown to improve the quality of conversation by promoting more analytical and substantive contributions to asynchronous discussion. The chapter further elaborates on tested classroom models that embed the coding approach in second order technology exercises. The chapter culminates in a synopsis of what has been ascertained about the coding strategy over a range of action research studies.

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EDUCATOR’S INTEREST IN CONVERSATION

The study of discourse has long been of interest to educators (Cazden, 1988; Edwards & Westgate, 1994; Young, 1992) and has culminated in sophisticated research agendas that include semiotics (Lemke, 1997), symbolic interactionism (Charon, 1998), and most recently a renewed interest in the notion of distributed cognition (Courtney, 2002; Karasavvidis, 2002). In the context of teaching, these interests all surround the educational aim of supporting and promoting quality student conversation. Ideally, conversations within classrooms or asynchronously through communication technologies have the potential to promote social construction of knowledge (Brooks & Brooks, 1993;

Prawat, 1996). With respect to discussions, Davey and McBride (1986) suggest that the process of generating questions helps students' comprehension and "encourages them to focus attention, make predictions, identify relevant information, and think creatively about content" (McTighe & Lyman, 1988). Some instructors have gone so far as to devise analytical symbols to cue students to the nature of their conversation and further, to involve them in metacognitive exercises where they examine how it was that they interacted in conversation (Knight, 1990). All of these research endeavours point to the fact that conversation is a complex process.

Often conversations are categorized based on their purpose. As such, Jenlink and Carr (1996) have identified four types of conversations—dialectic, discussion, dialogue, and design. Taylor (2002) further elaborates on these. "Dialectic conversation is a form of 'disciplined inquiry into whatever is being examined' (Jenlink & Carr, 1996). Its procedures are those of logical argument, and the underlying intention is the formation of rigorously defensible interpretations." "Discussion is the form of conversation where participants tend to argue their own position, and is more subjectively influenced by opinion and supposition" (Jenlink & Carr, 1996). Thus personal experience and assumptions tend to be at the centre of the conversation."

Dialogue is a form of conversation focused on the sharing and construction of meaning. It helps to develop collective mindfulness, and thus, "is a community-building form of conversation." The dialogic processes require individuals to "first examine their personal assumptions or opinions and then suspend these assumptions before the entire group" (Jenlink & Carr, 1996).

Design is focused on the creation of something new through "disciplined inquiry grounded in systems philosophy, theory, and thinking and practice" (Jenlink & Carr, 1996).

In particular, design conversations tend to look beyond existing constraints, seeking to design new systems that avoid or minimize those constraints. They require that participants suspend assumptions about what 'ought to be,' as well as 'what is possible.' Thus design conversation 'goes beyond the suspension of personal opinions and moves into a suspension of mindsets themselves.' These types of conversations tend to be unusual in everyday experience, and to be associated with the work of creative teams.

These modes of conversation can easily be envisaged in face-to-face settings yet Web-based models and variations are becoming increasingly popular with educators.

ELECTRONIC CONVERSATION COMMUNITIES: PRODUCTIVE STRATEGIES?

Electronic discussion has become a typical tool for teaching in online learning environments. In addition, asynchronous electronic discussion is commonly used to: (1) prepare students for face-to-face (hereafter Ftf) discussions in an ensuing class, (2) introduce a new reading in preparation for an ensuing Ftf class meeting, (3) discuss a topic that required further investigation than the Ftf class time allowed, (4) interview class members, and (5) provide an open forum for discussion led by student interest.

From early studies (Harrington & Hathaway, 1994, 1995; Harrington & Quinn-Leering, 1994) it has become clear (Kuehn, 1994) that the asynchronous nature of the electronic discussion group (hereafter EDG) and the accessible transcripts of dialogue, make the EDG a unique phenomena that is curiously different from Ftf conversations.

Considerable effort has gone into developing electronic environments that foster positive and productive discourse (Daradoumis & Marques, 2002; Hewitt & Scardamalia 1989; Scardamalia, 2002; Scardamalia & Bereiter, 2003). The

CSILE (computer-supported intentional learning environment) is a communication tool developed by Scardamalia et al. that allows students to purposefully process information via access to a unique database of information. This electronic model promotes quality conversation based on the premises of the seminal notions of distributed cognition and knowledge building (Pea, 1993).

Sherry, Tavalin, and Billig (2001) describe a project where multimedia telecommunications are used to encourage, support, and create an electronic environment for student inquiry, expression, and dialogue around assigned literature. Ultimately, it serves as a medium for presenting and assessing student's creative art, music, and multimedia. Arguably, this approach is an example of the "design" category of conversation.

Paulus (2005) also makes a case for using electronic conversation to support constructivist learning. "One purpose of online group projects is to encourage collaborative dialogue for new knowledge construction. During such projects students have a dual objective: learn through constructing new knowledge together while also completing the task."

Van Aalst (2006) makes particular reference to "knowledge building" in asynchronous learning networks. He proposes that productive electronic conversation can be subdivided into processes of collaboration, learning how to learn and idea improvement.

As promising as electronic conversation may seem, Chen and Hung (2002) issue a warning.

In this chapter, we highlight a concern with using online discussion for learning. We argue that there is a lack of technological support for the development of personalized knowledge representation for most online discussion forums. Analyses of existing discussion forums suggest that there is a range of collective knowledge representation mechanisms which support a group or a community of learners. However, such mechanisms may not necessarily lead to learn-

ers' internalization of collective knowledge into personalized knowledge.

The Pitfalls of Traditional Electronic Discussion

Since its inception, electronic discussion has been used primarily as a forum where students could carry on discussions related to course curriculum. While this has provided a comfortable setting for some students to have conversation, the nature of the conversation need not be particularly substantive. In an effort to promote quality interchange in these communications, some instructors have devised simplistic rubrics to track, for instance, the number of times a participant engaged electronic discussion. Furthermore, some educators have insisted that students discuss a certain question and grades have been assigned based on threads and numbers of threads of related queries. Recent research has indicated (MacKinnon, unpublished) that these "forced conversation" schemes tend to contribute to artificial conversational interactions which bear little resemblance to the educational ideal of quality Ftf conversation rooted in real questions and sociological positions of difference. Students in these EDGs tend to make inventive, less-than-spontaneous token contributions to the conversational exchange. How can we improve the impact of this technology-enhanced conversation mode?

Elevating the Ultimate Goals of Electronic Discussion

It is important to realize from the onset that electronic discussion offers a distinctly different environment for conversation than Ftf classroom discussions. Research on gender issue discussions in science teacher training (Hemming & MacKinnon, 1999) has shown clearly that individuals have different comfort levels in each communication venue. For instance, even in small group Ftf settings, amongst an even gender distribution

of mature (25 year old) teacher interns, women in the course felt very uncomfortable verbally sharing their ideas around gender discrimination in schools; they expressed a certain pressure to conform to the ideology that gender discrimination was no longer an issue in schools. The electronic discussion format was generally the preferred means for them to engage a conversation about gender issues in schools. The men in the same class generally and conversely felt less comfortable writing (in the EDG) about their sense of high school discrimination and preferred to express themselves verbally in an Ftf conversation.

Clearly there is pedagogical potential for electronic conversation in situating the process within meaningful learning exercises. The research (MacKinnon & Aylward, 1998) has demonstrated that the quality of student's electronic conversations can be improved substantially by instituting a system of pictorial discussion codes (called *cognotes*) that cue students to engage discussion using more substantive conversation styles. This model is generic to all course curriculum as it emphasizes the process of conversing rather than the content. Subsequent sections of this chapter begin with a description of the cognote foundation system and continue with an outline of the continuum of strategies for incorporating this system in progressively more embedded pedagogical approaches. Research conducted on these systems generally followed a format of: survey (and associated quantitative analysis), semi-structure open-ended interviews (Patton, 2002), member checks, focus groups (Morgan, 1997), and peer debriefing (Sagor, 1992).

The System of Promoting More Substantive Electronic Discussion

By comparison to Ftf conversations, EDGs offer the additional benefit of a recorded transcript. This allows for a unique interaction between instructor and student.

A coding system (*cognotes*) has been developed (Aylward & MacKinnon, 1999; MacKinnon & Aylward, 2000) for use in EDGs. The choice of categories for this system was based on (a) an extension of hard-copy journal coding explored by Knight (1990) and (b) an analysis of patterns in a case study EDG (Hemming & MacKinnon, 1999).

Based on the concept of 'thinking tools,' Lyman (1987) developed an instructional strategy called "Thinktrix." This thinking matrix was a device that assisted students and teachers in their analyses of classroom discourse. Thinktrix involved using thinking types as a metacognitive aid for students to generate and organize their thought processes and knowledge production through questioning. The goal was to encourage the students to think creatively and critically about content.

Janice Knight (1990) employed seven adapted Thinktrix cues for use in reading response journals in elementary school. The pictorial codes helped students identify and construct journal entries based on thinking types whilst reminding students to include a range of response types. The present cognotes coding categories are adapted from Knight's cues for use in an electronic discussion context (Table 1).

The *cognotes* have a grounding in learning theory. The key theory guiding the development and use of cognotes is the concept of 'procedural facilitation' (Scardamalia et al., 1998). In her work she notes, "procedural facilitation is an approach that grew out of efforts to foster higher-order processes in written composition." The approach involves providing learners with temporary supports through the use of memory aids and structuring procedures. In designing instructional environments using procedural facilitation, the emphasis is placed on the ultimate cognitive aims.

Inherent to procedural facilitation is the metacognitive aspect of the cognote coding. The explicit choice of 'thinking types' in the students' written discourse encourages a reflection on their individual thinking processes. The assignment

Table 1. Cognote icons and categories

Specific Interaction Grade		Coding Icon
Acknowledgement of Opinions (evidence of participation)	1	
Question (thoughtful query)	1	
Compare (similarity, analogy)	2	
Contrast (distinction, discriminate)	2	
Evaluation (unsubstantiated opinion/judgment)	1	
Idea to Example (deduction, analogy)	2	
Example to Idea (induction, conclusion)	2	
Clarification. Elaboration (reiterating a point, building on a point)	2	
Cause & Effect (inference, consequence)	2	
Off-Topic/Faulty Reasoning (entry inappropriate)	0	

of codes identifies specifically ‘what they know about what they know.’

The *cognote* categories correlate with specific levels of *critical thinking* best characterised by Garrison (1992). In his model of critical thinking, cognote types correspond well with Stages 1-5 including: problem identification & definition, problem exploration & evaluation, and problem integration (Aylward & MacKinnon, 1999).

While the range of discussion pattern categories may seem endless, 10 cognotes (see Table 1) were eventually designated as a starting point (opinion acknowledgement, question, compare, contrast, evaluate, deductive, inductive, clarification, cause and effect, and off-topic). The assignment of grades (1 or 2, corresponding to a hierarchy cognitive engagement) to each of the cognotes was based on definitions that were clearly indicated to interns. Teacher interns were purposefully engaged in numerous coding exercises prior to the actual EDG in an effort to ensure that instructor and intern shared the meaning of the EDG contributions. Putting the intern in the role of evaluator of the discussion as

well as evaluator of the peer’s discussion was an intrinsically valuable pre-exercise.

The ultimate aim of the coding system is to encourage participants (at all educational levels) to engage in more substantive electronic discussion through a grading scheme that favors higher order discussion patterns.

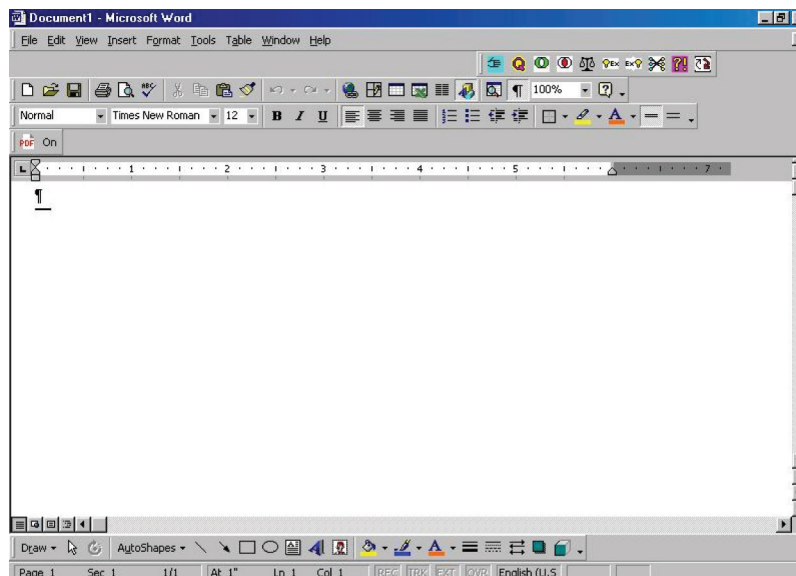
The Simplest Model: Instructor Coding

The instructor posted a discussion question to the EDG. The interns were encouraged to visit the forum and participate in the electronic discussion. The conversation proceeded for 1-2 weeks at which point the instructor captured the discussion (which is html-based). Using a set of macros (see Figure 1) each intern’s contributions to the conversation were coded with the aforementioned pictorial cognotes. The graded contributions were then returned to the intern via e-mail attachment. Interns had the opportunity to revisit and rationalize the nature of their conversation input before continuing with ensuing discussions. Quantitative studies (MacKinnon, 2000) have demonstrated that, over the course of three successive discussion group sessions, interns tend to write less, interns tend to contribute more substantively (i.e., the higher cognotes are assigned more often), and the instructor has assigned more cognotes (implying that the quality is also improving). The cognote system seems to promote critical thinking in that teacher interns tend to use higher order argumentation patterns over a period of three successive EDG sessions.

As the cognotes began to be used in more diverse settings it became important to examine two research questions: (a) the dilemma of assigning grades to a discussion and its impact on the spontaneity of participants (MacKinnon, 2000) and (b) the inter-rater reliability of the coding system (MacKinnon, 2003).

The research (MacKinnon, 2000) has shown that interns do improve their discussion patterns

Figure 1. Macro-enabled template for applying cognotes



because of the coding system. It remains a dilemma as to whether interns consciously access cognitively higher-order conversation tools because of the grades achieved or because the higher order discussion is part of their new process skill set. Interview data with interns have indicated that, despite the positive results, there is an even distribution of these two possible rationale for improvement. One might also ask the question, does it really matter why they are more substantive participants in the conversations? It does matter when we consider transferability of discussion skills, an aspect of EDG research discussed later.

The work on inter-rater reliability indicates there is potential for this system to be used with confidence. The findings (MacKinnon, 2003), based on a sample of 30 teacher interns suggest three indicators of reliability: (a) that raters assign similar grades to interns' discussion group contributions, (b) that raters predominantly assign the same cognotes to interns' discussion group contributions, and (c) that raters are selecting in excess of 50% of the same text in assigning the same cognotes.

Transferability of Improved Patterns Across Disciplines?

Do interns retain their electronic discussion skills in conversations held in other teacher education courses? Research was conducted to help answer this question (Pelletier, MacKinnon, & Brown, 2002).

Physical education students ($n = 70$) were asked to participate in an electronic discussion surrounding content issues in physical education. An exercise was then conducted in which students were (a) introduced to cognotes, (b) asked to distinguish between critical categories, and (c) asked to complete several coding exercises. The instructor then arranged for an EDG session on a second curriculum topic. Students were encouraged to consider the cognote pre-exercise as they participated in the second EDG. After the second discussion was completed, students were prompted to reflect on their initial EDG (i.e., prior to the introduction of cognotes). By comparison, over 60% (45 of 70) of students improved their discussion patterns in the areas of (a) building upon another's opinion in some manner and (b) substan-

tiating one's opinion. It is important to note that students were still assigned a grade based only on participation. While there was a marked improvement in discussion patterns, it was interesting to consider whether a grading scale may have had the impact noted in earlier work by MacKinnon (2000). These same physical education students were asked by a second professor (in an inclusive education course) to discuss two inclusion issues within an EDG format over separate, successive sessions. Concurrent with this, another section of inclusive education students, those who had not received any preamble to cognotes, were also asked to participate in two successive EDGs. Using the cognotes to evaluate the students' contributions, two trends became clear when comparing the two sections. The group that had received instruction on higher order thinking (i.e., through considering cognotes) in the physical education class showed, on average, more substantive discussion patterns in the inclusive education class than those who had received no instruction. A second observation was that students who had received instruction in the physical education class continued to improve their discussion patterns over two EDGs.

This research demonstrates that, given short time frames, a significant group of students transfer their improved skill of discussion between courses. From earlier work (MacKinnon, 2000), there also appears to be a trend strongly suggesting that applying higher grades to more substantive contributions improves discussion. Given this finding, it seems reasonable to suggest that the application of a grading scheme to inclusion course discussion sessions might also have led to an improvement in the transfer of discussion skills beyond what was recognized in this study (Pelletier, MacKinnon, & Brown, 2002).

Conversation Nested in Higher-Order Applications

There is tremendous potential for technology in going beyond the intended uses (Squires, 1999)

and incorporating technologies as "*mindtools*" for critical thinking (Jonassen, 1996). The practice of nesting technologies in higher order exercises, that in some ways subvert their initial intended use, is referred to by Maddux and Johnson (2006) as *Type II* technology applications. The following are three examples of how the coding exercise can serve greater aims irrespective of the content.

Why Not Have Interns Code Their Peer's Work?

MacKinnon and Bellefontaine (2000) have studied the use of the cognote tools in a middle school teacher education course. Seventy teacher interns were supplied with a CD-ROM containing case studies on middle school issues. Interns were placed in teams of three. Each team was responsible for participating in two electronic conversations concerning two separate case studies on their CD-ROM. In one EDG, a group was responsible for coordinating (focusing and leading) the discussion of a case study. In a separate second EDG, interns were participants (not leaders) discussing another case study. The discussions took place over a 3-week period. Each member of the coordinating team was responsible for leading the discussion during one of the 3 weeks. In addition, each member of the coordinating group was expected to use the cognote system to code and grade each of the participant's discussions for the 3 week period.

The added educational impact for teacher interns was evident through the means chosen for evaluating the activity. Each intern in the coordinating group was required to submit a written report on the case study over which they presided. A required component of that report was the "hard copy" captures of the online conversations they coordinated. They were expected to use the electronic discussion transcripts as a source of qualitative data for responding to the case study. The interns, knowing this in advance, had a sig-

nificant vested interest in leading a substantive discussion on their case study.

The electronic discussion is not simply used to share ideas but instead is further primed by the leaders to lend support and substantiation to the analysis of a case study. Moreover, facilitators may direct and focus the discussion to uncover new ideas and perspectives that potentially support or challenge their own ideas and analysis of the case. From a teacher educator perspective, this activity was especially important because it gave teacher-interns an opportunity to practice the role of coordinating a good discussion (whether the conversation may be electronic or Ftf) while simultaneously participating in a quality discussion and improving their cognitive engagement levels. It should be clear that embedding a rationale for contributing substantively to conversation in EDGs goes well beyond the token participation grade.

Coding to Scaffold Concept Mapping

In science education it is particularly valuable to employ concept maps to establish relationships between ideas in a hierarchal fashion (Novak, 1990). Recently (MacKinnon, 2006), the cognote system has been used to promote substantive conversation regarding the contentious issue of evolution versus creationism. More specifically, teacher-interns have been taught to support their understanding of the issues by drawing on the electronic discussion forum to improve relational understandings within a concept map.

In science education, teacher-interns are taught systematic strategies for engaging contentious issues in science (NSTA, 2000) with their students. In particular, science teacher interns are anxious to gain experience in dealing with the complicated controversy of creationism versus evolution.

The instructor supplied interns with an incomplete electronic hierarchical *concept map* (Novak, 1990) prepared with the software [®] Inspiration (see Figure 2). A conscious choice was made to

access electronic concept mapping tools in that they have been shown to result in more conceptually complex mapping amongst interns (Royer & Royer, 2004). The concept map was based on component ideas that the instructor would introduce in three consecutive class lectures on aspects of engaging evolution vs. creationism in science classrooms. The concept map was incomplete in that the relational phrases between concepts were left blank.

A special power of the Inspiration software[®] is the ability to hyperlink external documents not only to concept boxes but also to the propositional phrases that link the concepts. Priming this capability, interns can build up a meaningful graphic organizer in one dimension while providing substantiation of their understanding through hyperlinked supplemental information in the second dimension (see Figure 3).

Science teacher interns were introduced to the creation controversy in three consecutive lectures that conceptually were represented in a concept map (see Figure 2). As they constructed new knowledge they electronically added relational propositions (links between concepts) to their own individual concept maps. Interns were asked to write reflective journals (as Word[®] documents) corresponding to each of the concepts in the concept map which they then hyperlinked to their concept map. The Inspiration[®] map and linked local journal entries were saved to CD ROM.

Interns were then asked to link their relational phrases to html-based captured electronic conversation. Asynchronous electronic discussion was organized in such a way that each intern led a discussion and participated in at least three other discussions. Interns directed their coordinated electronic discussions in such a way as to promote and accumulate fruitful conversation around the nature of the propositional phrases they had applied to their individual concept maps. After 2 weeks of asynchronous electronic discussions, interns captured their discussion and then selectively quoted useful components which they

Figure 2. Incomplete concept map of evolution vs. creationism topic

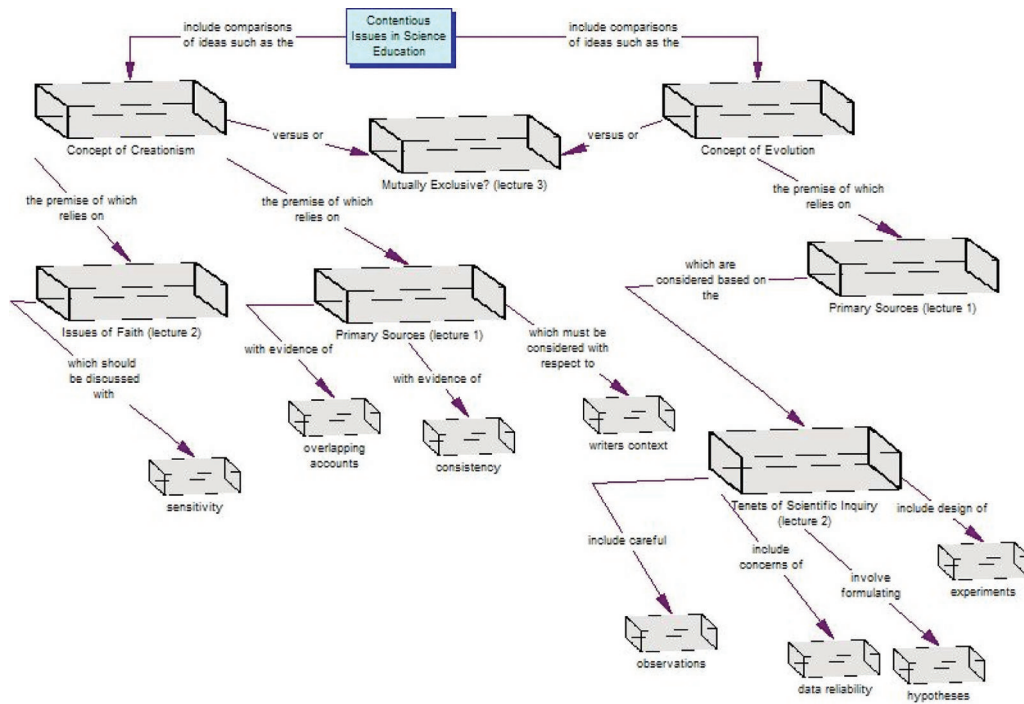
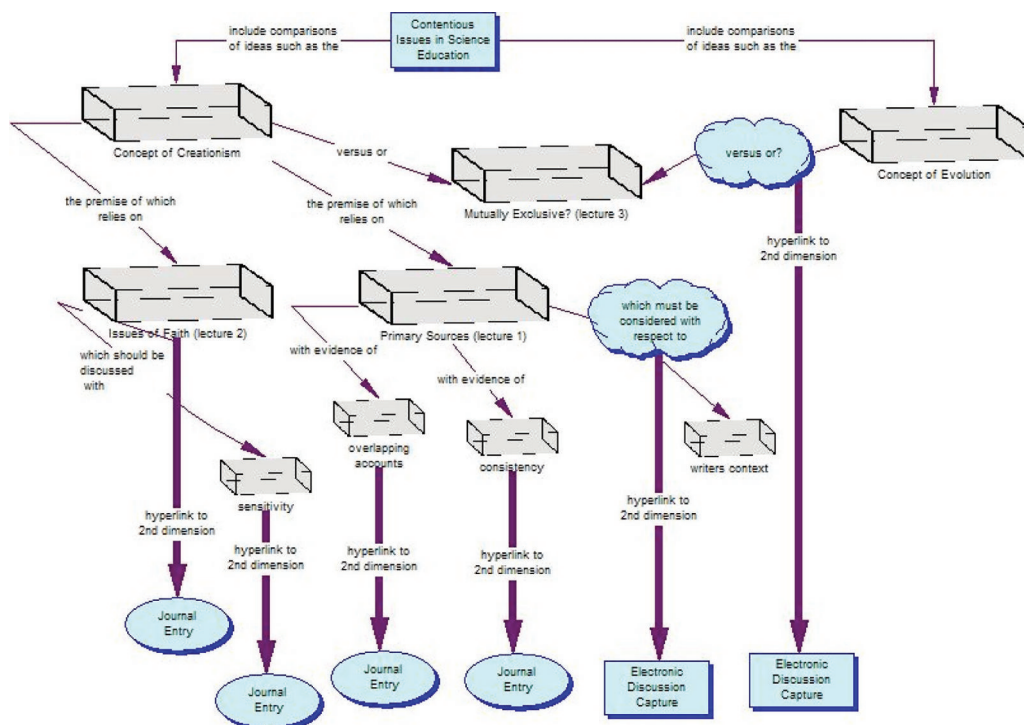


Figure 3. Substantiating relationships in the concept map



in turn linked to their concept map propositions (see Figure 3). Flexibility in the approach was ensured by maintaining that (a) interns could choose to add additional concept boxes beyond what was provided by the instructor, (b) interns were encouraged to prepare journal entries around all concepts, and (c) interns had the choice of selecting which propositional phrases they wished to hyperlink to electronic discussion. In evaluation of this activity, the onus was on the intern to demonstrate to the instructor they understood the topic by hyperlinking to well-chosen appropriate supporting documents as outlined.

The impact of the *concept mapping* exercise was deemed to be dependent on the quality of the linked documents which served to express the intern's depth of understandings. This is where the use of the cognotes became important. The conversations coordinated by interns had to demonstrate two characteristics: (a) they must lend an understanding to the relational phrase between the selected concepts and (b) they must be led in such a way as to promote critical thinking through productive conversation patterns. In an effort to promote substantive discussion within individual discussion groups, a series of preliminary exercises were undertaken with all interns.

Grounded in previous work (MacKinnon & Aylward, 2000), five categories of *critical thinking* modes were promoted: compare, contrast, cause and effect, inductive, and deductive reasoning. For each of these categories a graphic icon and macro was developed for Microsoft Word® such that interns could assign a cognote to specific portions of text in a discussion transcript. In three successive exercises, interns were supplied with a single page of captured electronic discussion. They were then asked to code the entire discussion based on the five aforementioned contribution styles. After each successive exercise, interns were paired with another intern to discuss their comparative recognition and assignment of the codes. Interns then compared their own assignment of codes to that of the instructors in a closure session. Ambiguity

in the assignment of cognotes was discussed. This was repeated in three independent exercises. The instructor noted that interns began to recognize discussion patterns in an analytical process; the rationale for instituting such an exercise being to extend intern awareness of the higher-order thinking patterns in which they could “contribute” to an asynchronous electronic discussion. In the end, the instructor hoped that interns would consciously promote substantive discussion so as to support their understandings of the conceptual relationships within their concept maps.

With their coding experience behind them, interns were encouraged to use the identified discussion patterns in their ensuing electronic discussions. The concept map-linked discussions were later evaluated based on the clarity of argumentation and support for the propositional relationships in the first dimension of the concept map.

At the conclusion of the project, teacher interns submitted for evaluation a CD ROM containing the concept map hyperlinked to “CDROM-local” reflective journals and electronic discussion captures.

Cognotes and Literature Databases

In another *Type II* application, the electronic discussion was used to support critical thinking around the qualities of children's literature (MacKinnon, 2005).

In this model, interns were first taught the tenants of good children's literature. An online electronic surveying system was made accessible to interns. This survey/questionnaire included fields that defined the characteristics of the chosen piece of literature (see Figure 4). Interns were asked to enter data for five of their best choices for children's books. Near the close of the semester, the survey data was compiled and made into a Microsoft Access© database and burned to CD ROM. In a workshop session, interns were then taught how to search the *database* to locate best

Figure 4. Book information: 72 entry fields

The screenshot shows a Netscape 6 browser window with the address bar displaying <http://plato.acadiau.ca/courses/educ/gmacdonn/surveys/booksurveyF2003.htm>. The page content includes the instruction "Please enter text information in the boxes provided and then press the submit button." followed by five numbered questions, each with a corresponding text input field:

1. The complete title of the book?
2. Please give a 75 word abstract of the story line of the book.
3. The author(s) of the book?
4. Is the author Canadian? ☐ no ☐ yes
5. The illustrator(s) of the book?

The browser's status bar at the bottom indicates "Document: Done (0.38 sec)" and the Windows taskbar shows the time as 9:47 AM.

resources for their teaching practice. For instance, interns could search and filter by author, title, media type, theme, and so forth (see Figure 5).

The cognote system was used in this project in the following way. An extended assignment was that interns needed to coordinate and lead an

electronic discussion with at least five peers. In this discussion the coordinator would individually pose their chosen book titles and correspondingly prompt discussion as to why each book was considered a piece of quality literature. During the discussion coordinators were responsible for

Figure 5. Filtering the data through a form search

This screenshot is identical to the one in Figure 4, showing the same Netscape 6 browser window with the book information form. The address bar, instructions, numbered questions, and input fields are all the same as in Figure 4. The status bar and taskbar also show the same information.

grading their peers contributions to the conversation using the cognote scheme outlined in Table 1. (It should be noted that the entire activity was prefaced with a “coding practice” session). The cognote system was employed in an effort to promote substantive conversation. This was done because the intern-coordinator then captured pieces of the electronic discussion to submit in a report designed to justify their choices of literature. In subsequent research interviews, coordinators indicated that participants in their EDGs were particularly focussed and that they felt the cognote implementation was a contributing factor to the quality of the conversations.

Synopsis of Research Findings

The cognote coding system has demonstrated (MacKinnon & Aylward, 2000) its utility in the simplest application of an instructor coding their student’s work for improved conversation patterns. Moreover, the system of assigning cognote grades has been shown to possess *inter-rater reliability* (MacKinnon, 2003). It has become clear that the application of the cognote system to classroom instruction benefits greatly from preliminary exercises where instructors and students become familiar with meaning of the individual codes. Studies have shown (Pelletier, MacKinnon, & Brown, 2002) that students exposed to cognote-assisted EDGs tend to transfer their improved discussion patterns to other curricular settings at least in the short term.

The aforementioned examples demonstrate that the cognote system can be embedded in educational exercises which capitalize on (a) the improvement in the conversation and (b) the ability to capture the discussion for use in substantiating ideas and concepts in related work.

The use of the cognote system in teacher education has been particularly valuable as it develops not only better discussion patterns amongst interns but also teaches them how to coordinate and promote engaging conversations. The inher-

ent organization and critical thinking that this requires is of great value as a process skill for the practicing teacher.

THE PRACTICALITIES OF USING THE COGNOTE SYSTEM

Objectives

In designing the cognote system, the instructors were most concerned that students engage content from a critical perspective. The content in itself was a lesser priority and the work described herein should demonstrate the general applicability of the coding system. The intent then, was not to simply have students discuss more but to develop their potential for higher order discussion patterns and in turn, better quality conversation. This objective was met when at least three successive iterations of electronic discussion and concomitant coding were undertaken. The system was initially designed for asynchronous conversation in a face-to-face course but due to its technological simplicity, has broad applicability to solely Web-based instruction involving variable content.

In the context of teacher training, the ability to communicate ideas effectively, formalize argumentation approaches, and coordinate objective-directed discussions was a most important goal for the instructor. Consensus was reached in focus group sessions involving students and instructors (using the system) that the cognotes were achieving all of these objectives to varying extents.

Student Response

Students from the onset have recognized improvement in their conversations commenting frequently that the metacognitive exercise of examining the nature of their discussion structures (with feedback) has improved their articulation of ideas. Moreover they have indicated in focus groups that the inherent formalized analysis of

the critical thinking strategies involved have not only activated new approaches to voicing their ideas but prompted them to deconstruct their ideas in ways that were not previously part of their thinking patterns. In addition, students suggested that reading the more carefully articulated conversations online improved their recognition of the impact of methodical idea development. In affect, they became much better listeners and processors of ideas. Students were quick to point out that preliminary exercises that clarified the nature of each of the codes were most crucial to them with regard to both understanding the coded conversation returned to them as well helping them to code other's discussion with consistency. Culminating interview data from all studies done to date has demonstrated that students need much practice using the codes in order that they begin to internalize legitimate changes in their conversation patterns. Ironically, some students have suggested that there are too many codes to remember while others feel there are discussion styles that "fall through the cracks" for lack of an appropriate code. Finally, it has been clear that students do not mind the additional work to employ the cognote system providing that the assessment of the activity is fair and most importantly emphasizes the process. Students have unanimously indicated that their understanding of the content is more highly developed because of the improved richness of the conversation.

System Support

The cognote system is relatively trivial to prepare from a technological perspective. The coding icons are easily constructed using any simple graphics program keeping in mind that appropriate sizing of the icon will be necessary. Microsoft Word® allows for the preparation of customized toolbars and simple macros to allow assignment of the cognotes to the html-based text.

Implementation of the system in a model where the instructor does the coding in three successive

iterations can be onerous if not undertaken systematically. Obviously, class size has a bearing on the efficiency with which the instructor can "turn around" coded conversation. The aforementioned coding research has shown that students will ultimately write far less in later iterations of the electronic discussion thus coding gets easier as verbosity decreases and articulation improves. As mentioned earlier, the value of doing preliminary coding exercises in a student-instructor activity can not be overstated. Clearly one benefit of instructor coding is the consistency with which the "definitions" of the cognote are applied to real conversation. While the research has shown the system to have *inter-rater reliability*, a single rater is bound to apply cognotes more consistently. Periodic discussions of the meaning of the codes helps to reinforce consistency as students are exposed to a wide range of conversation styles.

A system that employs students in coding each other's work has many benefits, not to speak of the instructors' workload implications. The ability of students to coordinate and promote quality conversation is a "life skill." Their improved communication of the ideas has the added benefit of promoting deeper understanding of the content. The engagement of ideas at higher cognitive levels with more critical stances is an objective most instructors will feel is worth the effort in terms of establishing the cognote system. The cognote system has no obvious limitations with regard to exclusive implementation in distance education. Introduction of the coding system, associated practice exercises, formal coding, and ultimate conversation exchange are all easily achievable via conventional e-mail exchange, much less more elaborate online learning systems (e.g., Blackboard®, WebCT®, & Moodle®). Instructors need only the ability to capture discussion from a html-based forum. Once the text is saved it can be opened in Microsoft Word®, codes assigned, and the entire coded work returned to students. The coding template is easily shared and implemented on students computers so they may participate, if

the instructor so chooses, to embed the coding in a higher order type II technology exercise (Maddux & Johnson, 2006).

For teacher education students, this system demonstrates how technology can be used to empower learning through development of more substantive conversations. The level of interaction and quality of feedback that the technology affords was never before possible.

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Chapter 7.13

E–Social Constructivism and Collaborative E–Learning

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ABSTRACT

Social constructivism is an established educational theory based on the principle that learners and teachers co-construct knowledge through social processes. This chapter proposes an updated theory, e-social constructivism, that takes into account the milieu of electronic communications in which e-learning occurs. Thinkers such as Dewey, Piaget, Vygotsky, and Bruner, who laid the theoretical foundations of social constructivism, wrote in a time when face-to-face interactions were the basis for instruction. The works of these writers are reviewed in this chapter. Together with the results of the author's phenomenological study of collaborative e-learning, they form the basis of e-social constructivist theory. The author uses grounded theory and situational analysis to derive

and support e-social constructivist theory. This chapter discusses the implication of that theory for research, teaching and instructional design.

INTRODUCTION

In online classes, interaction between learners and instructors occurs electronically. Online classes may expect learners to interact through discussions involving the whole class, in small groups, or in pairs. When assignments are designed for completion by collaborative teams, the objective is for peers to learn from and with each other. This instructional approach, called *collaborative e-learning*, is defined as: "Constructing knowledge, negotiating meanings and/or solving problems through mutual engagement of two or more learners in a coordinated effort using Internet

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and electronic communications”(Salmons, 2008, p. 131).

The rationale for including highly interactive collaborative assignments is usually supported by references to the theory of social constructivism. A core notion of constructivism is that knowledge has a subjective dimension because people construct meaning based on their relationships with the world. Each individual learner imposes meaning on his or her experience. A teacher cannot impose meaning on learners. Social constructivism focuses on the social phenomena that occur when conceptual schemes are transmitted by means of language. From a social constructivist's view, knowledge is not simply constructed, it is co-constructed. Constructivism is considered antithetical to positivism or objectivism, the theoretical position that explanations must be empirically verifiable and knowledge exists independent of our own perceptions of it (Schutt, 2006). Positivist world views translate into instructional theory based on the assumption that the instructor transmits knowledge through direct instruction (Arbaugh & Benbunan-Fich, 2006).

Theories of social constructivism have their roots in the thinking of Dewey, Piaget, and Vygotsky and Bruner. These theorists described social learning that took place face-to-face in classrooms with children. To what extent do their theories support and explain social learning in online classrooms at the college level and with adult learners? What new principles are needed? The author proposes e-social constructivism as a framework for answering these questions.

METHODOLOGY

Employing phenomenological, grounded theory and situational analysis methods, this chapter meshes analysis of two sets of data. One set of data is derived from a theoretical sample of literature. A second set of data is drawn from in-depth

interviews the author conducted with a purposeful sample of experienced online educators.

Phenomenological research methods provide a way to investigate human experience through the perceptions of research participants. Theorist Husserl distinguished between “noema,” the phenomenon which is experienced and “noesis,” the act of experiencing the phenomenon (Husserl, 1931). In the author's study, phenomenological research methodology provided a structured approach for inquiry into the perceptions of success factors for instruction using collaborative e-learning. The four basic steps of phenomenological research described by Moustakas (1994) provided a methodological framework for the study. The author used in-depth dialogue with research participants at each of the four stages of the process: preparing to collect data, collecting data through in-depth interviews, analyzing data, and reporting outcomes. The study investigated noesis, the experiences of teaching with collaborative methods online, and noema, the organization and design of the learning activities participants used to promote collaboration.

Grounded theory complements phenomenological research. To apply this theory, researchers build on the understanding of individuals' experiences derived through phenomenological methods to generate theoretical principles (Creswell, 2007; Straus, 1987). They look at categories discovered in the data and construct explanatory theoretical frameworks, which provide abstract, conceptual understandings of the studied phenomena. Situational analysis is a style of grounded theory. Situational analysis looks at the social *situation* while grounded theory looks at social *process*. Situational analysts diagram elements in the research *situation* to capture the complexities and show relationships in the data. Theory is thus “grounded” in the data from participants who have experienced the phenomenon. Grounded theory can help explain practice or provide a framework for further research and more formal theory development.

Analysis of both sets of data was organized in three broad steps: data management, descriptive accounts, and explanatory accounts. At the descriptive accounts stage the researcher worked with the ordered data to identify key dimensions, to map the range of diversity of each phenomenon and to develop categories. The researcher used inductive reasoning to look for and compare patterns and associations in the data, and to locate linkages between sets of phenomena. Situational analysis maps were used to compare online and face-to-face learning situations. The explanatory account is the researcher's interpretations of the significance, implications, and theoretical conceptions of the findings.

DESCRIPTIVE ACCOUNT SUMMARY: FROM THE LITERATURE

Contemporary literature in education and instructional design draws on constructivist theory to support active, rather than receptive, models of teaching and learning. When learning activities expect *individuals* to investigate, discover, and construct new meanings they actualize cognitive constructivist principles. When learning activities expect *groups* of students to exchange and explore ideas together, they embody social constructivist principles. The following sections briefly review the theoretical contributions of foundational thinkers in the field of constructivism. Principles that apply to the theory of e-social constructivism are highlighted.

John Dewey (1859–1952): Progressive Education

John Dewey's work sets the stage for inquiry into social constructivism. John Dewey wrote at the advent of the industrial age, and observed the potential of the railroad and telegraph to "eliminate distance between peoples and classes previously hemmed off from one another" (Dewey, 1916, p.

85). He predicted that new forms of educative community would emerge because new connections would be made between people who previously had limited access to one another. "Persons do not become a society by living in physical proximity [...] A book or a letter may institute a more intimate association between human beings separated thousands of miles from each other than exists between dwellers under the same roof" (Dewey, 1916, p. 4). Dewey foresaw the potential, as well as the challenges new communications would bring to established ways of thinking and learning.

Dewey created a theory that links education with experience because he believed that learning occurs by "constant reorganizing or reconstructing of experience which adds to the meaning of experience, and which increases ability to direct the course of subsequent experience" (Dewey, 1916, p. 76). Dewey's theory is based on the premise that learning is a social function, with a central principle of *interaction*. He described interaction between the student and teacher, between the student and the *situation*, and among students (Dewey, 1916, 1938). Dewey recommended that learners actively participate in learning situations outside of the classroom, equating the community to the laboratory—a place to experiment (Dewey, 1938).

Dewey was a philosopher who was concerned with education within the larger contexts of participatory democracy. He believed that to be fulfilled and successful contributors to a complex world, students need an education that supports development of creativity, critical thinking, and problem-solving skills.

Jean Piaget (1896–1980): Sociocognitive Constructivism

Jean Piaget was a pioneer in child development. He was especially concerned with children's development of logical thinking capabilities (Piaget, 1952). Piaget's work is cited as a foundation for a thread of constructivism called sociocognitive or cognitive constructivism.

When students learn, according to sociocognitive constructivism, they create, adapt and refine knowledge (Piaget, 1971). They create knowledge structures and mental models through experience and observation (Tuominen & Savolainen, 2004). This perspective drew on Piaget's theory of cognitive development. Piaget's theory proposed that teaching knowledge learners can understand and use goes beyond just transmitting information. Instead, humans must construct their own knowledge. Individuals build their knowledge through experiences that they can abstract into conceptual frameworks or *schema* of the world (Maraon, Benarroch, & Gaomez, 2000; Tuominen & Savolainen, 2004).

The teacher's task is to help students move from their inaccurate ideas and schemas toward conceptions more in consonance with what has been validated by disciplinary communities (Windschitl, 2002). While Sociocognitive Constructivism is primarily concerned with the individual's learning, Piaget saw peer interactions as crucial to a child's affective development and construction of social and moral feelings, values, and social and intellectual competence (DeVries, 1997). Piaget and subsequent sociocognitive researchers typically based their research on comparisons between pairs of child subjects of the same age or developmental level.

Lev Vygotsky (1896–1934): Sociocultural Constructivism

Sociocultural Constructivism views knowledge as primarily a cultural product and learning as a causal relationship between social interaction and individual cognitive change (Dillenbourg, Baker, Blaye, & O'Malley, 1996; Vygotsky, 1978). Vygotsky is frequently cited as the foundational thinker for sociocultural constructivism. He argued that development and learning involve the interplay of interpsychological and intra-psychological dimensions. He characterized these dimensions as functions of language with social speech used to

communicate with others and inner speech used to reflect and think.

Vygotsky's conception of a *zone of proximal development* (ZPD) describes the distance between what one can do alone and what can be accomplished in collaboration with others who are more capable (Vygotsky, 1978). This is also called "appropriation" because a learner "appropriates" strategies used by a teacher, parent or more experienced learner. When one learner is more knowledgeable than the other, it is expected that the latter learns from the former. However, researchers have discovered that when students work together learning extends to the more able peer, who also benefits from the interaction.

The teacher's task is to offer meaningful, "whole" activities, constructive tasks or problem-solving situations, where more knowledgeable learners can assist others. Constructive tasks, such as conducting scientific inquiries, solving mathematical problems, and creating and interpreting literary texts, are contrasted with decontextualized skill-building (Windschitl, 2002).

Jerome Bruner: Discovery and Spiral Learning

Bruner outlined three steps of the learning process: acquisition of new information, transformation of the new information to fit new tasks, and evaluation, which takes place when learners check whether the new information is adequate to the task. He did not see these as discrete steps, but as part of a spiral, where learning continues to build and evolve through interactions with new ideas and people (Bruner, 1966, 1977). The concept of spiral curriculum inspired the practice called *scaffolding*. Scaffolding is described by Wood, Bruner, and Ross as "...controlling those elements of the task that are initially beyond the learners capability thus permitting him to concentrate upon and complete only those elements that are within his range of competence" (Wood, Bruner, & Ross, 1976, p. 90).

Scaffolding is most effective when learners and educators iteratively communicate their growing understandings. With respect to collaborative learning, at least two classes of scaffolds can be distinguished: (a) scaffolds that provide support on a content-related or conceptual level, and (b) scaffolds that provide support related to the interactive processes between the collaborators.

Social Constructivism: Contemporary Interpretations

The concept of social models of teaching and learning has generated many interpretations. A few summarized below.

- *Social learning theory* explains human behavior in terms of continuous reciprocal interaction between cognitive, behavioral, and environmental influences. Albert Bandura termed this interaction “reciprocal determinism.” He formulated a four stage process: (1) Attention: the individual notices something in the environment; (2) Retention: the individual remembers what was noticed; (3) Reproduction: the individual produces an action that is a copy of what was noticed; and (4) Motivation: the environment delivers a consequence that changes the probability the behavior will be repeated through reinforcement or punishment (Bandura, 1977, 1986). The basic principles proposed by Bandura are that people learn by observing others, and that learning can occur without an observable change in behavior. Cognition plays a role in learning, with attention as the critical factor. Modeling teaches new behaviors, may influence the frequency of previously learned behaviors and may also encourage previously forbidden behaviors. The model may be a “live model,” the actual person, or a “symbolic model” portrayed in print or media.
- *Exogenous, Dialectical, and Endogenous Constructivism* exist on a continuum, according to a model offered by Moshman (Moshman & Geil, 1998). *Exogenous Constructivism* emphasizes “external” knowledge is best taught through direct instruction, in conjunction with exercises requiring learners to be cognitively active. *Dialectical Constructivism* proposes that learning occurs through realistic experience, but that learners require *scaffolding* provided by teachers or experts as well as collaboration with peers. *Endogenous Constructivism* emphasizes the individual nature of each learner’s knowledge construction process, and suggests that the role of the teacher should be to act as a facilitator in providing experiences that are likely to result in challenges to learners’ existing models.
- *Ideas-Based Social Constructivism* changes the focus from learning through practical problem-solving to direct encounters with ideas. Prawat suggests that curriculum be thought of as a matrix of “big ideas.” Teachers serve as “managers or orchestrators” who work alongside students as they explore ideas together (Prawat, 1993).
- *Sociotransformative Constructivism* merges multicultural education with social constructivism, providing an “orientation to teaching and learning that pays close attention to how issues of power, gender, and equity influence not only what subject matter (curriculum) is covered but also how it is taught and to whom” (Rodriguez & Berryman, 2002, p. 1019). These theorists point to the concept of *agency* that bridges knowledge and transformative action. They believe that agency can lead to a deeper understanding of the subject matter and to the application of newly gained knowledge in socially relevant

ways (Rodriguez & Berryman, 2002; Zozakiewicz & Rodriguez, 2007).

- *Radical Constructivism* is “a theory of rational knowing” championed by Ernst Von Glasersfeld. Von Glasersfeld wrote:

Radical constructivism holds that the only instruction or information a knower can possibly receive from ‘nature’ or ‘reality’ is negative. In other words, the world beyond our experiential interface may show us what concepts, theories and actions are not viable, but it cannot instruct us what to think (Glasersfeld, 1996).

Radical constructivists believe teachers or facilitators should provide limited support, and learners should construct their own mental models within the environment that exemplifies the topics being studied (Dalgarno, 2001).

Summary of Social Constructivist Theories

The theorists cited above explored a wide range of pedagogic and philosophical questions. This section analyses positions expressed by these writers with respect to their applicability to an instructional theory of e-social constructivism.

Positional maps are a tool used in situational analysis to visualize major positions taken in the data (Clarke, 2005). Figure 1 illustrates relationships among theories reviewed in this chapter, with respect to the two dimensions: learning style and instructional style. This map provides a reference for understanding e-social learning theory in relation to earlier theories.

The vertical axis represents a continuum from the individual to the group as the focus of learning.

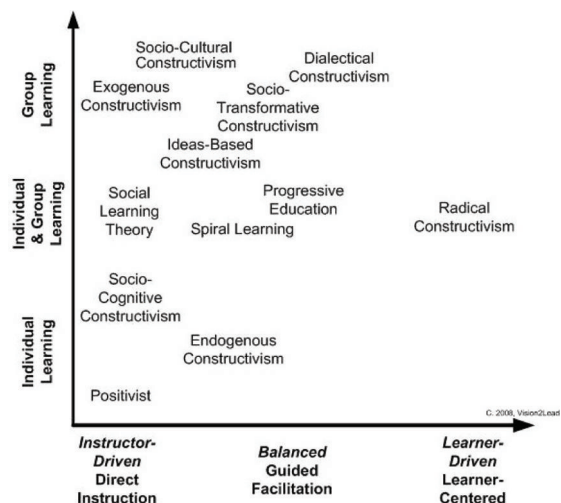
- In the first position, the focus is on the individual’s learning experience.

- In the middle position, the individual’s learning is catalyzed by the social process with the group.
- In the third position, the group is the focus with learning through interactions with peers and instructors.

The horizontal axis shows a continuum of instructional styles from instructor to learner-driven.

- In the first position, an instructor organizes and sequences content to convey information through direct instruction.
- In the middle position, an instructor facilitates learning by organizing and scaffolding assignments. The instructor shares knowledge, clarifies expectations and parameters, and keeps learners on topic and on task. The instructor is flexible and provides guidance as needed.
- In the third position, an instructor provides minimal guidance. Learners discover, contribute or generate knowledge independently.

Figure 1. Constructivist positions



DESCRIPTIVE ANALYSIS: FROM THE INTERVIEWS

In the author's pheomenological study of collaborative e-learning, participants were interviewed. The participants were instructors who taught various subjects using collaborative e-learning activities. Research participants self-identified as committed to constructivist epistemological views and pedagogies. While specific constructivist theories were not discussed, they generally reported a desire to teach in a "learner-centered" way. The interview questions were designed to elicit perspectives about instructional strategies the instructors used. They considered "success" in terms of sustained learner engagement throughout all stages of the activity, learners' ability to participate and contribute to the activity, as well as achievement of curricular objectives.

Three broad categories in the data from the study relate to the current analysis: (1) knowledge and skills needed to teach online with collaborative methods; (2) instructor commitment to collaboration; and (3) instructional milieu.

Knowledge and Skills Needed to Teach Online with Collaborative Methods

Research participants identified kinds of knowledge and skills they felt are essential for educators who teach using online collaborative methods. Throughout this section, quoted material is from research participants' responses unless otherwise noted. Responses were categorized into four areas:

- *Understand the new paradigm.* To be effective in designing and guiding collaborative learning, instructors need updated practical and theoretical understandings about teaching and learning. A research participant observed, "In order for faculty and students to succeed, [they] need to get

the sense of working in [a] different paradigm. [There is a] need for bridging theory and application."

- *Be an advocate:* Instructors need to be able to advocate the benefits of collaborative e-learning and overcome resistance and other barriers. A research participant asserted, "[the instructor] must be the enabler to get the collaboration done, the 'driver' to push the things."
- *Model collaborative behaviors.* The best way that instructors drive productive collaborative behaviors is by modeling them. A research participant said, "I make sure I am modeling openness and experimentation, being an equal learner with others in the class."
- *Have skills in online communication and facilitation.* Research participants spoke at length about what they considered the most essential skills: online communication and facilitation. Given the potential for dispersed class members to feel isolated, a research participant observed that, while in a face-to face lecture it is not necessary for instructors to know learners, in an online class, they interact one-on-one. Another research participant described the importance of using people skills online: being sensitive, patient and able to "show[ing] concern and guidance as needed, with a nurturing style."

Instructor Commitment to Online Collaboration

Research participants believed it is critically important for online instructors to be committed to collaborative methods and prepared to take varied individual and group actions to facilitate collaborative activities in online classes. All respondents made the point that, for online collaboration to successfully occur, the instructor must be prepared

to take an active role. Laying the groundwork for interaction between instructor and learners as well as among learners requires careful attention. They described three key responsibilities for instructors:

- *Designing, planning and structuring learning activities.* Study participants emphasized the value of well-planned learning activities. While in some cases the assignments are already in place as part of an online class design, instructional choices remain.

Research participants emphasized that successful collaboration happens when online learners trust each other *and* trust the process. This generalization is widely supported in the research literature on the subject. Learners, who may lack previous experience with virtual collaboration, want to know that the expectations, allocation of tasks in the collaborative group and assessments of shared outcomes are fair. They want assurance that instructor's assistance is readily available if the process is not working.

Several research participants pointed out that when the work is structured into stages, learners focus on the task and course content without being overwhelmed by the process. Participants recommended that the instructor direct the approach in the early stages of collaboration and increasingly put responsibility into learners' hands. The instructor begins by assessing learners' readiness for collaboration and makes choices about how, when and to what extent responsibility can shift to the learners. The instructor can gradually "allow learners to build on or suggest options so learners co-create the next steps."

Instructors "provide a framework so students can focus on the task. Define clearly the time limits, geographic or conceptual limits of the task." The instructor should work to "move students toward being autonomous and self-organized but, initially, show them how to participate." Research

participants were in consensus that expectations and specific instructional guidelines help learners understand how to move from one stage of the collaborative process to another.

- *Being a learning coach.* As instructors, research participants encourage critical thinking about learning, meta-thinking or meta-learning and reflection. A research participant pointed out that online instructors need to "be present but not present," to allow groups to solve their own problems and intervene only when the group cannot resolve a difficulty. Another participant made a similar suggestion: "when there is discomfort, be silent, be there and listen. Listen before intervening." In addition to group coaching, several research participants suggested that private coaching or one-to-one communication with a learner is appropriate when the collaborative process is stuck. A learner may benefit from the instructor's individual attention if that learner falls behind or surges ahead. In either case, such learners can jeopardize the success of the team. A participant depicted the circumstance where a highly motivated, capable learner works independently to complete an entire task, thereby disempowering the collaborative group and undercutting shared agreements and timelines. On the other end of the spectrum is the passive lurker, someone who is not pulling his or her weight. Instructors should intervene to explain relevant points about the collaborative process and motivate the learner to fulfill his or her responsibility to the team, and/or encourage the team to review work agreements for completing the project. In such situations timely involvement of the instructor can help the group avoid getting sidetracked by group process.

- *Developing learners' collaboration skills.* A participant made the collaborative process part of the lesson: "it is extremely important to discuss nature and value of collaboration before embarking." Several participants assigned regular and frequent partner work, then built up to the small group so learners get a taste of success. They provide suggestions for different roles people can take in teams and let learners choose, and allow learners to build on or suggest options so learners cocreate activities.

In summary, at each stage of the instructional process research participants took active, responsive roles to help learners structure, organize and complete the collaborative activity. In the process, they sought to build learners' skills in online collaboration while learners worked to achieve curricular goals.

Instructional Milieu

When asked, "Why do you think the collaborative e-learning was a success?" research participants discussed issues of trust and safety as the most important factors. Research participants described a safe learning environment as one where learners can take risks, "have wild ideas, be creative and innovative." A research participant suggested that instructors need to: "reduce stakes for participation to the point that people do not perceive a high risk for failure or perceive that not succeeding to the highest degree is a learning opportunity, with no comebacks or humiliating criticism." One participant stressed the importance of making mistakes in the class to avoid making them in professional life later on, when they could be very costly. This participant told learners that making such mistakes was a course expectation from the outset.

EXPLANATORY ANALYSIS: COMPARING CATEGORIES FROM RESEARCH AND LITERATURE

John Dewey talked about learning as interaction involving students, teachers, content, and situation. Later Joseph Schwab used the term *commonplaces* to describe these four interrelated factors (Schwab, 1983). The first three commonplaces receive similar consideration in the literature and in the results of the author's research. The fourth commonplace, *situation*, differentiates the literature written to describe instruction in the face-to-face classroom from the perceptions of those who teach in online milieu. The theoretical literature made only passing reference to the situation, whereas online instructors described it as critically important.

In situational analysis, researchers chart elements for comparison in an *abstract situational map* (Clarke, 2005). This type of map lays out the major human and nonhuman elements in the research situation. The following figure highlights elements that influence the instructor's role in collaborative e-learning.

Research participants discussed several ways that online milieu influence collaborative e-learning. They highlighted three points with important implications for online settings: trust and safety, *transactional distance*, and skills and equipment.

Issues of trust and safety were at the top of every research participant's list. Research participants described a safe learning environment as one where learners can build relationships and gain the trust needed to share ideas and learn together. Research participants believe that the instructor has an important role in creating this kind of atmosphere. They described the use of the constructivist principle of scaffolding, where learning activities build progressively to "gently walk learners" into the collaborative activities. They discussed starting with "low risk activities that encourage a sense of group" by inviting

everyone to participate. No grades are given for these foundational activities. In contrast, trust and safety issues were not referenced in previous theoretical literature.

Another aspect of online communications relevant to the collaborative process is transactional distance. The term *transactional distance* describes the gap in time between comment and response in discussions that occur asynchronously, not simultaneously. Online interaction differs from face-to-face conversation because nonverbal cues are absent. Researchers discuss the importance of creating presence (Rourke, Garrison, Anderson, & Archer, 2000) and immediacy (Conaway, Easton, & Schmidt, 2005) to overcome the isolation learners may feel. Instructors demonstrate social presence to make sure learners are engaged in the interactive process. They demonstrate cognitive presence by providing explanations, guidance, and resources to ensure learners are finding, comprehending and analyzing class content. When multimedia synchronous meeting tools and immersive environments are used to bring online classes and instructors together, learners may report fewer problems with isolation and transactional distance may decrease.

A third difference in the online environment is that special skills, hardware and software are needed to enter the virtual classroom and participate. This fundamental question of access was discussed by research participants, but not in the literature. (The literature reviewed was written before “access” for children with disabilities had become a consideration—or a mandate.)

Findings from this study suggest that online instructors need to support development of trusting relationships, demonstrate presence to prevent isolation that would keep learners from engaging in social learning exchanges, help learners either develop skills or find technical support services necessary for online participation, and guide them toward intellectual exchange and growth. An important conclusion based on this is that a radical hands-off interpretation of constructivism would

not offer optimal instructional presence necessary to support collaborative e-learning activities.

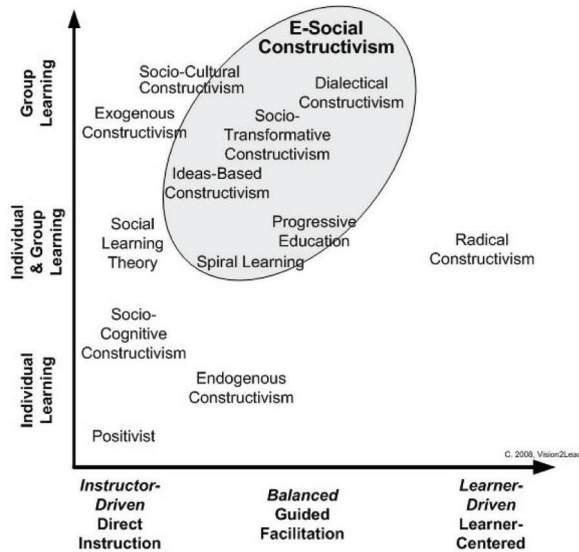
A THEORY OF E-SOCIAL CONSTRUCTIVISM

Based on the comparison of categories in the theoretical literature and the practical experiences described in the interview data, I propose e-social constructivism as an updated educational theory. Since this theory aims to contribute toward improvement of teaching and learning, it can be described as an *instructional theory*. Educational theories can be classified as either learning theories or instructional theories. According to Jerome Bruner, theories of learning are descriptive, while a theory of instruction is prescriptive (Morrison, Ross, & Kemp, 2004). Learning theories describe, after the fact, how people learn. A theory of instruction recommends the most effective way of designing and conducting instructional activities so learners acquire the knowledge or skill (Morrison et al., 2004). A theory of instruction is concerned with *improving* rather than describing learning.

In the following figure, the *theory of e-social constructivism* is placed in a central position. This position represents a balanced, guided facilitation role for instructors and a balance of individual and social learning. The theory acknowledges the interplay of individual and social constructions of knowledge, the need for internalized speech and reflection, and individual and collective contributions in the collaborative process.

This *e-social constructivism* theory recognizes the unique set of opportunities and limitations of the online social and learning milieu. While learner-centered, this theory recommends important roles for educators who endeavor to teach online with collaborative methods. Kouzes and Posner point out that, “As paradoxical as it might seem, leadership is more essential—not less—when collaboration is required” (p. 243). The same might be said in the educational context,

Figure 2.



where more instructional presence is needed for collaborative, in contrast to individual, online assignments. Thoughtful attention to structure, purpose, and guidance can result in collaborative e-learning that truly engages learners in construction of new meanings.

PRINCIPLES OF E-SOCIAL CONSTRUCTIVISM

Learning occurs through meaningful interaction with content, content experts (who may include instructors, authorities or skilled practitioners) and peers. Learning is supported in online milieu that are conducive to social exchange and to exploration by both individuals and groups. The collaborative process and the subject matter that is the focus of collaborative activity both provide important context as learners construct meaning from their activities.

Through collaborative e-learning activities, learners acquire new knowledge together with partners, exchange and appropriate knowledge through peer exchange, and/or create new,

innovative knowledge, skills and solutions. Instructors should acknowledge that learners' prior experiences and cultural, institutional, and historical contexts influence individual and team accomplishment.

If online courses are designed with social, collaborative activates, instructors must help learners avoid isolation and separation from the interactive process. Using the principles of scaffolding, instructors provide support and information learners need to interact successfully in online milieu. Instructors' social and cognitive presence is essential to the success of learners and learning teams.

Instructors should encourage learners to develop and use information and communications technology (ICT), competencies by integrating opportunities to develop progressively more complex online research, collaboration, and communication skills.

CONCLUSION

This chapter presented a grounded theory and situational analysis of two sources: theoretical concepts from the literature and perceptions of educators who participated in a phenomenological study of collaborative e-learning. After comparing positions of various theorists with tested, practical ideas reported by constructivist online instructors, those ideas and positions most applicable to collaborative e-learning were integrated into a theory of e-social constructivism. *E-social constructivism* principles integrate applicable ideas from previous theories with considerations specific to the online learning milieu. I hypothesize that designing, planning and teaching with collaborative e-learning activities based on principles of e-social constructivism will measurably improve learning outcomes as well as learner engagement and satisfaction.

The present version of this theory may serve as a framework for those who create and facilitate

learners in collaborative e-learning activities. However, I hope that the *e-social constructivism* theory will evolve with future research, discussion and thinking by other researchers and instructors. The theory will also evolve with the integration of more multimedia, synchronous tools into online learning—which may erase some of the distinctions between online and face-to-face learning situations. Like other constructivist theories that came before, I hope it will motivate educators and researchers to create new directions and advance the field.

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KEY TERMS AND DEFINITIONS

Appropriation: A kind of peer learning that occurs when a learner "appropriates" strategies used by a stronger or more experienced learner.

Collaborative E-Learning: Constructing knowledge, negotiating meanings, and/or solving problems through mutual engagement of two or more learners in a coordinated effort using Internet and electronic communications.

Collaboration Software: Collaboration software may operate either synchronously, allowing all users to participate simultaneously, or asynchronously, allowing users to participate at any time. Synchronous tools allow collaborative partners to meet and discuss projects, give presentations, view and edit documents in real time, or share applications. Synchronous collaboration tools include videoconferencing, online meeting platforms, shared whiteboard, Voice Over Internet, voting, chat or messaging, and immersive 3-D

environments. Asynchronous tools allow collaborative partners to exchange materials, contact lists, or to access shared files or resources, libraries or archives. Asynchronous collaboration tools include e-mail, Wikis, blogs, shared calendars, polling, track changes, and document exchange

Constructivism: Constructivism both an epistemological view and an instructional method. A core notion of constructivism is that individuals live in the world of their subjective experiences—a world where they construct their own meanings.

E-Learning: An educational activity or course conducted in an electronic learning milieu, using Internet communication technologies for delivery of instruction, curricular materials and learning activities. In this study, e-learning refers to instructor-lead academic courses which may be offered partially or entirely online.

Interaction: Reciprocal actions, effects or influences; the effect of one variable on another variable (Soanes & Stevenson, 2004). Between individuals, interaction entails acting in such a way to have an effect on each other; or a mutually affecting experience. Whether online or face-to-face, interaction typically involves communication between individuals.

Social Constructivism: An educational theory based on the principle that learners and teachers coconstruct knowledge through social processes.

Teaching with Collaborative Methods: Organizing learning activities and creating an environment where collaborative e-learning occurs, and assessing the success of outcomes.

Threaded Discussion: Threaded discussion (or discussion forum) is a form of asynchronous discussion where original comments and responses are organized by topic. Threaded discussion occurs when one user posts a message that is visible to other users, who respond in their owntime. A “thread” is formed when the software groups users’ comments hierarchically under the original post. Threaded discussions create a linear format with continuity of comments on topic.

Transactional Distance: Transactional distance describes the gap in time between comment and response in discussions that occur asynchronously, not simultaneously.

Zone of Proximal Development (ZPD): Zone of Proximal Development (ZPD) describes the distance between what one can do alone and what can be accomplished in collaboration with others who are more capable (Vygotsky, 1978).

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Chapter 7.14

Ethics in Interactions in Distance Education

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ABSTRACT

This chapter presents the desirable interactions involved in teaching and learning at a distance. In these interactions, there are considerable ethical issues—notably that one’s own learner autonomy should be reduced at times in order to help others learn, to achieve the learning task, and at the same time help oneself to learn. Accordingly, learner autonomy is not an overarching goal of education. This is controversial, and this chapter deals with this issue in detail to explain that learner autonomy at best is a rough guideline, and ethically based on reasoning that autonomy should be interpreted as flexibly applied. The maxim that learner autonomy must be flexibly applied is particularly true in both cooperative group learning and in collaborative group learning in distance education where student

interactions with other students constitute a major part of the education process. The ethics in interaction in distance education are extended to cover all possible interactions, especially the important interaction by the teacher to each student followed by the interactions by the student with the learning process, that can initiate the aesthetic social intrinsic motivation to lifelong learning and thus to one’s own emancipation. Accordingly, ethics are defined here as those pro-active interactions that induce the motivation to lifelong learning in all the students. Such ethics should override individualist autonomy as a goal in education.

INTRODUCTION

This chapter aims to define what is meant by ethics in interactions in distance education and presents the 2007 current state of the art with respect to

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such ethics. At first it is best to define and frame what is meant by ethics. Here, ethics covers what human conduct is right or wrong based on reasoning, whereas morals can be interpreted as that conduct based on social custom. This chapter will focus on only that human conduct that is good practice, and not on that which is bad. Therefore, bad practices such as copyright infringement, plagiarism, and intellectual property theft are not discussed, mainly because they are generally covered by relevant local law.

It is also important to explain what is covered by interactions in distance education. There are at least five types of interaction reported in the literature: student-teacher, student-student, student-content, student-technology, and vicarious interaction. The fifth one of vicarious interaction was suggested by Sutton (2001) to occur when a student observes interactions between or among others, but in a carefully controlled study, Kawachi (2003a) found that no educational advantage was attributable to such vicarious interaction, likely due to those active participants who were interacting also deploying similar attention so no significant difference was found. Because some poorer quality of learning was seen in those not participating, then vicarious interaction was concluded to be disadvantageous and that active participation was to be emphasized for learning. The fourth, student-technology interaction, was suggested by Hillman, Willis and Gunawardena (1994) mainly in terms of there being a human-computer interface barrier to learning for some students with weak computer and technological literacy. Both these are not discussed any further here. This chapter will focus on the other three interactions.

Distance education may need clarification, and here the definition is drawn from the transactional distance theory of Moore (1993). Transactional distance may be interpreted as the psychological gap between what the student already knows and the content about to be learned. In particular, this theory describes transactional distance in terms

of the three dimensions of structure, dialogue, and autonomy. Based on this theory, a four-stage model of learning has been proposed and validated by Kawachi (2003b, 2005), notably in open and distance education in 15 regions throughout Asia. How to interact optimally and therefore ethically through applying this model will be one of the two key points presented in this chapter. The other key point will be that autonomy must be moderated by some affective motivations in the student in order to interact optimally to learn.

METHODS

Transactional distance theory postulates four categories of distance education according to the amount of structure (S+) imposed by the institution, and the amount of educative dialogue (D+) between the student and other persons. The most distant category has no dialogue and no structure (D- S-), the next closer has added structure (D- S+), the third has then added dialogue (D+ S+), and the fourth category of minimal transactional distance has dialogue and freedom (no imposed structure) (D+ S-). It should be kept in mind here that dialogue (D+) means being with educative intent. Accordingly, it should be mentioned somewhere here that young distant students often want student-teacher interaction such as face-to-face tutorial time to get their money's worth, and at the other end of the scale, older distant students want student-student interaction for socialization purposes, but because other students may be much younger, then they choose student-teacher interaction. Both these can be moved aside as not being ideally educative in purpose or intent.

Based on these categories, a model of learning in distance education has been designed and tested out as effective by Kawachi (2004) with four stages that constitute the learning process, bringing the student from furthest transactional distance to closest; in other words, bridging the gap between not knowing and knowing. The first

Stage 1 (D- S-) is characterized by cooperative brainstorming and eliciting the student's prior knowledge and ideas; the second Stage 2 (D- S+) is characterized by vertical thinking to discern collaboratively the theory underlying the student's knowledge; Stage 3 (D+ S+) is characterized by collaborative hypotheses testing, problem solving or disjunctive horizontal thinking to consider all other possible solutions and ideas, and find a potentially better way forward; and then Stage 4 (D+ S-) is characterized by experiential learning cooperatively to test out this potential new way to socially construct new personal meaning, as detailed in Kawachi (2003c). These four stages constitute one cycle, and new learning then proceeds iteratively.

Worldwide, validation has found that students have difficulty in the collaborative theorizing of Stage 2 and in collaboratively performing disjunctive reasoning in Stage 3. Generally, students successfully completed the four-stage cycle and achieved deep quality learning if they were in small groups of 4-8 students, if they had high prior knowledge, or if they received close tutor monitoring and guidance. When in large classes, with low or mixed prior knowledge, and when given normal tutor care, then students were unable to move into and through Stage 3. Similar findings have been reported by Perry (1970), who found college students in large classes could not acquire critical thinking skills. Piaget (1977) has also acknowledged that many people do not reach the Stage 3 level of formal operations involving hypotheses-generating and testing even in adulthood. Similarly, Renner (1976) has reported that only 81% of final-year law students, and McKinnon (1976) that only 50% of college students overall at seven different colleges, could acquire critical thinking skills, expressed here as the goals in Stages 3 and 4. In their analysis of computer-mediated conferencing, Gunawardena, Lowe and Anderson (1997) found that participants did not proceed beyond the discovery and sharing of ideas, concepts and statements of Stage 1, and

did not reach any collaborative phase of negotiation and co-construction of new knowledge. The participants in their study were relative experts in the use of distance education being (likely) graduate students and university-level teachers participating in ICDE95-Online virtual preconference of the International Council on Distance Education. In a following study, Gunawardena, Plass and Salisbury (2001, p. 39) found that the "intended collaboration and sharing of ideas and issues simply did not happen."

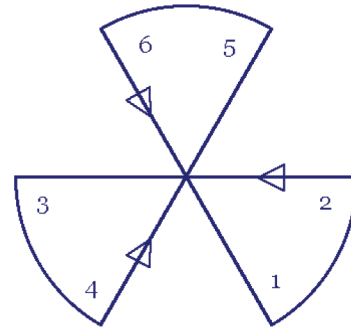
In cooperative group learning in which one participant already knows the content to be learned by the others, the ethics of the cooperative interactions by the knower—either the teacher or an expert student—have been reported by Lewis (1995, p. 27) as being limited to the four following educative purposes: (1) summative to explain a grade, discuss and link the student's work to the institutional criteria; (2) formative to further the student's learning; (3) summarising what has been done; and (4) comment to help the student plan future learning. The ethics of all other cooperative interactions need to be weighed carefully according to whether the interaction is performed synchronously or asynchronously. In synchronous media, other participants may not have adequate time to read or listen to long utterances. Being overly verbose in synchronous mode may be deemed unethical by others in the group. In asynchronous mode, files can be transferred and read more easily. Cooperative lengthy exposition is unethical during the collaborative learning stages, Stage 2 and Stage 3, and should be put aside into a Virtual Coffee Shop or other chat forum for the explicit purpose of keeping the collaborative forum uncluttered. It is, however, in the collaborative stages that all the participants (the teacher here is equally as unknowing as the students) need to understand and follow some right conduct based on reasoning, in other words, abide by some ethics in the interactions they engage in, for learning together.

Scaffolding has been suggested (Kawachi, 2003b) to guide students through collaborative group learning, particularly the disjunctive reasoning and group interactions of Stage 3 (D+ S+) for hypotheses testing and co-construction of new nonfoundational knowledge. Scaffolding may be cooperative between a participant (such as the teacher) who knows the content and the student who does not, where according to Wood, Bruner and Ross (1976, p. 89) “an adult or expert helps somebody who is less adult or less expert ... a situation in which one member knows the answer and the other does not,” while Vygotsky (1978, p. 86) indicates that cooperative scaffolding can be from a “more capable” student to a less capable student. The ethics of teacher to student interaction in Stage 1 involve the teacher making explicit to the student the aims and objectives of the task so the student can indeed comprehend these, noting that if the teacher fails here, then any later teacher feedback and error correction become merely vehicles for imitation and copying (which in turn may be described as student unethical conduct). The difficulty actually lies in scaffolding the collaborative interactions, and ethics here can pre-empt needless “flaming” and irrelevant argumentation in countering views from others.

Zimmer (1995) has proposed the collaborative scaffolding, involving three functional turn-taking steps ABA between two persons A and B, which when repeated as BAB give both participants the opportunities each to give opinions and receive counter-opinions empathically, as follows.

- (A) (Hello) Affirm + Elicitation
- (B) Opinion + Request understanding
- (A) Confirm + Counter-opinion
- (B) Affirm + Elicitation
- (A) Opinion + Request understanding
- (B) Confirm + Counter-opinion

Figure 1. Ethical interactions in collaborative distance education



The scaffolding of the ethical interactions necessary is reproduced here from Zimmer (1995, p. 142) as a three-leaf pattern in Figure 1.

In Figure 1, the ethical expressions are as follows: (1) warm affirmation “you’re okay by me;” (2) inviting open disclosure in response “please tell me what you want to do here, so that I can see your point of view;” (3) open disclosure “here’s my own experience and what I want to do ...;” (4) inviting empathic comprehension in response “I’d welcome knowing what you think I mean, to be sure my feelings are accepted” or “I’d like your sense of what I mean;” (5) empathic comprehension “what I think you mean in essence is ...;” and (6) “my own view differs ...” or “I’d like you to hear my own view” inviting warm affirmation in response.

The phrases in the above paragraph for use in the interactions are reproduced almost verbatim from Zimmer (1995, p. 142 and p. 144). Zimmer suggests that these interactions (p. 143) “dissolve competitive opposition, by inviting open disclosure, warm affirmation and empathic comprehension in direct response to perceived dogmatism, disparagement and invalidation.” It can be noticed for ethics that the interactions (3), (4) and (6) on the left side deal only with one’s own learning, and the interactions (1), (2) and (5) on the right side deal altruistically with the learning in the other student. Moreover, I suggest that

any participant(s) may be behind either voice, so the scaffold could be effective for more than two persons at the same time. In the distance education virtual classroom in a collaborative group task, the author can confirm that prior awareness of this template by (at least) one participant can successfully scaffold the interactions to reach the task goal.

Now a literature search has found (only) one other scaffolding model, suggested by Probst (1987) as transactional theory for literature. From reading his work, I have drawn the ethical interactions for collaborative learning in literature and art, in which the interactions are not aimed at hypotheses-testing characterised by counter-opinion, but rather aimed at achieving a new insight built on critical reflection that while shared may be personalised in each individual. In literature, learning is not cooperative: There is no “knower,” the teacher or expert student does not guide the less able student to some preset conclusion of the meaning of the text. In literature, the teacher or any expert student (A) elicits opinion to initiate the three functional turn-taking steps BAB, and then followed by ABA, as follows.

- (A) (Hello) Affirm + Elicitation
- (B) Opinion/Analysis + Request understanding
- (A) Affirm + Elicitation of Evidence
- (B) Reflect + Elicit other opinions/Analyses
- (A) Opinion/Analysis + Request understanding
- (B) Affirm + Elicitation of Evidence
- (A) Reflect + Elicit other opinions/Analyses

This scaffolding model involves reflective analysis followed by articulation, bringing in ideas from one's own prior reading or ideas elicited from other students, then repeating the reflective analysis with accommodation to construct a new personal insight. As in Zimmer's model, I suggest any participant may be behind each voice, so any number of participants can be collaboratively involved.

RESULTS

These two models each illustrate and scaffold the desirable ethical interactions which are essential for achieving one's own collaborative learning and ethically helping others to learn. The interactions can be performed either synchronously in a virtual classroom or asynchronously through e-mail or discussion board. In each model, the scaffolding clearly and explicitly indicates what content should optimally be included in an utterance (and therefore what should not be included), and specifies in what serial order to progress toward achieving discovery and co-construction of new understanding and new knowledge. It should also be noted that the use of a framework also implies some timeliness in replies. The system would not function if turn-taking were violated or not forthcoming. Participants need to take responsibility for the group succeeding by actively providing ethically what is required and when it is required. In this way, some pacing is inevitable if the group is to move toward achieving its goal. To some large extent, nonresponse in an asynchronous environment can be overcome by others offering up the required content in time. This is often the case in synchronous free discussions. However, group cohesiveness depends on the active participation of all members of the group. If a student does not participate, the group is fragmented and not functioning as a whole. Prior to the task, coping strategies should be acquired, agreed upon, and then used when required, such as pre-arranging the time interval allowed within which a student should contribute, pairing up students to provide back-up in case one is at a loss, or behind-the-scenes coaxing and elicitation by the moderator.

DISCUSSION

Ethics in interactions in distance education can be determined as those that are appropriate to achieving emancipation and learning for one's

self, and to helping altruistically learning in others. Such help may be at one's own expense in money, time and effort, and are not just with kind intentions but constituting educationally effective help. There is an old Indian proverb that is relevant here concerning these ethics: "Help your friend's boat cross the raging river, and lo you will find that you yourself have crossed the river."

Here then, the ethically good interactions are identified. And it is noted en passant that student-student interaction such as only commenting "Great work!" on another student's Web-log does not ethically qualify as fulfilling a course requirement for interaction.

The above discussion has looked at the two dimensions of structure (S+) and dialogue (D+) in distance education. There is the third dimension of autonomy to be discussed now. Autonomy was defined by Moore (1990, p. 13) as "the extent to which the learner determines objectives, implementation procedures, and resources and evaluation." Generally, definitions of autonomy in learning have in common an emphasis on the capacity to think rationally, reflect, analyse evidence, and make judgements; to know oneself and be free to form and express one's own opinions; and finally, to be able to act in the world, according to Tennant and Pogson (1995). These qualities characterise the collaborative thought processes of Stage 3, and also the experiential aspect of Stage 4. Stage 1 has maximal transactional distance, and for a student to succeed here in independent learning Moore (1993, p. 27) points out that the student would need maximum autonomy. Autonomy is thus seen as a highly powerful and desirable quality for independent learners. Not all students bring this high level of autonomy with them initially into their studies, and so the teacher must bring the student around to acquire this autonomy. The four-stage model of learning illustrates the cyclic iterative process through Stages 1 to 4 to equip and bring the student to go onto independent learning in a further new cycle starting at Stage 1 in a new learning venture. Autonomy has also

been related to recognizing one's interdependence on others (Boud, 1988). Interdependence relates to understanding the need to learn together with others either in cooperative mode or at other times in collaborative mode. Interdependence is a maturity characterising an adult student, and is acquired through awareness and prior experience of the critical thinking process. Toward the end of Stage 4, the student can have acquired this sense of interdependence. So in entering a new Stage 1 iteration, the student may be interdependent (post-Stage 4) and once more newly independent (starting a fresh Stage 1). These attributes of independence and interdependence have already been found to be separate, orthogonal, and coexisting in mature students at the end their course (Chen & Willits, 1999). While autonomy is defined as an attribute of the student, different distance education programmes and the different stages in the model relate to different levels of autonomy for the student to be a successful learner. In a programme at Stage 2, the deployed structure means that the student is charged with thinking rationally but vertically rather than horizontally, and is analysing already given evidence, rather than finding new evidence, so the quality of autonomy is somewhat measured to fit the limited freedom given to the student. At Stage 3, different qualities of autonomy for hypotheses testing are needed for success, including a mature openness to new ideas that might be in conflict with one's previous and present conceived view of the world. The student needs to exercise the freedom to formulate or reformulate one's own conceptions. While in Stage 4, the quality of autonomy should include the willingness and ability to act to test out these newly constructed ideas to see experientially how they operate in practice. The amount of autonomy in each stage or different programme varies according to the task and nature of the course. The ethics involved in the interactions then in distance education govern the conduct of autonomy at some times requiring certain qualities to be forthcoming and at other times different qualities in order

to achieve learning. It is difficult therefore and moreover unhelpful to assign an integrated level of autonomy to each stage in the model of learning. The student should utilize measured amounts of the various qualities that constitute autonomy during each stage to support learning.

Clearly, ethics are needed in interactions in distance education to achieve efficiently one's own learning, and also to help others to learn cooperatively and collaboratively in a group, as detailed in the four-stage model of learning.

Finally, in this chapter it may be useful to consider the various lines of interaction between the student and content, student and teacher, and between the student and other students, and the affective motivations that drive these interactions and consequently moderate the level of autonomy. Here "modulating" the level of autonomy may be a more appropriate term, because autonomy must be varied and at times be consciously reduced, and such variation and occasional reduction is ethics in the interaction: One does not single-mindedly pursue ever-increasing autonomy; rather, some aspects are relaxed or reduced while other aspects are increased to achieve one's own learning goals and, more importantly for ethics, to help others learn. This chapter has so far considered aspects in three of the four known dimensions of learning: the cognitive, metacognitive, and the environment. The fourth dimension is the affective domain, involving the will and motivations that drive learning, detailed in Kawachi (2006). A comprehensive categorization of the motivations to learn was discovered and drawn by Taylor (1983) with the vocational, academic, personal, and social motivations, and later divided by Gibbs, Morgan and Taylor (1984, p. 170) into their subcategories of extrinsic and intrinsic. Of interest here is the social intrinsic motivation to learn, that acts along the lines of the interactions in distance education.

The three interactions involved here are the student-student, student-teacher, and student-content. The first two are already covered above in cooperative learning and in collaborative learning.

The third interaction between the student and the content which is collaborative has been described as being aesthetic reading in transaction theory by Rosenblatt (1994, p. 27). The process of motivation to learn is described in detail by Kawachi (2006). Briefly, the student is motivated to learn when the student compares his or her own perception of her current state with some reference goal value, when the observed gap (constituting a want or need) drives the student to act to reduce the discrepancy. The standard reference goals are generally preset socially and culturally, and the teacher should ethically make all efforts to know these in the distant students. The other factor here is that the student must also perceive there to be an opportunity to act and that there is a reasonable chance of success based on prior learning experience. The student-teacher interactions above have covered these points.

The student-content aesthetic interaction gives rise to the motivation for lifelong learning (Kawachi, 2005, 2006), which is generally recognized as being a central goal of education. The teacher or any other participant can initiate this motivation in the student. It occurs through experiencing pleasure or joy. There are only three positive affects in the affective domain. These are interest, pleasure, and joy, according to Tomkins (1984), and six negative affects (distress, fear, shame, contempt, disgust, and anger). It may be worthwhile reiterating here that ethics in interactions in distance education should carefully avoid causing these negative affects in others, and they are not discussed further here.

Barthes (1976) developed a theory of pleasure distinguishing between pleasure and joy, in which pleasure is the gratification usually previously experienced and therefore within the known world of the student. The student knows what brings pleasure and can look forward to experiencing it again by revisiting similar circumstances. Joy, on the other hand, occurs at the boundary of the student's world. When the boundary is momentarily and unexpected broken, then at that instant

of ecstasy, the student experiences the joy of learning. The teacher or any other participant can bring the student to within reach of this by moving the student toward his limit and then presenting surprising new information. “The penny drops” in the student’s mind, sometimes immediately, sometimes much later unexpectedly, and sometimes never. The aesthetic experience derives from this process or activity of group learning, and is addictive.

The interactions involved and the ethics involved here in the interactions to promote aesthetic motivation and lifelong learning in others are important. When carefully guiding others in this direction, one must suspend one’s own desire for increasing one’s own learning autonomy. Autonomy is accordingly ethically modulated by these affective factors for learning. Whether or not one is engaged in learning for oneself as a simple-minded student or is helping others to learn as a mature responsible student or teacher, nevertheless one must be careful ethically so as not to disturb others negatively, and ideally one should help others if at all possible.

FUTURE RESEARCH DIRECTIONS

Future research is warranted into optimal transactions for learning online. In particular, scaffolds should be constructed and provided to students to facilitate their cooperative learning in a group and for their collaborative learning in a group. For students new to online learning, these scaffolds can be detailed templates for them to use to support their learning, and at the same time will serve as metacognitive tools to guide their thinking and reflection. The templates will also comprise an e-learning portfolio for the students individually and as a group, and for the teachers and accrediting institution. At more advanced levels, the templates can be less detailed and more flexible.

Future research should not only focus on ways to promote ethically good practice, but should

analyse online discourse to illustrate where and how unreasoned practice leads to breakdown in communication and poorer quality learning outcomes. So, three-way control studies should be undertaken into online discourse analysis of learning. Three groups are needed to detect the influence of observations and any novelty or Hawthorne effects.

How students learn online independently of others is also a worthwhile avenue to explore in future research. It is generally accepted that in conventional face-to-face education studying in a group leads to better quality learning than studying alone independently, but while hundreds of studies have demonstrated this in face-to-face education, there are none so far to date that have compared these ways of learning in an online e-learning course. This maybe due to the transfer of what works best in the conventional mode into the online mode. However, the online mode now offers rich learning environments that likely support independent study. These rich environments include search engines that can pick out key phrases from blogs, wikis, stored powerpoint presentations, lecture notes, annotations by previous students, and so forth. Moreover, if learning-by-doing has validity in face-to-face conventional education, it may also have validity in online virtual reality and other technologies. Studying alone will raise many more questions of online ethics, which have hitherto not yet been considered.

CONCLUSION

This chapter has looked at what is distance education and at the three dimensions of structure, dialogue, and autonomy of transactional distance theory that can describe distance education. It has also looked at the interactions involved in distance education to achieve learning in one’s own mind and to help others to learn, both in the cooperative mode and in the collaborative mode, and it has looked at the desirable good conduct that is

based on reasoning which is known as ethics. All these points have defined ethics in interactions in distance education.

Some reports in the literature (for a typical example, see Conrad, 2002) have tried to uncover student thoughts and ways of learning online through teacher observations, but it is noted here that the author of this chapter has been a lifelong student within online interactivity, and this discussion draws from this long, wide and continuing learning experience. In particular, the author thanks my tutor Fred Lockwood at the British Open University, now Professor Emeritus at Manchester Metro University, and my teaching staff Stacey Rowland, Janet Gubbins and Melanie Clay at the University of West Georgia, from where the author graduated in Advanced Technologies for Distance Education in July 2007, and the fellow distance education students there, including Pam Miller, Bessie Nkonge, Diane Fulkerson, Sue Walters, Mauri Collins, and others.

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This section offers a few selected literature references that offer different perspectives on the topic of online dialogue and interactivity based on reasoning for ethical practice.

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Chapter 7.15

Implications of Anonymity in Cyber Education

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ABSTRACT

This chapter explores the pros and cons of anonymity in cyber education and discusses possible ethical and social implications for online learning. It evaluates both sides of the anonymity issue and presents strategies that may help cyber educators and instructional designers safeguard academic integrity. The educational implications include concern for authenticity and academic integrity, and the dynamics found in social presence. This chapter discusses pertinent policy while analyzing anonymity's potential for limiting and monitoring academic freedom and the social benefits it brings. Strategies are suggested to enhance social presence by planning for interaction through the instructional design process. The far-reaching

effects of anonymity within online educational settings and group dynamics have immediate and long term implications for instruction and learning.

CHAPTER OBJECTIVES

The reader will be able to:

- Understand the educational implications of anonymity in cyber education
- Understand how the enactment of policies attempt to protect individuals as well as institutions
- Identify the main two ways in which academic integrity breaches may occur in on-line courses.
- Evaluate different strategies that may be used to safeguard academic integrity.

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INTRODUCTION

The topic of anonymity in cyber education presents ethical concerns as well as benefits. The privacy offered by the anonymity of cyberspace can influence a person's level of isolation. This is a risk that online learners take and which instructional designers must minimize by planning for interactions that increase social presence. Anonymity also brings about the added concerns of academic integrity and authenticity. This chapter will explore ethical and social implications of anonymity in cyber education.

Anonymity affects class discussions, emerging online identities, and interpretations. This brings a new freedom for learners or instructors who do not want to feel categorized, such as those with a physical disability who could be perceived negatively (Lance, 2002). The benefits of anonymity also create challenges. Constructivist learning theories support online instructional modeling strategies that may help enhance social presence and thus reduce the feelings of remoteness.

While some individuals may actually prefer seclusion, most online learners either choose or are required to actively participate in the course. New social norms are developed within the course room as students get to know each other through interactions. These norms require that individuals use new communication skills (Kerka, 1996). Monitoring within the online environment is also a necessary task for instructors and administrators alike. E-learning platforms, such as WebCT, not only let instructors monitor how learners are using the course room, but also offer features for administrators to go behind the scenes and assess the effectiveness of the instructor.

There is a dichotomy in a technological society: on one hand, anonymity is one of the characteristics of technology; on the other hand, evolving technologies are making anonymity increasingly less evident. Misconduct and improper use of the Internet have prompted governments around the globe to seek regulation and control over the

anonymity inherent in Web-based communications. The online community, including distance learners, is affected by these policies and/or lack of them.

Anonymity is the capability to act in private. Privacy means the ability to act without being known or isolated from the invasion of others. In years past, choosing not to reveal one's name or writing with a pseudonym enabled anonymity. Through anonymity, individuals have the freedom to think and express their ideals, even if these ideals may not be in favor politically or socially. It also offers protection from ridicule and retribution. Being unreachable though, has other consequences (Nissenbaum, 1999). Some of these consequences include identity theft, lack of authenticity, and lack of personalization. Anonymity may also exaggerate fear and isolation.

Cyber culture may present a false sense of online security. While the learners hold that their interactions are private and secure, the reality is that everything is traceable. The ability to track, profile, trace, and categorize are inherent in the media. It is inescapable that in order for data to travel to a designation around the world it must know where to go. "Most of society is not equipped to understand what is going on underneath the shiny, glossy surface of the World Wide Web. While it appears that most of the Internet makes it possible for us to lose contact with our bodies and assume some ethereal cyber presence, the amount of surveillance also possible is surprising" (Herman & Swiss, 2000, p.148).

Improvements in telecommunications and mobile learning, as well as the continuing development of alternative technologies to deliver education, are creating a climate of digital access that has more user entry points daily. The kinds of issues surrounding anonymity and the way these issues influence cyber education are difficult to pin down. According to the National Research Council, the observations we make today will not only be different from observations in the past, but will be changed by the events in the future

(Kettler, Klensin, Medin et al., 2001). On the other hand, good policies cannot be developed unless a constant conversation is taking place regarding the issues faced by distance educators, especially those who are part of online learning communities. As national boundaries disappear, the international concern for safeguarding individuals and their information from possible misuse also grows (Karmaker, 2002). The protection afforded by policy varies not only by nation, but also by economic sector. Educational institutions in the United States are affected primarily by the Family Educational Rights and Privacy Act of 1974 (FERPA) and the Uniting and Strengthening America By Providing Appropriate Tools Required To Intercept and Obstruct Terrorism (U.S. Patriot) Act, which will be discussed in the next section.

In order to plan for cyber education successfully, it is critical that the issues confronting the extended cyber space community are understood (Kettler et al., 2001). The term cyber education will be used throughout this chapter when referring to online teaching and learning. The implications of anonymity are far-reaching in cyber education, and instructional designers will need to focus on ways to create engaging online courses while maintaining accountability for students and instructors.

PROTECTION AFFORDED BY POLICY

The meaning of anonymity today is not the same as it was as 25 years ago. The concept becomes obscure in a society that is electronically capable of sending information around the world in nanoseconds and has implications far beyond those of just remaining nameless. Anonymity takes on new a meaning when technologies make it possible to trace people or access networks in ways that World Wide Web pioneers never imagined. Security breaches are a real concern for institutions and governments, which have enacted policies

and laws to protect the rights of individuals, and protect themselves from intruders.

Security breaches are an unpleasant reality for educational institutions as well as businesses. In a 2005 report to Congress, it was revealed that about half of all security breaches in the U.S. happen within higher education settings (Tehan, 2005). Many major U.S. universities such as Indiana University, Michigan State University, and California State University among many others, have experienced security breaches that have put at risk of exposure confidential information residing in the school's server. Personal information, such as social security numbers and bank accounts, has been accessed by hackers and virus infections have threatened entire networks.

While the institutions at risk may have taken great steps to remedy this situation, one can not help but wonder how much information from anonymous surveys and confidential documents is actually out there. Certainly one way to minimize security breaches is to let technology correct the problem. Technologies have been developed to deter the loss of privacy and anonymity, which include firewalls, Web browsers that can deny loading personal information, and Platform for Privacy Preferences (P3P) that allow Websites to communicate their privacy practices to end users (Wenning, 2006). Regulation through the enactment of laws is another approach (Spinello, 2003).

In 1960, the Supreme Court passed a law declaring privacy as a separate right. The federal government has since passed several laws upholding this right including the Privacy Act of 1988 (Adamson & Mietus, 2000). This Privacy Act has 11 Information Privacy Principles (IPPs) and 10 Nation Privacy Principles (NPP) that apply to government agencies, the states, health care, and the private sector. The federal government has also passed a host of additional legislations to address data mining, matching, and telecommunications (Office of the Privacy Commissioner, 2006). As educational initiatives move into this dimension

of cyberspace, personal privacy is affected, thus influencing the anonymity inherent in distance education.

Even though Internet use policies warn users of the open nature of the Internet, caution should still prevail. The Privacy Rights Clearinghouse Document "Privacy in Cyber Space: Rules of the Road for the Information Super Highway" states "there are virtually no online activities or services that guarantee an absolute right of privacy" (Academic Senate of California Community Colleges, 1999).

U.S. vs. Europe: Policy on Internet Anonymity

The European Union has taken a stronger stance than the United States to assure privacy and anonymity on the Internet. Because of the global reach of cyber education, it is interesting to examine the diverging paths taken by these entities. While the United States has relied on a "hands off" policy and self regulation, Europe has passed laws to protect privacy and the individual directly.

The United States' stance is founded on the belief that market regulation and self-policing by technology tools is the best way. Instead of sweeping policy regarding the issues of privacy and anonymity of Internet data, the United States has taken the approach of regulating specific industries. Laws such FERPA offer control and protection in situations where sensitive data could be compromised (Spinello, 2003; United States Department of Education, 2006).

Europe has taken an opposite approach. The European Union has chosen to directly regulate the privacy rights of the individual across all sectors. The legislation covers the next generation of Internet protocol and requires the maintenance of proper confidentiality with respect to location, actual data, and information trafficking (British Parliament, 2000). This initiative empowers users to take control of safeguarding their own personal information. The major problem with this policy is that it is not supported by the technologies

currently available for Internet communications. The current protocol gives away the location and traffic information when a user accesses the Internet. What is important is the philosophical underpinning behind the laws.

FERPA vs. U.S. PATRIOT Act

In an attempt to protect citizens from unforeseen terrorist attacks, the U.S. government has enacted laws that make monitoring easier. While these laws may mean well, they have impacted the ability for individuals to take shelter in anonymity. The U.S. Patriot Act, although amended, may have limited academic freedom and diversity of perspective. These limitations come about the heightened concerns for protecting national security at a time when expressing divergent opinions publicly may be construed as a threat. Only a good balance of different views can ensure freedom of academic pursuit. The problem is compounded in a digitally connected world of traceable information and profiling.

The importance of protecting the privacy of online learners may be seldom discussed, but the consequences may be brought to light under the U.S. Patriot Act (Kettler et al., 2001). Because of the implications of this act, face-to-face, as well as online, learners may have to make politically correct displays of opinion and interests, or they could potentially experience the inquisition of government officials. It could be argued that this type of limitation may warn off the pursuit of academic freedom. Interactions within the virtual course room for example, are easily identified and traced, thus potentially discouraging intellectual discourse and difference of opinion if placed in the wrong hands. These interactions could be e-mails, blogs, wikis, discussion postings, or written assignments that could include subversive political thoughts.

FERPA provides a tough standard for the review of educational records by third parties. Prior to September 11, 2001, few third party inquiries

required release of student records. Only a court subpoena or pursuit of a subpoena could disclose student records. In *Gonzaga University and Roberta S. League v. John Doe* (Supreme Court of the United States, 2001), the rights guaranteed under FERPA were somewhat diminished, as the case restricted the threat of exposing a learner's private record to loss of federal funding. With the federal government given easy access to a student's records and undermining privacy rights in enforcing FERPA, the privacy of student records is vulnerable (American Civil Liberties Union, 2001).

Policies enacted in Europe and the United States affect the educational sector as well as other sectors which rely on the Internet (Spinello, 2003). Cyber education could be affected by the methods used to empower the users to determine which information is communicated and allow them to select control of their anonymity. As cyber educators take into consideration how the different policies impact educational practices, taking a balanced approach to anonymity remains a challenge.

ETHICAL IMPLICATIONS OF ANONYMITY IN THE ONLINE LEARNING ENVIRONMENT

In addition to traditional ways of securing the individual's information, educational institutions must now monitor the quality of their online programs and ensure the authenticity of student work. The feelings of "distance" inherent in anonymity may tempt some individuals to cheat (Burgoon, Stoner, Bonito, & Dunbar, 2003). This realization has cyber educators seeking to secure assessments in an effort to validate the grades they issue. Two ways to possibly deter ethical infractions are through monitoring the learning environment and implementing certain design strategies to enhance authenticity of student work.

Just like there are rules for driving on roads and highways, it is necessary to have guidelines for navigating and interacting within online environments. Shea (1994) introduced 10 core rules of Netiquette. Although these were developed for commercial application, they apply to all cyber communications. These include:

- Remember to be human
- Adhere to the same standards of behavior online, that you would follow in real life
- Know where you are in cyberspace
- Respect other people's time and bandwidth
- Make yourself look good online
- Share expert knowledge
- Help keep the flame wars under control
- Respect other people's privacy
- Don't abuse your power
- Be forgiving of other people's mistakes

These 10 core rules have served as a bare minimum in cyber courtesies. The legal status of anonymity on the Internet is unanswered and debatable. Yet, basic guidelines such as these 10 Netiquette rules may help set ethical boundaries to help safeguard academic integrity and reinforce an online learner's sense of presence in the course.

Authenticity of student work and sense of presence may well be influenced by the level of anonymity experienced. Every learner is required in most asynchronous and blended courses to participate in online discussions and assignment postings. These discussions and assignment postings reveal the person's name but not the physical cues that help form an opinion about the individual. Therefore, in this semi-anonymous environment there is both safety and concern. Threaded discussions, for example, are captured digitally and can be retained for extended periods of time. Academic institutions, such as Baker College (Heberling, 2002), archive entire online courses for quality control. A student's interaction patterns can be analyzed for any particular purpose and opinions can be formed based on the patterns found.

The level of anonymity may affect student contributions and feedback. Because of the permanent and visible characteristics of posting information online, many students, for example, may hesitate to share unpopular ideas. One way to protect against fear of retribution is to provide anonymity to the learners. Because discussions are so critical to learner exchange and communications in cyber space, developing interesting and robust exchanges is desirable.

While instructors are not in the business of judging students, they must monitor their course room interaction and the quality of their discussion postings, which is often a large component of their grade. Instructors and peer learners are bound to form unintentional misunderstandings and misconceptions if the social constraints of anonymity are not removed by purposely creating safe online learning environments.

In Pursuit of Academic Integrity

The lack of identity brings to light serious issues about how we distinguish, handle, and negotiate identifying information. Having authentic records is critical to cyber education, the credibility of entire educational institutions rides on the ability to prove who did what work. Authenticity then becomes an interdependent of anonymity. In face-to-face settings, anonymity is generally indistinguishable if the norms are followed and socially acceptable behaviors are adhered. In cyberspace, the observance of mainstream and socially acceptable behaviors are mainstay. The counterweight to anonymity is accountability, thus safeguarding academic integrity is of utmost importance to cyber educators.

Anonymity is seen as undesirable when it becomes an enabler for fraud or deception, yet the need for accountability creates ambiguity and concern. Minor educational implications include tracking when and how long a student has accessed the virtual classroom, documenting interaction and “surfing” patterns, and personal tendencies

or preferences. Major implications can include tracking subversive political views or actions that are perceived to be threatening. While the latter is a provocative thought, academic institutions may be more interested in curtailing plagiarism than following radical points of view. Academic integrity is mainly breached in two ways: when students plagiarize from Internet or other written sources and when students have someone else do their online assignments or assessments.

The problems that cause students to cheat are the same in face-to-face and online classrooms; for example, a student may feel pressured to produce an essay he did not have time to write, or maybe he did not understand the topic covered (Christe, 2003). Anonymity can be wrongfully used in ways that would be more evident in the face-to-face classroom, such as having someone else take the exam. Nonetheless, educators are responsible for safeguarding the authenticity of assignments and assessments and may do so utilizing specific tools and strategies

Tracking student access to a course can provide important information to the instructor. For example, if the student has spent little time in the course, or has not navigated to the appropriate lessons, yet produces high quality assessments for those lessons, a flag of concern is raised. In this case, the student may be getting information from someone who has previously taken the same course.

In the online environment, distance and anonymity may tempt a student to bend socially accepted norms. Although tracking personal tendencies and preferences could possibly be mishandled, instructors may gather clues as to the writing and communication style of their students. When an instructor knows students as individuals, she or he is better prepared to notice any sudden changes in a person’s writing or communication style that may indicate some one else has completed the assignment.

The most common type of academic integrity breach may be plagiarism. Cheating online is

often seen as easier both psychologically and technologically. Academic institutions, however, rely on services such as *Turnitin.com*. to identify and curtail such behavior. Equipped with search engines, these companies can scan Web-published documents, online books, and their own repertoire of previously scanned documents, to find any matching content. This technology has empowered cyber educators to easily detect plagiarized work.

Instructional designers can employ different strategies that enhance authenticity and promote honesty in the virtual classroom. Attention must be paid to assessments and appropriate monitoring. The consequence of ignoring academic integrity in the online environment is a threat to online credibility (Christe, 2003). Authentication is only as valid as the morality of the person accessing the information (Rezmierski & Soules, 2000).

Designing for Authenticity

In a midst of frustration and a sense of urgency, distance educators are looking to the instructional designer to provide added security and authenticity in the online course room. Anonymity should remain part of the environment if it indeed protects privacy and promotes academic freedom. This must be balanced with the need to have a secure environment free of security or academic integrity breaches. Teachers and learners must be protected from anonymity concerns that compromise work, their identity, or their validity (Rezmierski & Soules, 2000). Two strategies that may help cultivate academic integrity are to create meaningful assessments (Olt, 2002) and monitor student activities.

Good assessment tools are fundamental to ensuring the quality of online learning. Carefully selected and crafted, these tools can support the positive aspects of anonymity online and decrease the impact of the negative. Using multiple techniques and selecting various methods that evaluate students in an authentic manner may foster academic integrity.

These techniques include synchronous activities such as virtual presentations, debates, position statements, or interviews. Another approach might be to craft questions that are broad enough to be authentic and allow the learner to apply the knowledge to their life and their world. These techniques may also have the side effect of not only diminishing the “need” to cheat, but also facilitating transfer by internalizing the knowledge gained. Although these synchronous assessment strategies are a departure from the more popular multiple choice tests, they still do not guarantee that the person participating is indeed the student enrolled.

Overall, instructors and designers should strive to design assessments and assignments that are meaningful, require mastery of the subject matter, and call for real-world applications. Thus cyber educators can focus on the process instead of the product. If the designers make the assessments a learning experience and add variety and meaning, the learner is more likely to see the assessments as meaningful and less likely to cheat (Rowe, 2004).

Several other things can be done to help minimize cheating in online assessments and curtail plagiarism. Expectations and consequences for breaching academic integrity should be communicated to learners at the beginning of the course. The instructor may also use monitoring tools within the Learner Management System (LMS) to track student activity. If such monitoring tools are available, they should be used to monitor participation, times, and duration (Christe, 2003). Other strategies include: (1) changing the assessment each time the course is offered, (2) using a larger pool of questions for the assessment, (3) conducting oral assessments via phone, and (4) monitoring student communication. These strategies may be helpful but are not without weaknesses and challenges.

Course design and instructional methods can make a critical difference in reducing the negative effects of anonymity online and supporting the positive attributes. The classroom should be

supportive and impartial. Communications and interactions can enhance collaboration and sharing, and minimize remoteness. Designers and instructors need to meet the increasing ethical challenges of assessment in online education. The biggest challenge is awareness and acceptance of the problems brought about by technologies and the temptations afforded by anonymity.

SOCIAL IMPLICATIONS OF ANONYMITY THAT IMPACT EDUCATION

The social implications of anonymity are evident in the interactions of online learners. Student-student as well as student-instructor interactions display clues to the level of anonymity as well as the type of emergent persona chosen by each individual. Proper interactions provided by instructional design and modeling can help create safe environments where learners are encouraged to participate in academic discourse. Activities should be designed to support authenticity and help instructor and learners build a learning community.

The potential to experiment and explore different perspectives is at the heart of online teaching and learning. The anonymity of teaching and learning in cyberspace supports the experience of leaving one's culture and wandering into another, or experimenting with one's sense of identity and returning home safe and sound. It also supports the freedom that is responsible for challenging and shifting perspectives and encouraging appreciation for differences, while valuing members of the learning community as independent thinkers (Chester & Gwynne, 1998; Rheingold, 1994).

Social presence is a way of defining our place in cyberspace. Heim (1992) implies that interactions in cyberspace are a way of defining our sense of reality. Kennedy (2000, p.13) defines cyberspace as the "cultural space in cyberculture" where "subjective empowerment, pleasure, play, and creative connection(s)" occur. Social position-

ing in cyberspace becomes one of questioning the subjective and pre-subjective elements of the encounter. Whether it is through course management systems, e-mail, bulletin boards or the Web, encounters in cyberspace rely on positioning through discourse. In cyberspace, each learner is at equal distance from the learning stimuli. It is only the learner's perception of closeness and intimacy, which is influenced through interactions that provides a sense of presence and social identity (Gunawardena, 1995).

Current educational epistemology supports the theories of constructivism. Constructivist theorists Cote (1996) and McAdams (1998) support the theory that each individual has some control over the development of his or her identity. An online learner's identity is constructed through a combination of social forces and the learner's ability to navigate through these powers (Cote). Online identity is often put together through the use of language as a text through which identity is constructed and maintained. Reality is then born through narrative assumptions that help shape identities (McAdams).

Constructivist theory has greatly influenced how collaborative learning is applied in the online environment and supports the concept that thinking is grounded in social and physical experiences. Knowledge is constructed by interactions with others and the learning environment. Constructivist pedagogy asserts that knowledge is constructed by the learner through meaningful interactions and this can lead to substantial learning gains (Jonassen, 1999).

In a constructivist environment, learners and instructors do not exist independent of each other, nor can knowledge transfer be measured by an end-of-unit test. Each learner has a host of responses applicable to a situation depending on progression, cognitive processes, and resources. There are qualities inherent in meaningful and engaging constructivist learning environments, which can be applied to understand the why and how individuals engage in an activity (Jonassen &

Rohrer-Murphy, 1999). These qualities include use of active, constructive, collaborative, intentional, complex, contextual, conversational, and reflective environments (Jonassen, 1999; Jonassen & Rohrer-Murphy, 1999). Where many instructional designers fall short is not effectively integrating these aspects into a distributed learning environment (Morice, 2002).

Building environments that support multiple perspectives and authentic examples can support collaboration and the construction of knowledge through social negotiations. Learning environments that support the active construction of knowledge must also foster social presence and trust. The promotion of social presence may be a significant factor in instructional effectiveness and collaborative learning.

Minimizing Perceived Instructor Authority: Benefit or Detriment?

Because these Internet communications lack the initial social and emotional cues that are provided in face-to-face environments, there is an initial feeling of anonymity. This allows introverted learners to participate in discussions and share feelings in ways they may not be able to do in face-to-face classrooms. This same distancing also creates equality between professors and students by eliminating things like standing in front of the class and divesting the professor of some authority. Learners feel a greater sense of anonymity and therefore empowerment to express ideas and open discussions, which leads to a changing role for the instructor. The role is certainly more of a facilitator and less of an expert; it breaks down the authority structure and opens up channels of communication.

Disarming the traditional lecturer of some perceived authority has its own social implications. For instance, traditional societies that have long valued and respected educators will find it inappropriate for a student to address the instructor by

the first name or question the grade received on an assignment. Placing the instructor at a more equal level with the student can potentially undermine the instructor's authority, especially when the student is frustrated about something that could otherwise have been resolved in a face-to-face environment (DeVries & Lim, 2003). Instructors and designers must take this aspect of anonymity into consideration, as it can impact the way learners from different cultural backgrounds interact with the instructor.

Equalizing instructor and learner roles can bring benefits to building online learning communities. Online learning communities are the framework that facilitates the exchange of social information as well as reinforcement of key concepts learned. Wegerif (1998) agrees that learning communities provide the social dimensions necessary for learners to be successful in asynchronous learning environments.

The Emergence of a New Persona

This initial sense of anonymity and freedom gives way to a different feeling, as individuals experience the emergence of a new online identity. The acknowledgement that one's style and presence can be easily identified by the consistencies expressed in writing and the ideas and attitudes that have not only been captured but also preserved over time. Anonymity may also affect the quality of comments offered in communications by students. Peer accountability and anonymity can affect the degree to which learners communicate with each other as well as the quality of these communications.

Asynchronous learning environments create a new dimension for learner interaction. New patterns of social interactions emerge as students take on their new online identity. Gender differences can play a huge role in the way a learner interacts within a course room (Rovai & Baker, 2005). Rovai and Baker found that female online

learners felt more connected during their learning experience. But how does interaction relate to anonymity?

The feelings of anonymity will impact the student's interaction patterns. If females tend to feel more connected, this could mean that females deal differently with the feelings of anonymity than males. Further research is needed to investigate the relationship between anonymity and interaction as they are impacted by gender. Recent research shows that there are personality factors which may influence a person's inclination to follow norms or be academically dishonest. Etter, Cramer and Finn (2006) found that students who perceived sensation-seeking behaviors to be acceptable, were at a higher risk of breaching academic integrity, yet cheating in church-affiliated institutions versus traditional institutions was very similar.

Earlier studies in online learning showed contradictory conclusions in regards to anonymity. Kiesler, Seigel and McGuire (1984) suggested that anonymity would minimize gender differences. But, Herring (2000) insisted that gender-based communication styles carry over into electronic environments. Herring bases his claim on research showing that males who tend to be more aggressive face-to-face, also displayed the same behaviors in online environments, such as listserves. Meanwhile, the women tended to be more assertive in male-dominated groups. Herring found a myriad of gender differences that are visible in online environments; thus, he believes that true anonymity is very hard to achieve.

Deindividuation: Setting "Self" Free

Deindividuation is the psychological state of mind that causes a person to become less inhibited and less self-evaluative (Postmes, Spears, & Lea, 1998). Postmes et al.'s social identity model of deindividuation (SIDE) targets the interaction of online learners as individuals and as members of a learning community. They found that computer-mediated communications did not free individuals

from being influenced by social norms or pressures. This is contrary to the idea that anonymity only brings freedom of expression.

Other researchers, such as Scott (1999), have concluded that when a person's identity is salient or emergent, the person is less likely to follow the group norms. But, when a more social identity emerges, the person is more likely to follow group norms and feel part of the social structure. He contends that the same anonymity that causes students to become uninhibited creates social salient identities that in turn increase the stereotypical behaviors of those individuals. In other words, when we identify ourselves with a group, we are likely to behave according to the group's norms. The effects of depersonalization on group dynamics are astounding. When learners are depersonalized, their individuality is less salient, thus they bond with the group, giving way to the emergence of stereotypes (Postmes et al., 2002).

The power of culture is also a factor to consider. Individualistic cultures influence the way learners from that particular culture identify themselves. Jetten, Postmes, and McAuliffe (2002) found that people from individualistic cultures, like in North America, tend to have low identifiers, in contrast to cultures that value collectivism. Collectivist cultures, such as those from Asia, show high identifiers, but follow the salient group norms, more so than low identifiers. This reveals how cultural background influences a learner's interactivity and feelings of anonymity.

The question as to whether asynchronous learning environments are better at sustaining anonymity poses a concern for designers who are being asked to do just that. Research has shown that computer mediated communications are not necessarily asynchronous. Wegerif (1998) cites the example of frustrated students and instructors having to sort through an extensive list of messages after being a short time away from the course room. The first challenge is to provide a sense of community for learners of both individualistic as well as collectivist tendencies while the second

challenge is to design learning environments that encourage learners to actively participate.

Designing for Interaction

From the instructional design standpoint, the positive aspects of anonymity can possibly be nurtured while deterring fraud or deception. Courses may be created to include activities that support learner-learner and learner-instructor communications, foster collaboration, and fight isolation. The more connected the learners feel to each other and to their instructor the less likely they are to cheat and or be successful at it (Burgoon et al., 2003).

Face-to-face interactions have the effect of immediacy as the results of unethical and improper behaviors are immediately conveyed. On the other hand, online interactions can establish a mental distance that may make individuals feel more distant from ramifications (Rowe, 2004). Overtime, though, and with established guidelines, this psychological detachment can be reduced. Cheating is a genuine concern for cyber educators. Pressure to get good grades and lack of knowledge on how to address cheating may contribute to even more academic infractions (Gearhart, 2001).

Instructional designers have the responsibility of modifying instructional design models to ensure that different types of interaction are built into the course for diverse purposes. Best practices in the field should include those that have set guidelines for dealing with plagiarism, building online communities, and planning and organizing to implement learning theories that promote interaction. Message boards, IM, chats, blogs, wikis, and social networking software are just some of the tools that can be used to foster interaction in the course room. These tools help enhance social presence and build a sense of community. Many of these technologies already have built-in features to password protect and trace published content, thus providing other ways to monitor academic integrity.

Design frameworks should support building good and close relationships between instructors and learners as well as encourage direct and regular communication. Multiple communication methods enhance social presence and reduce the negative effects related to anonymity, such as remoteness. Furthermore, such interactions should purposely take into account differences in gender, culture and individual preferences.

Gunawardena (1995) conducted a study that indicates participants in online conferences create social presence by projecting their identities and building online communities. In order to encourage collaboration and interactive learning, it is important that learning environments are conducive to the creation of social and individual presence. Building social cohesiveness requires that instructional designers build interactive learning environment where learners feel comfortable choosing the level of anonymity and where instructors encourage and respect freedom of expression. Recognition and acknowledgement of learner presence by the instructor as well as developing protocols, etiquette and expectations will also enhance interactions and communications, thus potentially decreasing the desire to cheat.

Building an online community is as important as dealing with ethical infractions. Ethical guidelines must be practiced and enforced daily (Campbell, 2001). Palloff and Pratt (1999) stipulate that there is no online course without a learning community. It would then be logical to say that a learning community cannot exist without interactivity. Yet, these communities must be built with academic integrity as the foundation.

Planning and organization are pillars for building interaction among learners as well as between learner and instructor. There are a myriad of other skills and responsibilities that stem from planning, such as facilitating collaborative groups; choosing questioning strategies (Cyrs, 1997) and applying the most pedagogically sound practices that fit the objectives.

Cyber educators are responsible for creating a student-centered environment that encourages interaction for different purposes. According to Wagner (1997), there can be interaction for the purpose of increasing participation, developing communication, enhancing retention, supporting learner control/self-regulation, and interaction to receive feedback or clarification. Another important purpose of interaction is to increase motivation, which is a big factor of learner success in distance education.

Sims (2000) cites four dimensions that should be taken into account when assessing learning theories for the purpose of identifying how they promote interactivity:

1. **Learners:** The who of the learning process
2. **Content:** The what of the learning process
3. **Pedagogy:** The how of the learning process
4. **Context:** The when and where of the learning process

Seasoned cyber educators understand the need for interactivity. As Pelz (2004) puts it, "interactivity is the heart and soul of effective asynchronous learning."

Two defining elements of online learning are the creation of learner identity and social presence. Learner identity can not be addressed in cyberspace without including the balancing act innate in anonymity. The opacity of cyberspace invites the learner to play with identity and build multiple selves (Turkle, 1997). The culture of cyberspace must be advanced with an open and eclectic approach to instructional design and modeling.

CONCLUSION

Anonymity in cyber education presents ethical concerns as well as benefits that must be taken into consideration when designing online courses. The privacy offered by the anonymity of cyberspace is threatened by the technological advancements

that make possible the access to personal information. Online learners take the risk of having their ideas and thoughts exposed, thus it is the duty of instructional designers, instructors, and educational institutions to create a safe haven for scholarly discourse.

Anonymity affects class discussions, emerging online identities, and interpretations. But, at the same time, there are new dimensions, such as group dynamics, that affect the quality of discussions. New social patterns and norms emerge, as learners tend to identify themselves with their cultural background or relate to specific group behaviors. The tendency is to prefer either individualism or collectivism; such preferences will dictate how a person will blend in a group situation that is deindividualized.

Gender differences, once believed to equalize computer-mediated communication, emerge in asynchronous and synchronous learning environments. Furthermore, online courses cannot be successful without a learning community, and a learning community cannot exist without interactivity. Only by understanding this relationship can cyber educators realize the impact of anonymity.

There is now a heightened awareness on the part of governments and educational institutions on the need to protect personal privacy and anonymity. This awareness has prompted legislations such as the FERPA and Patriot Act in the United States. While these initiatives are meant to protect, they may set back the intellectual exchange of ideas, especially those with political connotations. Political tensions around the globe aggravate the problems with privacy already faced by cyber educators. The European Union has taken a different approach than the United States, leading the way in the enactment of laws that directly protect consumers. Only time will tell how the rest of the world will deal with these issues. Educational institutions face the challenge of maintaining data secure from intruders, as well as safeguarding the academic integrity of online programs.

In the mean time, cyber educators and instructional designers must evaluate implementation choices that build interactivity in online courses without compromising a learner's self-identity or the institution's academic integrity. By carefully balancing anonymity and identity, cyber educators have the task of creating online learning environments where students can safely exchange ideas that promote cultural understanding; a daunting task in a world that craves diplomatic dialogue.

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Chapter 7.16

An Ontological Approach to Online Instructional Design

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ABSTRACT

This chapter introduces the ontological instructional design as an alternative to the traditional instructional design in teaching and learning. By comparing the differences between traditional instructional design and e-Learning, the authors suggest that instructional design in e-Learning require a different model than the existing traditional models due to the idiosyncratic nature of e-Learning in terms of population, environment, and resources. An ontological instructional design model is proposed with a focus on the sharability, reusability and interoperability of ontological entities and design components within the ontological entities, which provides a holistic approach to online instructional design compared to the segmented, linear design approach in traditional

instructional design models. A case study is included to illustrate the use and application of the ontological instructional design model in an online business course. Finally, guidelines for implementing the model are made with suggestions for future research.

INTRODUCTION

The proliferation of web technology in education, particularly with the introduction and implementation of semantic web, has called for the need of re-examining the traditional instructional design in online learning (Snelbecker, Miller, & Zheng, 2007; Zheng & Ferris, 2007). The traditional instructional design models focus primarily on epistemological approach in design by examining the experiential process related to knowledge representation as well as the means related to the

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production of knowledge based on various principles in instructional design (Han & Park, 2008; Spector, 2001). Although the epistemological approach contributes to a general understanding of the relationship between the knowledge representation and the knowledge production, the implementation of epistemological approach in terms of shared conceptualization of domains in online learning remains an area that warrants further exploration and validation. In other words, how to implement instruction, particularly online instruction from an ontological perspective has been the focus of many online instructional designers and researchers (Abel et al., 2004; Berners-Lee, Hendler, & Lassila, 2001). The present chapter offers a discussion on (1) issues in applying traditional instructional design models to online learning; (2) differences between epistemological design and ontological design in instruction; (3) the need to apply ontological design to e-learning with respect to recent development in semantic web; finally (4) a conceptual framework for ontological instructional design in online teaching and learning.

ISSUES OF APPLYING TRADITIONAL INSTRUCTIONAL DESIGN MODELS TO ONLINE LEARNING

Studies over the last decade have focused on the issues related to the applicability of traditional instructional design models to e-Learning (Akbulut, 2007; Rutherford & Kerr, 2008). Research in this field has so far produced mixed results. Some believe that traditional instructional design models can be universally applied to any instruction, online or offline (Anglada, 2008; Bi, 2000). Others argue that traditional instructional design models may not fit e-Learning due to their rigidity and lack of flexibility in design (DeSchryver & Spiro, 2008; Gunawardena, Ortegado-Layne, & Carabajal, 2006; Koh & Branch, 2004). Crawford (2004) explored online learning and traditional instructional design

and found that there were apparent discrepancies between the two models. According to Crawford, the e-Learning model allows for exploratory, constructivist concept building whereas the traditional instructional design model is procedure-centric which allows little room for creative learning. Consistent with Crawford's finding, Barron, Orwig, Ivers, and Lilavois (2002) found mismatches between traditional design models and e-Learning models in terms of individualized learning, collaboration, instructional delivery, and instructional design.

Individualized Learning

There are significant differences regarding the theoretical assumptions of individualized learning between traditional design models and e-Learning models (Barron et al., 2002; Harris, 1998). Traditional design models assume that all learners must learn at exactly the same pace and at the same level of content mastery. As such, instructional goals and learning objectives in traditional instructional design are routinely set to fit the normal curve, with little concern for the individual outliers (Moller, Foshay, & Huett, 2008). The above theoretical assumptions and their resultant approaches in traditional instructional design can be problematic because it is difficult to fit online learners into this traditional normal curve. An online learning community is characterized by its diversity in terms of prior knowledge, learner characteristics, motivation, social and economic status, and so forth (Moller et al., 2008; Proske, Narciss, & Korndle, 2007). Therefore, designing online instruction based on normal curve practice and the assumptions of traditional design theory would adversely affect the online learning community where individualized support at various levels is needed.

Collaborative Learning

Although both traditional instructional design and online learning emphasize the importance of collaboration in learning, there are fundamental

differences between the two due to the distinct learning mode that each takes in learning. In the traditional classroom, collaborative learning occurs in a face-to-face environment where students concurrently interact with each other in the same place (Topper, 2007). The physical and time constraints thus restrict the mode of collaboration in instructional design. Typically, instructional designers would maneuver factors related to physical environment such as seating arrangement, student grouping, and so on in order to maximize learners' learning (Lim, Kim, Chen, & Ryder, 2008; Rutherford & Kerr, 2008). Contrary to traditional collaborative learning, collaboration in online learning is defined as virtual collaboration, meaning the physical interaction that is present in traditional learning environment is not available in online learning. As a result, synchronous and asynchronous communication, virtual grouping, as well as transactional distance (e.g., the interaction among the students, between the students and the instructor, etc.) in online learning become the foci in online instructional design (Giguere, Formica, Harding, & Cummins, 2007; Murphy & Rodriguez-Manzanares, 2008).

Instructional Delivery

What makes online learning idiosyncratic and different from traditional learning is the unique way that the online instruction is delivered. Traditional teaching relies heavily on the instructor, texts, and classroom media to deliver the content (Rutherford & Kerr, 2008; Solimeno, Mebane, & Tomai, 2008). An instructor would typically resort to texts, handouts, worksheets, and sometimes classroom media like Smartboard, video, or PowerPoint to deliver the content. Solimeno et al. (2008) point out that in a traditional classroom environment the instructor simply coordinates what is available to make the content delivery successful. They argue that the traditional teacher-centered approach impedes learners' self-initiation in learning. Learners have little control over the

content delivery and learning process. Conversely, in an online learning environment, learners have much control over the content delivery and are able to make decisions during the learning process (DeSchryver & Spiro, 2008). For example, e-Learning is characterized by multiple nodes and nonlinear presentation of information. Learners can thus choose the information appropriate at their level of learning. Moreover, since the content in e-Learning is delivered digitally, there is an opportunity for the instructional designer to incorporate various media including multimedia and hypermedia and various communication tools like email, blogs, threaded discussion, synchronous and asynchronous learning, and so on to deliver the content in the way that promotes learner self-initiation and constructivist learning (Papastergiou, 2006). Papastergiou noted that the traditional instructional design that capitalizes on teacher-centered approach in content delivery appears to be ill-fitted for e-Learning environment where learner-centered information access and delivery are emphasized.

Instructional Design

Most of traditional instructional design models were derived from behavioral models (Gustafson & Branch, 1997). This behavioral origin underscores the philosophical differences between the traditional learning and e-Learning, which result in differences in design between the two camps. Crawford (2004) observed several differences between traditional instructional design and e-Learning design. First, the traditional instructional design follows a hierarchical, linear approach in which the design components are disconnected and segmented whereas the e-Learning design is characterized by a non-linear approach in which instructional information is presented in a form of web or network. Second, in traditional instructional design, goals and objectives are always defined by quantifiable behavioral indicators, whereas in e-Learning design the focus is on

open-ended learning process. Crawford argued that because of the differences between e-Learning and traditional learning, the instructional design related to each type of learning has been distinctly different: the instructional design in e-Learning accentuates developing a learning environment where learners are able to share and construct new knowledge whereas the design of traditional learning focuses on achievement of a set of specific goals or objectives (see also Shoop, Nordstrom, & Clariana, 2007; Rutherford & Kerr, 2008).

As was mentioned, there are significant differences between traditional and e-Learning design. Such differences derive primarily from the underlying design philosophy of the two schools. Research indicates that simply migrating traditional instructional design to online instructional design without considering the unique characteristics of e-Learning would cause more harm than doing good (Wuensch, Aziz, & Ozan, 2008). Instructional designers should therefore be cautious about applying traditional instructional design models to e-Learning. Researchers (e.g., Abel et al., 2004; Gasevic & Hatala, 2006) suggest that the current study on e-Learning should go beyond the superficial differences such as learning environments to explore the epistemological and ontological aspects in design, particularly by examining the design consequences of each in teaching and learning.

EPISTEMOLOGICAL AND ONTOLOGICAL INSTRUCTIONAL DESIGN

Epistemology and ontology are related and at the same time are distinct from each other. They differ in the approaches toward the nature of knowledge which consequently result in different learning outcomes. The following is a discussion of the differences between epistemological and ontological instructional design.

Ontology

The term ontology essentially refers to the study of being or existing. It seeks to describe or posit the basic categories and relationships of being or existing to define entities and types of entities within its framework. In modern era the theory of ontology has been mapped to a new discipline -- computer science and has thus assumed a new meaning different from its philosophical origin.

Ontology in Philosophy

In Greek philosophy, ontology means understanding the eternal reality (Reginald, 1985; Spector, 2001). Plato defined the reality as primary and the perception and experience of reality as secondary. Socrates held the similar view that the purpose of learning was to recognize eternal truth and therefore the instruction was to remind someone of something already known and accepted as true (Spector, 2001). This classical view of ontology has changed due to a realization that the explication and uncovering of external reality involves human as perceiver and that human judgment, with respect to such uncovering, is subject to error.

One of the assumptions of modern ontology is that instruction should focus on bodies of knowledge rather than individual knowledge (Merricks, 2007). Instead of relying on one-to-one correspondence between individual beliefs and external reality, the modern ontology proposes a coherence theory of truth in which acceptance or rejection of new beliefs should be based on how well new beliefs fit with and how coherent they are with the established beliefs (Merricks, 2007; Quine & Ullian, 1978; Spector, 2001). This assumption is important in that it influences the formation of ontology in computer science in which the shared conceptualization of reality across knowledge domains is emphasized.

Ontology in Computer Science

Derived from its philosophical origin, the ontology in computer science is a data model that represents a set of concepts within a domain and the relationships among those concepts. For example, in artificial intelligence, software engineering, biomedical informatics and information architecture, the ontology is defined as a form of knowledge representation about the world. Ontologies in computer science generally describe:

- Individuals: the basic or “ground level” objects
- Classes: sets, collections, or types of objects
- Attributes properties, features, characteristics, or parameters that objects can have and share
- Relations: ways that objects can be related to one another
- Events: the changing of attributes or relations

The advent of web technology, particularly the semantic web, necessitates educators, instructional designers, and other educational professionals to re-examine the existing practice in web-based instructional design by putting in perspective the ontological design as they develop their web-based instruction. Henze, Dolog, and Nejd1 (2004) point out that the challenge of web-based learning is to provide distributed information with well-defined meaning, understandable for different parties. They assert that one solution to such challenge is to develop an ontological approach so that applications will be used to “provide individually optimized access to information by taking the individual needs and requirements of the users into account” (p. 82). Sampson, Lytras, Wagner, and Diaz (2004) concurred that ontology, which is a major component of semantic web, should play a key role in enabling the representation and

dynamic construction of shared and reusable learning content (see also Yang, Chen, & Shao, 2004).

The Semantic Web is an evolving extension of the World Wide Web in which the semantics of information and services on the web are defined, making it possible for networked computers to understand the requests of people and machines to use the online content. Berners-Lee et al. (2001) posit that the Web as a universal medium for data, information, and knowledge exchange ought to comprise a set of machine-readable content using design principles, collaborative working groups, and a variety of enabling technologies. Some elements of the semantic web are expressed as prospective future possibilities that are yet to be implemented or realized. Other elements of the semantic web have been defined and are expressed in formal specifications. They include eXtensible Markup Language (XML), database connections (SQL), Resource Description Framework (RDF), and notations such as RDF Schema (RDFS) and the Web Ontology Language (WOL), all of which are intended to provide a formal description of concepts, terms, and relationships within a given knowledge domain (Antoniou & van Harmelen, 2004). In addition, people-readable specifications using notations such as Cascading Style Sheets (CSS) and eXtensible Stylesheet Language (XSL) have been widely accepted as standard forms for machine-readable documents to enhance sharability and reusability.

Epistemology

Epistemology or theory of knowledge is the branch of philosophy that studies the nature, methods, limitations, and validity of knowledge and belief. Much of the debate in this field has been focused on analyzing the nature of knowledge and how it relates to similar notions such as truth, belief, and justification (Spector, 2001). The early epistemology such as Cartesian philosophy emphasized the first truths as a foundation to construct a picture of reality (Fuller, 1955; Williams, 2001). Differ-

ing from the classical ontology as represented by Plato and Socrates, Descarte's epistemology challenged the established truths by questioning every belief that one holds about external reality. This view of beliefs was associated with the rise of science and the success associated with the scientific method, which Descartes helped codify (Spector, 2001). Descarte's work laid the foundation for epistemological study which centers on the experience of reality through perception and persuasion, the very "enemies" which Socrates and Plato attacked with such vigor.

One approach that epistemology tries to reach truth is through empiricism - what we can know through our senses - which we can summarize as "we believe what we see". Another approach is skepticism which asks "how can we believe what we see?" Fisher and Nicholas-Everitt (1994) point out that empiricism and skepticism are two ways of approaching our experience of life and the subjectivity of our minds. By relating this philosophical view to the educational practices, we saw the boom of behaviorism which taps into in the empirical aspect in learning (Bloom, 1956; Skinner, 1953), and the rise of cognitive information process theory which explores the unknown of the mind pertaining to learning processes (Baddeley, 1986; Klahr & Wallace, 1976).

Differences between Epistemological and Ontological Views on Knowledge

Epistemology and ontology differ significantly on the views of knowledge with former focusing on the nature and production of knowledge, and the latter on the concept of knowledge. For example, epistemology primarily addresses the following questions: "What is knowledge?", "How is knowledge acquired?", and "What do people know?" whereas ontology searches for answers to the question "How do you know it?" So far, there has been a great emphasis on epistemology in instruction. For example, most instructional design

models and strategies are based on epistemology to answer the questions of how knowledge is acquired and what people know. Little attention has been given to the ontological aspect in the design of instruction.

THE NEED TO APPLY ONTOLOGICAL DESIGN TO E-LEARNING

As was mentioned elsewhere, the current status of instructional design has been characterized by the epistemological approach which focuses primarily on single knowledge domain in design. With the increasing use of World Wide Web in teaching and learning, particularly the use of semantic web, it is important to consider the ontological aspect of knowledge in design by answering the question "How do you know it?" We believe that there is an imminent need to develop a framework for ontological instructional design in e-Learning. However, before we proceed to an indepth discussion of the issue, let us first examine the existing ontological models in computing.

A Review of Computational Ontological Models

To date, research on ontological design has been primarily focused on computational perspective with an emphasis on instances and classes, objects and property attributes associated with domains. Several computational models of ontological design have been proposed that include Hendler's (2001) ontological design model, Henze, Dolog, and Nejdl's (2004) domain ontology model, and Abel et al.'s (2004) ontology-based organizational memory model. The first two are generic ontological models whereas the latter one deals with organizational memory work in ontological design. For the purpose of this chapter our discussion will center on generic models in computational ontological design.

Hendler's Ontological Design Model

Hendler's (2001) model represents a data model that describes the relationship between domains. The model defines the domains in terms of dimensions and values. For example, a weather service domain may be represented by dimensions containing advertisement, description, and logic, as well as values that include format, service type, and service logic. The values corresponding to their respective dimensions can be expressed as follows:

```
advertisement.format:=[multimedia];
description.description:=[service
type];
logic.transfer:=[TransferOccurs(#co
st, service):= Reached (ServState),
ServiceCost(#cost)].
```

The logic.transfer notation describes the information about services associated with a transfer action during severe weather (Figure 1). In Hendler's model, different domains (e.g., weather service and transfer service) are connected based on semantic rules of dimensions, values, and universal resource indicators (URIs). The model describes objects that act as binding glue between different systems and services and serve as a basis for interoperability among various ontological entities (Ullrich, 2004). Hendler

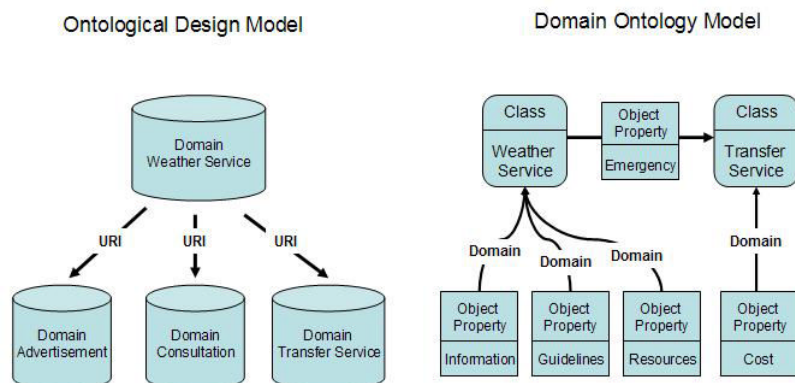
(2001) points out that the model enables computer program constructor to "use ontologies to ensure that everyone agrees on terms, types, constraints, and so forth" (p. 32).

Domain Ontology Model

While Hendler's model defines domains in terms of dimensions and values, the domain ontology model proposed by Henze et al. (2004) focuses on classes and object properties. The model uses computational notation to define class type and object properties. In the example of weather service mentioned above, the weather service domain is related to other domains in terms of class type and object property. For example, weather service can be defined as a service class type which includes the properties of information, guidelines and resources. The weather service class is related to the transfer service class through the activation of emergency object property. Thus, the above relationship can be expressed by following computational notations.

```
type:weatherService[
type:class ->weatherService:object_
oriented
weatherService:information->type:web_
doc
weatherService:guidelines->type:web_
```

Figure 1. Comparing ontological design model with domain ontology model



```
doc
weatherService:resources->type:web_
doc]
type:transferService[
type:class->transferService:object_
oriented
transferService:cost->type:web_doc]
```

The above computational notations indicate that weather service and transfer service are two reusable objects, each of which is defined by its properties. The object properties in the notations are web document type that is subsumed under the relevant domains. Figure 1 shows the differences between two models discussed above.

Limitations of Computational Models in Ontological Design

Although computational models of ontological design provide a blueprint for e-Learning by examining the components across domains in a web environment, they are limited by their micro-level analysis that deals exclusively with computational objects and pertinent semantic relationships. In addition, the models are marked by such high level technicality that renders little applicability to general educational community. To conclude, the models are effective tools for designing computational semantic web, but are insufficient in terms of serving the purpose of general educational community.

A MODEL FOR ONTOLOGICAL DESIGN IN E-LEARNING

As indicated, the epistemological instructional design is limited by its narrow focus on single knowledge domain and can be problematic when applying to the design of e-Learning, partly because most traditional models were developed well before online learning becomes a reality in education, and partly due to the fact that online

learning is characterized by interoperation among multi-domains that form a new knowledge representation in learning (Lundin, 2000; Snelbecker et al., 2007). On the other hand, the computational model of ontological design demonstrates little relevancy for general educational purposes because of its high technicality. Having discussed the limitations of both models in e-Learning, we would like to offer a different perspective on e-Learning by proposing an ontological approach toward online instructional design.

A Model of Ontological Instructional Design in E-Learning

One of the key issues that frequently surfaces in the study of e-Learning is learners' self-initiation in learning (Allen, 2005; Berge et al., 2000). Allen (2005) examined the variables that affect learners' self-initiation in e-Learning and concluded that self-initiation is critically related to (a) the presence of constructivist learning environment in learning, (b) levels of content challenge and learners' prior knowledge, and (c) the connection between the target domain and germane domains of knowledge. According to Allen (2005), learners become more active in learning if they are given the opportunity to construct their own knowledge by relating the new content to their prior knowledge and to make meaningful connections among various domains of knowledge. Berge et al. (2000) point out that active online learning entails collaboration in learning where knowledge collaborators share knowledge and new ideas through various social negotiation processes. Research shows that quality collaboration can influence the quantity and quality of knowledge that flow into the virtual learning community (Chapman, Ramondt, & Smiley, 2005) and that effective collaboration is characterized by positive interdependence, individual and group accountability, and interpersonal and small group skills in learning (Johnson & Johnson, 1994; Zheng, 2009).

Recently, efforts have been made to incorporate the above factors in the design of learning (Morrison, Ross, & Kemp, 2007; Yang et al., 2004). Morrison et al. propose a model that focuses on fostering active learning and collaborative experience for students. Instead of presenting the instruction with a linear, segmented design, Morrison et al.'s model takes a holistic approach by examining the critical role of each design component in learning as well as the interoperability and sharability among the design components. Yang et al. delineate a design architecture for knowledge management for collaborative learning in virtual learning community. Their architecture presents the relationship between ontological entities in a knowledge management system that promotes learners' self-initiation in learning.

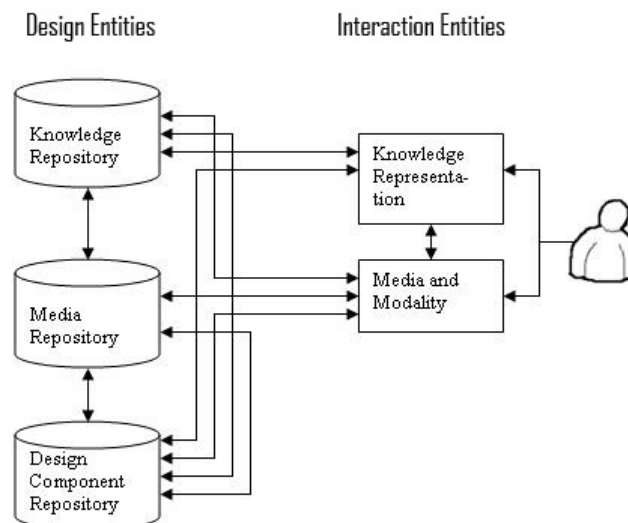
Drawn from both Morrison et al.'s model and Yang et al.'s design architecture, we propose an ontological instructional design model that incorporates the features of sharability and interoperability from Morrison et al.'s model and the interactive relationship of ontological entities from Yang et al.'s design architecture. Figure 2 shows the model of ontological instructional design for E-Learning.

The model in Figure 2 describes the relationship between ontological entities in an educational system. At the right end are the interaction entities (e.g., knowledge representation and media). The learner accesses the knowledge representation via media that combine one or more media instances (e.g., visual, auditory, haptic, etc.) with one communication mode (e.g., synchronous or asynchronous) to deliver the content. At the left end are the design entities (e.g., knowledge repository, media repository, and design component repository) that interact with one another in the design process and provide inputs to the structure of knowledge components in knowledge representation. The above model demonstrates the architecture of an ontological instructional design showing the relationship among different ontological entities (i.e., interaction entities and design entities) within an instructional system. A discussion of the proposed ontological design model follows.

Ontological Entities and Design Principles

Reigeluth (1983) defines the instructional design principles as means to explain and predict instruc-

Figure 2. A model of ontological instructional design for e-learning



tional phenomena. The instructional principles are primarily based on the relationship between strategy components, in this case, the ontological entities, in an instructional model. For example, if the strategy components show a sequential relationship, the design principle derived from this relationship would define a linear, hierarchical approach as its design strategy. The following discussions focus on relationship among different ontological entities that include design entities (e.g., knowledge repository, media repository, and design component repository) and interaction entities (e.g., knowledge representation and media,), followed by a presentation of the ontological design principles related to the ontological instructional design.

Knowledge Repository and Knowledge Representation

The interaction entity of knowledge representation is directly interfaced with the knowledge repository, a design entity, and indirectly related to the media repository via the media entity. According to Yang et al. (2004), knowledge representation in e-Learning is composed of content structure and format. For the knowledge representation to be functionally meaningful, it must draw on and interact with the knowledge repository and be shaped by the design principles and strategies in the design repository. In other words, the content structure of knowledge representation is formulated based on the inputs from the knowledge repository and the design component repository.

The knowledge representation has two formats: carriers and shells. The carriers are knowledge representation tools to deliver the concepts and skills to learners whereas the shells represent the space for knowledge construction and creation (for details on the discussion of knowledge representation as carriers and shells, see Kyzylkaya, Torun, & Askar, 2007). In the event of e-Learning, the selection of the format is dependent on the purpose of the instruction. For example, if the instruction

is to deliver the content for learners to learn the basic concepts and skills, the carrier presentation will be used to deliver the content. If the purpose of the instruction is to develop skills in knowledge construction, the shell presentation will be used for learners to construct new knowledge. In short, the shells enable learners to create new knowledge and share it with other learners. The carriers store the knowledge which is presented to the learner.

Media Repository and Modality Concerns

Media are interfaced with the media repository to support the knowledge representation in e-Learning. They can be integrated with the carrier to present the content. Examples include using multimedia or hypermedia to present the content. They can also be used with the shell to support knowledge construction. For example, learners can use multimedia tools to create a learning object that contains the new knowledge created by the learner and post it to the web to share with others.

A related issue concerning the use of media is modality effect on learning (Mayer, 2001; Zheng, 2007). Although there is an overlap between media and modality, they are distinct from each other in terms of the role they play in e-Learning. Media refers to the use of one medium (e.g., video) or a combination of several media (e.g., video, audio, textbook, etc) in instruction. Modality means the presentation of information that is cognitively processed in a certain way by the working memory. For example, information can be presented through either auditory or visual channels. Positive modality effect occurs when the information presented through auditory or visual or both formats assists in knowledge acquisition. Negative modality effect is observed when the information presented through visual or auditory channels competes with limited cognitive resources in working memory, thus impeding learning (Mayer, 2001; Mayer & Johnson, 2008; Sweller & Chandler, 1991). Presenting knowledge

with multiple media does not necessarily produce positive modality effect. Selecting media or determining instructional modes often depends on the nature of, and structure of knowledge to be presented (Zheng, Miller, Snelbecker, & Cohen, 2006). When learning simple declarative knowledge such as the name of a place, the text mode would suffice. However, when learning complex procedural knowledge such as advanced geometry, images, text, even auditory modes become essential for understanding the content (Butcher, 2006). In an ontological design environment, selection and design of media should be considered in conjunction with modality effects.

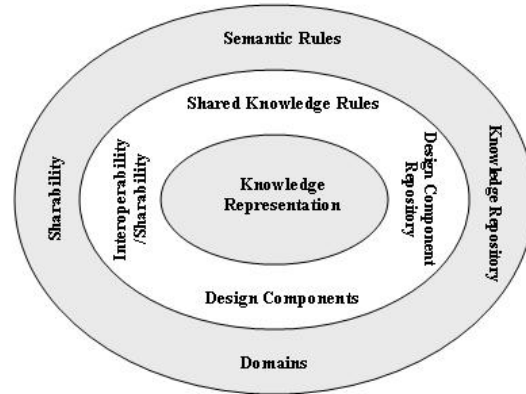
Design Component Repository

The design component repository consists of rules, strategies, principles, and procedures of instructional design (Dick, Carey, & Carey, 2005; Gustafson & Branch, 1997; Smith & Ragan, 2005). It interacts with other design entities (e.g., knowledge repository and media repository) to provide support to knowledge representation. Its primary roles are to package an instructional material based on the instructional design principles and to deliver it to learners in a more effective manner. Because of its organizational and delivery functions, design component repository is included in this model as one of the key functions for e-Learning.

Taken together, the above ontological entities demonstrate a high level of sharability and interoperability across domains. Figure 3 shows the relationship among knowledge repository, design component repository, and knowledge representation.

As was demonstrated, the outer circle in Figure 3 is the knowledge repository that contains domains operating on semantic rules. The middle circle shows the design component repository that consists of design components operating on the shared knowledge rules. Distinct from traditional design models, the proposed ontological instructional design model emphasizes sharabil-

Figure 3. Relationship among knowledge repository, design component repository, and knowledge representation



ity and interoperability of knowledge domains and design components. The ontological design underscores a holistic approach in which the analyses of goals, learners, instructional strategies, and so forth are interdependent on one another. For example, the determination of an instructional goal is affected by variables in both design entities and representation entities. That is, considerations should be given simultaneously to such factors as the task, the content, and so forth (knowledge repository) and mode of presentation, instructional strategies, etc. (media and design repositories). The interoperability between ontological entities characterizes what is called dynamic ontological instructional design in this model. Further discussion on the component interoperability will be presented later in a case study in the chapter.

Ontological Design Principles

By definition, ontology means to query “how do people know it” in the process of knowledge acquisition. Following this fundamental philosophical view, we propose three basic ontological instructional design principles based on which we design and develop the instruction.

Principle One: Ontological design is most effective when it promotes “how do people know it” rather than “what do people know.”

This principle is based on the coherence theory of ontology that emphasizes the coherence between new knowledge and an established body of knowledge (Spector, 2001). New knowledge is gained through successful social negotiation with a larger social group to reach a harmony between new beliefs and established beliefs. This principle reflects the basic tenets of social constructivist learning in which self-initiation and social collaboration are at the core of knowledge construction (Bi, 2000; Bird, 2007; Brooks & Brooks, 1993).

Principle Two. Ontological design is most effective when ontologies are interfaced with each other to form a network of knowledge domains.

This principle is based on recent research on computational ontological design and studies on semantic web (Hendler, 2001; Henze et al., 2004). Research on semantic web reveals that learning becomes more effective when instructional resources are organized in a meaningful network that facilitates knowledge association and creation (Gasevic & Hatala, 2006; Yang et al., 2004).

Principle Three. Ontological design is most effective when a network of known knowledge exists to facilitate the construction of new knowledge.

Based on the second principle, this principle focuses on constructing new knowledge by relying on an existing body of knowledge. It aligns with the schema learning theory which posits that meaningful learning occurs when new knowledge is integrated with the existing schemata (Piaget, 1952; Zheng, Yang, Garcia, & McCadden, 2008). An ontological design for learning becomes meaningful when learners' learning experience, both as knowledge consumers and as knowledge constructors, is supported by a larger body of

knowledge to which learners are able to relate themselves in the process of learning (Winberg & Hedman, 2008).

The ontological entities and design principles identified above provide a theoretical framework for designing and developing an ontological instruction in learning, particularly in online learning. To understand the application aspect of the principles, we introduce a case study in which the above principles are applied to teaching and learning in an online environment.

APPLYING THE ONTOLOGICAL INSTRUCTIONAL DESIGN MODEL TO ONLINE LEARNING: A CASE STUDY

This section focuses on the practical aspects of ontological design model, that is, the application of the ontological instructional design to online learning. Our discussion starts with a case study on a course design related to international leasing, followed by an analysis on the challenges pertaining to the course design and delivery. Finally, an ontological design approach is suggested with a focus on the application of identified design principles and the ontological design model.

The Case Study

Due to the fast growing economy in Asia, the international leasing business has blossomed, bringing an annual net revenue of 53 billion USDollars for the industry. Accompanied with this growing business are issues related to culture, business regulations and practices, international laws, and so forth. A recent study shows that litigations on international leasing are on the rise, partly due to a lack of understanding of different cultures, and partly because of unfamiliarity with the business regulations and practices in the partner countries. Therefore, there is an immediate need to train people to become familiar with the areas mentioned above.

S University decides to start a joint online program on international leasing with its partner university in Asia. The purpose is to bridge the gap between two countries by training people to become familiar with the cultures and business regulations of both countries and to independently problem solve complex situations in international leasing. Students enrolled in this program are expected to go beyond the minimum requirement of learners as consumers of knowledge but would be able to share and construct new knowledge in learning.

Challenges

There are several challenges pertinent to the design of the new program. First, there is a lack of adequate resources. Although general resources can be found in the library or other academic database, a well-organized resource on perspective culture related to leasing business is lacking. Secondly, due to a rapidly changing market economy in the partner country, the business regulations have been under constant revisions. This becomes a challenge to the program in keeping up with the changes so that the information does not become dated. Finally, there is a big challenge to the instructional design in terms of meeting the expectation that students go beyond knowledge consumers to become sharers and constructors of new knowledge.

Using Ontological Instructional Design Model to Meet the Challenges

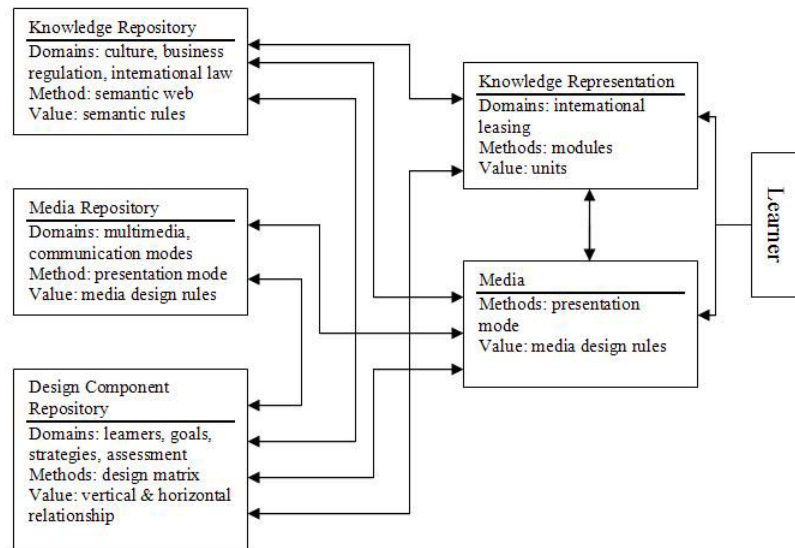
The application of ontological instructional design model involves examining the relationships between ontological entities in a system and between ontological components within an ontological entity. As the ontological design model is used to organize and make connections between various ontological entities in the system, considerations must be given to whether the ontological entities facilitate learners' experience in knowledge

construction and sharing (principle one) and whether the ontological entities operate on the rule of interoperability and sharability so that a network of knowledge domains can be created (principle two). Further, it is important to have a mechanism within the established network of knowledge domains that supports the creation of new knowledge (principle three). Figure 4 displays the relationship between ontological entities in ontological instructional design.

The above ontological model enables the designer to clearly identify the functions and roles of the ontological entities in the system. For example, knowledge representation provides the learner with the access to the domain content which is connected to a larger ontological entity called knowledge repository. Both knowledge repository and design component repository provide the inputs in determining the content structure in knowledge representation. Finally, knowledge presentation is presented via media which draws resources from the media repository. Each ontological entity is defined by domain, method, and value. For example, knowledge representation consists of international leasing as its domain that is represented in modules. The quality of the modules is defined by the value of structural rules. A well organized and structured module means it is well executed and highly efficient whereas a poorly organized and structured module means less efficiency. Besides, by looking at the diagram in Figure 4 we find that the modules in knowledge representation have two forms: carriers and shells. This means the learner can access the content either via carriers or shells. In the former, the learner plays the role of knowledge consumer. In the latter, the learner becomes a knowledge constructor.

As indicated, Figure 4 provides a map of the relationship among ontological entities. However, understanding such relationship requires a further examination of the components within an ontological entity as well as the association and connections among those components. In the following

Figure 4. Relationship between ontological entities in the ontological design model



sections, we first describe the components in each entity (i.e., knowledge repository and design repository), then we present a discussion on the associative relationship among the components from each entity and how they are effected in the knowledge representation.

Knowledge Repository

Since international leasing is known as a multinational business, it encompasses several domains of knowledge. The domains may include cultures, business regulations, international leasing, international laws, history of international leasing, and so forth (Figure 4). A semantic web approach is used to organize the individual domains into an ontology of knowledge domain. For example, specific identifiers are used to define the domains in the metadata section of a HTML or XML so that they become searchable in the web. In a semantic web, learners are able to develop, as the webmaster does, sharable ontological content with many built-in tools in the Web. Thus, the domains are no longer a static repertoire of knowledge. Instead, they become active, dynamic resources powered

by the learners who become actively involved in the learning process by creating ontological learning content which is further shared by a larger group of online learners.

Design Component Repository

The design component repository consists of all the design components in instructional design. Not every instructional design needs to include all the design components. They can be selectively used based on the purpose of the instruction. However, when the components are used, they must be considered simultaneously in the design process. Table 1 shows a matrix that demonstrates the horizontal and vertical relationships between the components.

In this matrix, the horizontal relationship describes the interrelation between components whereas the vertical relationship delineates the dimensions of the component in relation to other components. For example, by examining the horizontal relationship between the instructional strategy and learner characteristics, the designer is able to determine the degree to which instruc-

Table 1. Component matrix of ontological instructional design

Components Components	Content	Learner Characteristics	Instructional Strategy	Assessment
Content	Understanding the concepts and principles in international leasing, cultural factors, local business regulations, international laws that influence the business operation	Determining the relationship between content and learner characteristics	Identifying instructional media and strategies for content delivery	Determining assessment strategies to measure the delivery of content
Learner Characteristics		Identifying the range of learner characteristics	Developing instruction that gears toward individual needs	Identifying assessment tools to measure learner characteristics
Instructional Strategy			Developing instructional strategies that support knowledge sharing and construction	Developing the assessment to measure the effects of media and instructional strategies in content delivery
Assessment				Developing the assessment that measures students' basic knowledge, creativity, and constructivist thinking.

tional strategy is related to learner characteristics, thus detect the level of interplay between two components. Likewise, by examining the vertical relationship of the instructional strategy with other components such as content and learner characteristics, the designer identifies the functional dimensions of instructional strategy. That is, instructional strategy can be functionally operated at the level of learner characteristics and content. Obviously, the matrix analysis enables the instructional designer to gain an understanding of the design components in considerable depth and breadth.

Knowledge Representation

Next, the components identified in both ontological entities, i.e., knowledge repository and design repository, are being considered in a larger context in terms of representing the knowledge to learners. For example, the design of semantic web for multiple knowledge domains is examined through the lens of design components. Specifically, the designer looks at the associative strength between

the knowledge domains and the design components such as learner characteristics, instructional strategies, and so forth.

Based on the inputs from design component and domain knowledge analyses, the knowledge representation is formed. Various learning modules are formulated to represent the knowledge identified and at the same time the rules of reusability and sharability are applied to the design and development of instructional modules. Different from the traditional design, the ontological approach of representing knowledge enables learners to experience the construction and creation of knowledge through multiple venues, thus promoting a learning process that focuses on the understanding of “how do people know it” rather than “what do people know.”

In conclusion, the ontological design model is used in the case study to illustrate how an online instructional program can be created to facilitate dynamic knowledge acquisition and creation, as well as promote learners' self-initiation and collaboration in learning. The model identifies the relationship among ontological entities in the

design process. It reveals the interactive nature of components within an ontological entity and their connection with other ontological entities.

GUIDELINES FOR APPLYING ONTOLOGICAL DESIGN TO ONLINE LEARNING

As an alternative to traditional instructional design, the ontological instructional design has been increasingly adopted by instructional designers who perceive it as a promising approach to teaching and learning, especially in online learning (Kyzylkaya et al., 2007; Ullrich, 2004). With the advent of semantic web, knowledge is no longer considered to be individualized entities. Instead, they are ontologies of domains that can be constructed, reused, and shared. This change of knowledge representation demands a parallel change in instructional design. Rather than following a sequential, segmented approach in traditional instructional design, the ontological instructional design takes a nonlinear, interactive design approach in which resources become globally sharable and learning is regarded as a process of knowledge construction and creation (DeSchryver & Spiro, 2008).

Although ontological instructional design has shown its presence in teaching and learning, the complexity and evolving nature of the design requires instructional designers to take careful consideration of the factors that may affect the application and implementation of the design. It should be noted that the model could not be expected to address all aspects of the issues in ontological instructional design. However, it can help designers to identify the critical elements in design by examining the knowledge domains, knowledge representation, and relationship between ontological design components. Here are some general guidelines to consider:

1. The ontological instructional design should take in perspective the differences between ontological and epistemology approaches toward instructional design by distinguishing the epistemological view of *what-do-people-know* from the ontological view of *how-do-people-know-it* in learning.
2. The ontological instructional design should take into consideration the interoperability and sharability of ontologies and use a design approach that examines simultaneously various ontological entities as well as the components within an ontological entity.
3. The implementation of the ontological instructional design should take into consideration the design principles so that effective learning occurs in an ontological learning environment.
4. A balanced approach should be taken toward ontological instructional design which draws strengths from different research and practices including computational ontological design, instructional design in epistemological approach, pedagogies and best practices related to everyday classroom teaching and learning.

SUMMARY

The traditional design approach that focuses on linear, single domain design has become inadequate to address the increasing challenges faced by online learners, especially when the growth of knowledge has outpaced human's processing capacity (Andrade, Ares, & Garcia, 2008; Dede, 2004). A new mode of learning that emphasizes knowledge interoperability, reusability, and sharability should be instated to meet the challenges of new learning. The ontological instructional design model proposed in this chapter is to provide an alternative perspective to the traditional design by introducing a methodology that will affect an ontological approach in learning.

By identifying the ontological entities which include knowledge representation, knowledge repository, design component repository, and so on, the model presents a holistic view of the functions and roles of ontological entities in design. Rather than presenting segmented instructional units, the ontological entities are related and interfaced with each other to promote knowledge sharing and construction. For example, knowledge representation is interfaced with knowledge repository so that domain knowledge in the knowledge representation is not segmented or isolated pieces of information. Instead, knowledge that flows from knowledge repository enriches the domain content in knowledge representation.

Related to knowledge repository and knowledge presentation is the design component repository. As an ontological entity, design component repository contains all the design components essential to the instructional design. In traditional design, the design components are sequenced in a hierarchical manner. The drawback for such design is that the designer typically focuses on one component at a time. There is a lack of holistic approach to the design. The proposed model provides a holistic approach by coordinating different design components in a single design platform called design matrix so that the designer will be able to simultaneously consider multiple factors in terms of their horizontal and vertical relationship.

To summarize, the proposed model presents an ontological approach to instructional design. The model can be applied in various online instructional design and learning. Taking an ontological approach, the design zeros in on knowledge sharability and reusability which have been commonly accepted as a design rule in semantic web. Drawn from its philosophical origin as well as major tenets from constructivist learning theory, the model promotes the experience of knowledge construction as the way of knowing. A case study is provided to illustrate how the model can be applied to the design and development of an

online curriculum. As has been pointed out, the model cannot be expected to address all aspects of the issues in ontological instructional design. Future research is needed to test the model and its design principles in variety of online learning environments.

FUTURE RESEARCH

Online instructional design can be challenging to educators who are accustomed to traditional models of teaching. The proposed ontological instructional design model suggests a different way to traditional instructional design by drawing attention to the interplay of various design components and the relationship between ontological entities in a learning system. Instead of examining the roles of individual design component as does the traditional design model, the ontological model proposed in this chapter underscores the functions and roles of ontological entities in supporting various instructional goals and objectives. Future research is needed to test the generalizability of the model that can be applied to various online learning curricula and subject areas. Further empirical studies are needed to prove the validity and reliability of the principles, especially when they are used to support online learning. Finally, research should be conducted to examine the correlation between the proposed model and other online models to further validate the usability and applicability of the model.

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KEY TERMS AND DEFINITIONS

Design Component Repository: The design component repository consists of design components similar to those in traditional design models

(Dick, Carey, & Carey, 2005; Gustafson & Branch, 1997; Smith & Ragan, 2005). It operates on the shared knowledge rule which determines the interactivity of the design components and the level of interfacing with the domains in knowledge repository.

Epistemology: Epistemology or theory of knowledge is the branch of philosophy that studies the nature, methods, limitations, and validity of knowledge and belief. The early epistemology such as Descartes emphasized the first truths as a foundation to construct a picture of reality (Fuller, 1955). Differing from the classical ontology as represented by Plato and Socrates, Descartes' epistemology challenged the established truths by questioning every belief that one holds about external reality. This view of beliefs was associated with the rise of science and the successes associated with the scientific method, which Descartes helped codify (Spector, 2001). An important focus in epistemology is to try to reach truth through empiricism - what we can know through our senses - which we can summarize as “we believe what we see”.

Knowledge Repository: Knowledge repository refers to a wide range of knowledge domains across various subject areas including math, physics, biology, social science, language, etc. Domains within the knowledge depository are connected by semantic rules and can be accessed through domain identifiers and classes. Knowledge repository primarily interfaces with the design component depository in which the design components like goal analysis, task analysis, learner characteristics, and so forth interact with the knowledge domains to provide inputs for the design of knowledge representation. Since knowledge repository operates on semantic rules, the domains become sharable within the knowledge repository as well as with ontological entities outside the knowledge repository such as design component repository.

Knowledge Representation: Knowledge representation in ontological design consists of content structure and format. The content struc-

ture of knowledge representation is formulated based on the inputs from knowledge repository and design component repository. The format often takes the form of modules which have two different presentations, shells and carriers, the selection of which is dependent on the purpose of the instruction. For example, if the instruction is to deliver the content for learners to learn the basic concepts and skills, the carrier presentation will be used to deliver the content. If the purpose of the instruction is to develop skills in knowledge construction, the shell presentation will be used for learners to construct new knowledge. In short, the shells enable learners to create new knowledge and share it with other learners. The carriers store the knowledge which is presented to the learner.

Ontology: The term ontology essentially refers to the study of being or existence. It seeks to describe or posit the basic categories and relationships of being or existence to define entities and types of entities within its frame work. In Greek philosophy, ontology means understanding the eternal reality (Reginald, 1985). Plato defined the reality as primary and the perception and experience of reality as secondary. Socrates held the similar view that the purpose of learning was to recognize eternal truth and therefore the instruction was to remind someone of something already known and accepted as true (Spector, 2001). This classical view of ontology has changed due to a realization that the explication and uncovering of external reality involve human perceiver and that human judgment with respect to such uncovering is subject to error. One of the assumptions of modern ontology is that instruction should focus on bodies of knowledge rather than individual knowledge. Instead of relying on one-to-one correspondence between individual beliefs and external reality, the modern ontology proposes

a coherence theory of truth in which acceptance or rejection of new beliefs should be based on how well new beliefs fit with and how coherent they are with the established beliefs (Quine & Ullian, 1978; Spector, 2001). This assumption is important in that it influences the formation of ontology in computer science in which the shared conceptualization of reality across knowledge domains is emphasized.

Ontology in Computer Science: Derived from its philosophical origin, an ontology in computer science is a data model that represents a set of concepts within a domain and the relationships between those concepts. For example, in artificial intelligence, software engineering, biomedical informatics and information architecture, the ontology is defined as a form of knowledge representation about the world. Ontologies in computer science generally describe (1) Individuals: the basic or “ground level” objects; (2) Classes: sets, collections, or types of objects; (3) Attributes: properties, features, characteristics, or parameters that objects can have and share; (4) Relations: ways that objects can be related to one another; and (5) Events: the changing of attributes or relations

Ontological Instructional Design: Ontological instructional design involves examining the relationships between ontological entities in a system and between ontological components within an ontological entity. The ontological design model is used to organize and make connections between various ontological entities in the system. Considerations must be given to whether the ontological entities facilitate learners’ experience in knowledge construction and sharing and whether the ontological entities operate on the rule of interoperability and sharability so that a network of knowledge domains can be created.

Chapter 7.17

Lost in Translation: Improving the Transition Between Design and Production of Instructional Software

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ABSTRACT

Developing modern instructional software has become very complex. As a result, the communication between instructional designers and other stakeholders in the development process is becoming increasingly important. However, due to differences in background, focus, and tools among ISD stakeholders instructional designers lack the means to provide reasonably unequivocal design documentation for these stakeholders. These differences in stakeholders create a context where the design documents produced are not sufficiently related to the specific needs of the stakeholders, in terms of meaningful organization and differentiation of level of detail. This problem is complicated by the lack of shared design languages. These problems prevent precise expression of design

information. The 3D-model is introduced to support instructional designers to stratify, elaborate, and formalize design documents, even if design languages are hardly shared between designers and other stakeholders. Two validation studies show that the 3D-model contributes to a better information transition between instructional designers and software producers—one of the stakeholders in the development process.

INTRODUCTION

Currently, the educational field is characterized by many innovations: mobile learning, next-generation e-learning systems that retrieve information from business processes, or case-based learning in virtual environments. These innovations, and others, provide the flexibility to enable the integration of working and learning,

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with time and place independent learning, and adaptive learning, personalized for individual learners (Rosenberg, 2000). These innovations illustrate how organizational, technological, and pedagogical aspects of instructional software can change rapidly. Also affected by these innovations is the way instructional software is developed. The combination of organizational considerations (e.g., “What are the new roles of teachers using instructional software?”), pedagogical considerations (e.g., “How can authentic learning tasks be implemented in the instructional software?”), and technological considerations (e.g., “Which media mix is optimal?”) makes the development process highly complex (Jochems, van Merriënboer, & Koper, 2003). Consequently, a structured approach to design, production, and implementation of instructional software is required.

One area in the instructional software development process that appears to be negatively affected by this increased complexity is the transition of information from the design phase to subsequent phases, or, from an instructional designer to the other stakeholders in the process (Boot, van Merriënboer & Theunissen, submitted). A bottleneck is created in that the intentions of the instructional design, described in training blueprints and storyboards, are not communicated clearly enough to other stakeholders of the development process. For example, instructional design information may be insufficiently represented in the specifications created by software producers. As a result, time-consuming reviews and frequent discussions between instructional designers and software producers are often required to reach correct technical specifications that are fully in line with the blueprint and storyboard. This sub-optimal transition process is further undermined by the fact that many software producers are not specialized in instructional software, and therefore inexperienced in specifying and creating instructional software programs. When reviews and discussions are impossible, due, for example, to legal reasons, the production process often results

in an unsatisfactory outcome: flawed instructional software that requires correction afterwards (“design by debugging”). This example focused on the most obvious stakeholders, as designers traditionally interact mostly with producers. Of course, modern, complex development processes require that a large number of other stakeholders are also sufficiently informed.

In this chapter, we discuss the transition problem between design and other development phases, and identify three major causes for this problem. To overcome these three problems, we introduce the 3D-model as an aid to stratify, elaborate, and formalize design documents, even if design languages are hardly shared between designers and stakeholders. Finally, we present an empirical validation of the 3D-model and discuss the implications of the use of that model.

THE TRANSITION BETWEEN DESIGN AND PRODUCTION

Most instructional software is developed using some variation of the instructional systems development (ISD) model, which often is an instantiation of the generic, five-step ADDIE model: analysis, design, development, implementation, and evaluation model (Dick & Carey, 1996). Every phase in the ISD model identifies specific types of activities and outcomes for which any number of different specialists (e.g., subject matter experts, instructional designers, or software producers) are responsible.

In contrast to ISD models, instructional design (ID) models are a subset of ISD models and encompass only the first two steps of ISD, namely analysis and design (van Merriënboer, 1997). This distinction is useful because it helps to highlight a logical grouping of activities. In general, instructional designers are the specialists responsible for the activities that occur during these two phases (van Merriënboer, 1994).

By the end of the instructional design, the designer usually has some sort of description or documentation of his design (e.g., a training blueprint or a storyboard) that is ready to be delivered to the next phase to be used by the specialists responsible. This is central to the task of the instructional designer, or, as McDonald states in Chapter II (p. 19): “It may not be overstating the point to say that the business of instructional design cannot be separated from communication.” The next phase is the development phase and the responsible specialists may include software programmers, audio and/or video producers, graphic designers, or other multimedia specialists.

Regardless of the form the design documentation takes, there is an expectation that it will be able to effectively communicate the intentions of the instructional designer. This is an important assumption as producers will make specifications for their products based upon this design and subsequently create the instructional software (see Figure 1 for a process description of the several transitions that take place). Although producers are an important target group, the design documents are also used to communicate the instructional design to other stakeholders who are responsible for the following steps in the ISD process (i.e., implementation and evaluation) or validating the previous ISD steps (i.e., analysis and design).

The transition process from design to production and other ISD phases is not without problems. Many instructional designers lack the necessary means to provide design documentation that ensures a reasonably unequivocal representation of

the design to the other ISD stakeholders. As can be seen in Table 1, the concerns of different ISD stakeholders are related to a variety of organizational, pedagogical, and technical issues. Consequently, there is an expectation placed upon the instructional designer to produce a design document that will answer the need for different kinds of information. However, in most situations, instructional designers will have a different background than most of the other stakeholders (e.g., educational vs. management) and use different tools (e.g., analysis and design tools vs. technical production tools), and are therefore unaware or unable to provide the right information to the right stakeholder. As McDonald (Chapter II) puts it:

“Designers do need to act with integrity and communicate in ways that maintain the essential qualities of their message. But they also need to remember that they are not designing only for themselves, and so have an obligation to make sure they present ideas in ways that communicate clearly to others outside of design communities” (p.28). Yet, it is quite unfeasible that instructional designers are able to “collect” all the needs of the other ISD stakeholders, for it is quite difficult to speak in a design language that is not mastered by others. Nonetheless, *“instructional designers should be careful not to confuse meaning with mechanics so that when necessary they can separate the two and express their meaning in other ways”* (McDonald, Chapter II, p. 24).

The next section discusses three problems with conventional design documentation, which are

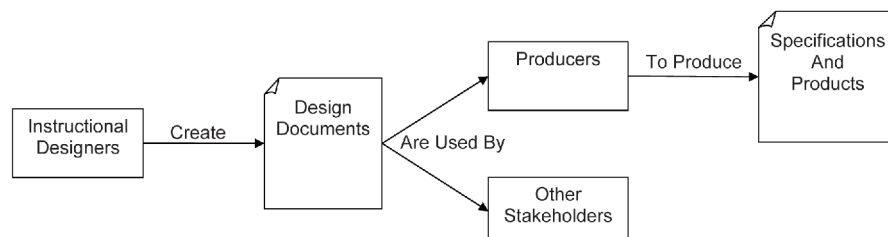


Figure 1. Transition process of instructional design information

Table 1. Concerns of different stakeholders in the ISD process

Kind of stakeholders	Types of Stakeholder Activities	Examples of Concerns
Project Leader	Manage the whole ISD process	Optimal transfer of information and product during the ISD process
Subject Matter Experts	Validate the domain content	Impact on work floor
Instructors	Validate the didactical model	Impact of instructional design on their teaching (e.g., classroom based, coaching in practice)
Managers	Approve the instructional design	Impact of instructional design on their organization (e.g., financial, roles, infrastructure)
Producers	Translate instructional design into technical specifications (often conduct their own type of analysis and design)	Impact of instructional design on production process (e.g., selection of tools and media, programming, interfacing, usability)
Implementers	Use the instructional design as guidelines	Impact of instructional design on infrastructure, roles, school management, etc.
Learners	Participate in usability studies, interface design studies, and other formative evaluation activities.	Personal preferences and impact of instructional design on their learning processes
Evaluators	Use the objectives set in the instructional design as evaluation criteria	Impact of instructional design on assessment process

the result of the differences between instructional designers and other ISD stakeholders.

THREE PROBLEMS IN THE TRANSITION PROCESS

Highly Integrated Design Documents

The first problem relates to the meaningful organization of the design documentation, more precisely, its highly integrated character. In conventional design documents, there is often little to differentiate the organizational, technical, and pedagogical aspects of the documents. As a result, if a particular aspect of the design changes, it is difficult and time-consuming to trace the resulting consequences throughout the design. For instance, if a stakeholder such as a manager decides that instruction by synchronous communication (e.g., using Webcams or instant messaging) is not feasible due to relative high costs or security issues, all aspects in the instructional design related to the possibilities of synchronous communication must be traced and modified. This one change could affect organizational aspects such as dif-

ferent infrastructure, technical aspects such as different e-learning systems, and pedagogical aspects such as different learning tasks, which are all connected to each other

Inconsistent Level of Detail in Design Documents

The second problem relates to the level of detail of the design documentation. The level of detail in conventional design documents varies depending on the capabilities of the designer. For example, more capable designers will typically add more detail to instructional issues but not to technical issues. However, the level of detail should also depend on the needs of the receiver of the information, that is, a particular stakeholder. For instance, for designers to communicate among themselves, the application of delayed cognitive feedback following a particular learning task, a rather conceptual description will suffice. The designers will readily understand each other. But for a producer or an implementer, much more detailed descriptions of timing, content, and presentation of feedback are needed to be able to specify, produce, and implement it as intended by the designer.

The result from the two problems described above is that design documents are not related to the specific needs of particular stakeholders, in terms of meaningful organization and differentiation in level of detail.

Lack of Design Languages for Design Documents

The third problem may deserve more attention, for the lack of design languages that are shared between designers and other ID stakeholders is actually more serious than the previous concerns, because unless an agreed-upon design language is established, it may be difficult also to define an optimal organization and detail level of design documents. In domains other than the instructional design field (e.g., architecture, music, movies), visual design languages are able to capture and describe the design in design documents (e.g., building blueprints, music-books, storyboards) with such a level of detail that they will be interpreted reasonably unequivocally by other stakeholders (e.g., contractors, musicians, directors). Gibbons & Brewer (2005) state that we may speculate that some of the differences in composer excellence are the result of a more expressive set of (personal) design language terms or a better set of (personal) rules for synthesizing expressions from the terms. In the field of Instructional Design, visual design languages are mostly used to explore design spaces and solutions, for they provide common, explicit notation systems for describing an instructional design in design documents (Gibbons, Nelson, & Richards, 2000; Waters & Gibbons, 2004). A notation system is an embedded element of a visual design language and captures abstract ideas to create transferable designs (Gibbons & Brewer, 2005). Examples are the blueprints symbols of an architect or the musical notation system for composers.

In instructional design, visual design languages require such notation systems to convey their message by means of symbolic, graphical, textual

or other conventions. An example of a graphical modeling language, not bound to the field of instructional design, is the unified modeling language (UML; Booch, 1994; see also Chapter 11). The notation system of UML (i.e., diagrams) enables different stakeholders to describe and understand a particular software design.

Among the most recent attempts to introduce design languages in the field of instructional software development is IMS learning design (IMS-LD; Koper & Tattersall, 2005; see also Chapter XV). Yet, the IMS-LD language is meant to promote the design of de-contextualized learning objects (Chapter XIII), needed for instructional strategies “that engage the learners in authentic tasks that are relevant to their personal needs and goals” (Reigeluth, 2005, p. 212). Hence, the cooperative problem-based learning meta-model (CPM; Nodenot et al., 2003, Chapter XIII) was introduced to design contextualized learning scenarios, particularly problem-based ones. Other design languages are at stake too. Think for instance of the recently proposed educational environment modeling language (E²ML; Botturi, 2006; see also Chapter VII), which allows its users to represent the components of an instructional environment through a visual notation system. Another example is the typified objects visual modeling language MOT and its extensions, whose purpose is to help designers to visualize activity sequences, actors and tools (Chapter VIII) of the instruction to be designed. The classification scheme of Botturi, Derntl, Boot, and Figl (2006) shows that each of these design languages has a set of identifiable features and may be used for various purposes (e.g., creative purposes versus final documentation). However, for the most part, each design language is created for a particular target group, and therefore seldom shared among different stakeholders in the ISD process. For instance, the more precise the design language is, the more technical its notation system is likely to be, making the language too difficult for non-technical stakeholders.

Ideally, the design should be transferred from the instructional designer (or design team) to the software producer and other stakeholders only once, and be completely understood. In this way, there is either no further information exchange necessary, or stakeholders can formulate clear and concrete questions about, for instance, details of the task domain. Thus, in the case of outsourcing, an ideal design document should allow the production company to make an exact estimation of costs and time (before the contract is signed), and ensure a product that is fully compatible with the original design (after the contract is signed).

In the next section, a decision model for instructional designers is introduced to provide support in improving design documents for better communication of their designs, taking into account the three problems described above.

THE 3D-MODEL FOR SUPPORTING INSTRUCTIONAL DESIGNERS

A good solution to overcome the transition problem should focus on supporting instructional designers to provide stakeholders with exactly the design-related information they need. This chapter focuses on supporting instructional designers rather than software producers or other stakeholders; this choice was not without reason, because the designers are pre-eminently responsible for the didactic quality of the final instructional products (defined as the extent to which desired learning outcomes are attained in an efficient manner). This didactic quality is of utmost importance, because technical quality (defined as the extent to which the software takes care of the input, information processing, and output as intended, and the responsibility of the producers) alone is a necessary but insufficient condition to fuel the desired learning processes and reach intended learning outcomes.

As described in the previous sections, the three problems regarding the transition of the instructional design are related to the affect upon

the various stakeholders due to (a) the integrated character of instructional design documents, (b) the lack of differentiation in level of detail, and (c) lack of instructional design languages and matching notation systems. As a result, design documents may be difficult to interpret for three reasons: (a) different instructional and technical structures are often not meaningfully organized; (b) different levels of detail are inconsistently applied, and (c) different expressions are used in a non-standardized manner, as designers and producers have hardly any shared design languages to their proposal.

The 3D-model (developing design documents) was developed to support designers in creating better design documents. The three components of the model include (a) stratification, (b) elaboration, and (c) formalization.

Stratification

To overcome the highly integrated nature of design documents and to create more meaningful organization, Gibbons' model of design layers (Gibbons, 2003; see also Chapter XVII) is used to stratify the instructional software design into seven, interrelated layers: content, strategy, control, message, representation, media logic, and data management. Each layer is typified by the designer's selection of design languages pertaining to the solution of different instructional design subproblems. Collectively, the functional designs at each layer together make up the total design. Stratification helps to determine the relations between the functionally different instructional and technical structures that are relevant for a particular stakeholder, while at the same time staying cognizant of the need for integration of those structures within the complete design.

Elaboration

To overcome the inconsistent level of detail and to create more differentiation between the informa-

tion offer to stakeholders, the three perspectives of Fowler (2004) are used for the *elaboration* of the instructional software design: (a) A conceptual perspective, with more or less superficial and descriptive information; (b) a specification perspective, with more or less comprehensive and detailed information, and (c) an implementation perspective, with more or less technical and highly-detailed information. Elaboration helps to determine the required level of detail used in the design documentation, depending on the capabilities of the designer and the needs of a particular stakeholder.

Formalization

To overcome the lack of instructional design languages and matching notation systems and to promote more unequivocal understanding of the design, designers may achieve *formalization* of their design by making their selection between informal and formal design languages explicit. They should strive for combinations of formal languages, as these languages provide the most precise and concrete designs descriptions. However, depending on their capabilities and the needs of a particular stakeholder, they can also apply combinations of informal languages as well. Formalization is not necessarily a requirement, nor is it always desirable because, as stated above, not many complete formal instructional design languages are available yet. Formalization helps to determine the required various levels of standardization used in the design documentation.

As Figure 2 shows, the 3D-model uses stratification, elaboration and formalization as its three dimensions. Designers, with or without producers, may first analyze their design situation in order to determine the optimal configuration of the 3D-model (e.g., What kind of designers are involved? Who are the stakeholders to be addressed? What kind of design languages are shared with those stakeholders? Which design tools are available?), and then use this configuration to stratify, elabo-

rate, and formalize their design documents. For instance, they can determine which design layers to address along the stratification dimension, and which combination of level of detail (elaboration dimension) and notation system (formalization) will be used for that layer. Figure 3 shows two possible resulting configurations of the 3D-model.

For stakeholders, on the other hand, the particular configuration of the 3D-model provides insight in the underlying structure and content of the design documentation they were given, even when the design languages used are not standardized or completely shared.

VALIDATION OF THE 3D-MODEL

In order to evaluate the 3D-model, an empirical study was set up (Boot, Nelson, van Merriënboer, Gibbons submitted), which was replicated in a second study. Both studies will be described here briefly. The studies focused on the communication of the instructional design to one important kind of stakeholders, software producers.

Participants

Study 1. Sixteen master and PhD students from an American University's Computer Science Depart-

Figure 2. The 3D-model for developing design documents in its full configuration

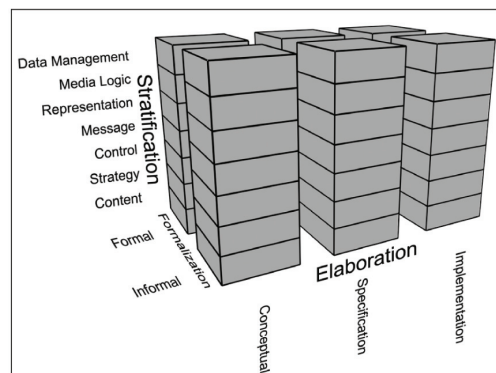
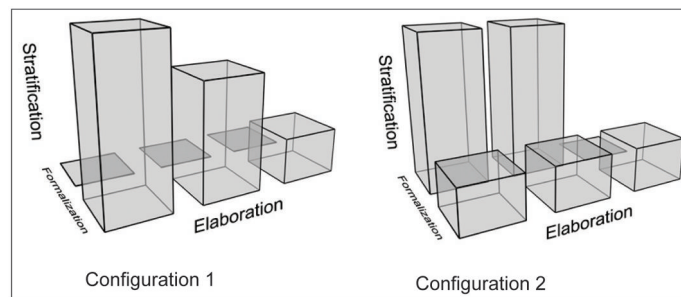


Figure 3. Two possible configurations of the 3D-model



ment participated in this study, acting as producers of instructional software. They were randomly assigned to either the conventional instructional design documents group ($n = 8$) or the improved instructional design documents (based upon the 3D-model, see below) group ($n = 8$).

Study 2. Thirteen bachelor students from a Swiss university's Computer Science Faculty participated in the same role as in the first study. They were randomly assigned to either the conventional documents group ($n=6$) or the improved documents group ($n = 7$).

Both groups had considerable experience in specifying and programming software. Table 2 presents the experience of the participants with typical producer tasks such as object-oriented modeling and programming. There were no significant differences with regard to this experience

between the conventional and improved conditions within both studies.

Materials

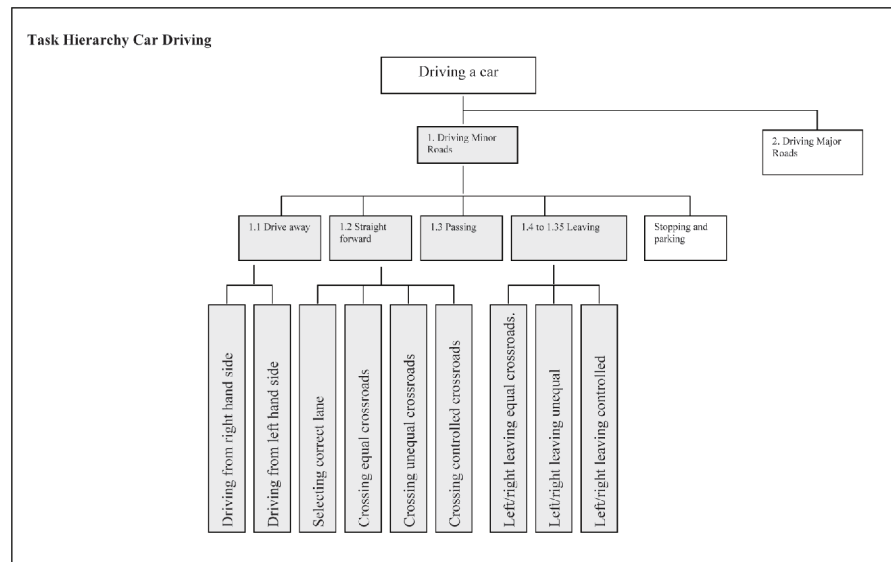
The conventional and improved design documents covered an identical topic (an instructional software application for learning to drive a car) and had identical functionality (providing input for the technical specification process for an advanced educational car-driving simulation).

With respect to the *elaboration* and *stratification* dimensions of the conventional design document, the document is mostly directed at providing much detail (implementation level) at the content and strategy layers, average detail (specification level) on the control, message, and representation layers, and little detail (conceptual level) at the media logic and data management layers.

Table 2. Means and standard deviations of proficiency with programming languages and ratings on experience with object-oriented software development

	Study 1				Study 2			
	Conventional design documents group ($n = 8$)		Improved design documents group ($n = 8$)		Conventional design documents group ($n = 6$)		Improved design documents group ($n = 7$)	
	M	SD	M	SD	M	SD	M	SD
Number of familiar OOP languages	2.37	0.92	1.87	0.99	4.00	1.41	4.29	1.60
Object-Oriented Programming ^a	7.13	0.99	6.63	1.99	7.17	0.75	7.29	1.11
Object-Oriented Modeling ^a	6.75	0.88	6.37	1.41	6.67	1.03	6.00	1.41
Unified Modeling Language ^a	5.75	2.52	5.25	2.31	5.33	1.51	5.29	0.95

Figure 4. Example page of conventional design document



Considering the *formalization* dimension in the 3D-model, the conventional design document is based upon informal representations only, such as text and sketches. This configuration reflects the traditional approach towards design documents (see for instance Driscoll, 1998; Kruse & Keil, 2000; Van Merriënboer, Clark, & de Croock, 2002), and is presented as Configuration 1 in Figure 3. Figure 4 presents an example page of the conventional design document.

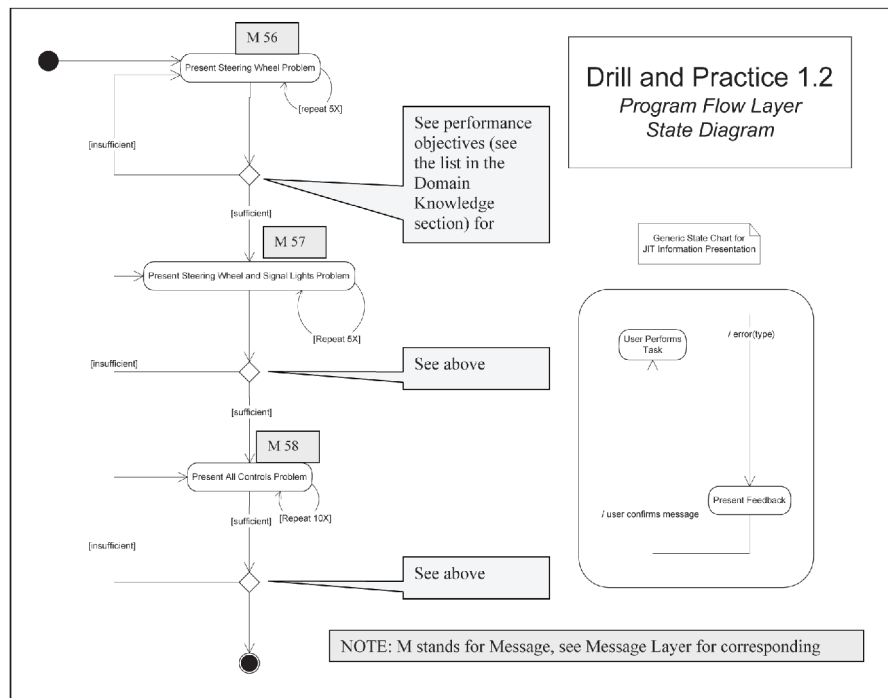
The improved design document is based upon both informal representations and formal representations (*formalization* dimension in the 3D-model). For the informal representations, the values on the *elaboration* dimension are conceptual, specification, and the values on the content and strategy layers are implementation. For the formal representations, the values on the *elaboration* dimension are specification and conceptual for the layers content up to data management. For these formal representations, UML diagrams are used. This configuration reflects the use of the 3D-model to stimulate and support designers to stratify, elaborate, and formalize design documents more than they usually do, and is presented as

Configuration 2 in Figure 3. For instance, Figure 5 presents an example page of the improved design document, showing such a formal representation of a media logic structure, from a specification perspective.

Measurements

Specification questionnaire. The ability to translate the design document into technical specifications, defined as the agreement between technical specifications and the intentions of the instructional design documents, was measured by the specification questionnaire. It consisted of 25 open questions, each question on one printed page with sufficient space to note down the answer. There was no time limit for answering the questionnaire, but the experimenter measured the time on task for each question unobtrusively. Each question addressed a particular aspect of translating the design document into technical specifications. For instance, the participants had to distill from the design document how many databases should be used in the instructional software; what the consequences would be from changing text-based

Figure 5. Example page of improved design document



messages into audio-based messages (the so-called “ripple effect”); how a particular program flow should be implemented; what it meant if just-in-time information would be applied in a particular learning task; where the producer would need a subject matter expert to provide additional domain information; which instructional design components should be implemented as reusable learning objects, and so forth. Based on a checklist with correct answers (as determined by instructional designers and production experts), two reviewers rated items as correct or incorrect (the Intra Correlation Coefficient, ICC, is .94, which is very good, Fleiss, 1981).

Cognitive load questionnaire. This questionnaire measured the perceived cognitive load for each question in the specification questionnaire, defined as part of the costs of the translation process. It used the standard 9-point rating scale developed by Paas (1992; see also Paas, Tuovinen, Tabbers, & van Gerven, 2003). The rating scale was included at the bottom of each page of the

specification questionnaire, and ranged from 1 = “very, very low perceived load” to 9 = “very, very high perceived load.” The ICC for the questionnaire is .89, which is good.

Results

The use of the 3D-model for generating instructional design documentation, as applied in the enhanced document set, showed a significant increase in efficiency of creating technical specifications while requiring the same time and cognitive load. Table 3 shows that the improved design documents indeed resulted in higher scores for the agreement between technical specifications and the intentions of the instructional design documents. This indicates a higher level of understanding of the instructional design documents, which is required to translate the functional model into technical specifications. The results with regard to time were mixed. In Study 1, working with the

improved design documents required less time, but in Study 2 there was no significant difference. In both studies, there were no significant differences in perceived cognitive load when comparing the same question on the conventional and the improved design documents.

CONCLUSION

This study investigated the transition problem between design and other development phases and identified three major causes for this problem. It also introduced a means to improve the efficiency of the translation process between the design phase and the production phase. The results of two studies show that the application of a structured, three-dimensional approach by designers helps producers come to an understanding of the design that is more in agreement with the intentions of the instructional designer. Developing design documents while supported by the 3D-model results in a higher efficiency of the translation process, reflecting better results with the same time and cognitive load input. Further study should demonstrate if design documents based upon the 3D-model also promote a better transition process to other ISD stakeholders, as listed in Table 1.

The use of the 3D-model by ISD stakeholders has several implications, among others, for

training/education, support tools, and the further development of design languages.

First, with respect to training/education, this study suggests that instructional designers need to become proficient in at least three new activities. Besides being knowledgeable and skilled in traditional instructional design activities such as domain and task analysis, strategy selection, and media selection (see Richey, Fields, & Foxon, 2001), our results indicate that they should be able to (a) stratify instructional design documents to describe aspects associated with design as well as the concerns of different ISD stakeholders (see Table 1), (b) decide for each layer how much detail is required for unequivocal understanding of the design by these stakeholders, and (c) represent—where possible—their designs in formal design languages. Second, with respect to support tools, this study suggests new generation tools should be used. An example of such a support tool is ADAPT-IT (De Croock, Paas, Schlanbusch, & van Merriënboer, 2002), which supports the creation of design documents in a structured manner. If analyzed based upon the dimensions of the 3D-model, then ADAPT-IT helps designers to create design documents that are both formal and informal, are elaborated at the conceptual and specification level, and describe the content and strategy layers. Future research may either investigate the contribution of support tools such as ADAPT-IT to the creation of design

Table 3. Means and standard deviations for measures of the communication process

	Study 1				Study 2			
	Conventional design documents group (n = 8)		Improved design documents group (n = 8)		Conventional design documents group (n = 6)		Improved design documents group (n = 7)	
	M	SD	M	SD	M	SD	M	SD
Quality of production (0 – 25)	12.25 ^a	2.35	17.18 ^a	1.94	8.33 ^c	2.34	12.57 ^c	1.62
Mean time per question (mins.) ^b	3.46 ^b	0.89	2.75 ^b	0.71	3.36	0.41	3.25	0.39
Mean perceived cognitive load per question	4.43	0.42	4.06	1.10	4.54	1.23	4.35	0.75

^a*t* = 4.58, *p* < .001 ^b*t* = 1.77, *p* < .05 ^c*t* = 3.85, *p* < .001

documents, or use the 3D-model to develop new tools that take the stratification, elaboration, and formalization dimensions into account.

Second, with respect to further development of design languages, this study suggests that more instructional design languages are necessary to provide formal representations of instructional designs in order to sufficiently balance formal and informal representations according to the formalization dimension. Although the number of visual instructional design languages is rising, it is yet to be demonstrated which impact this has on the development process. For instance, it is likely it will promote a better transition process in terms of shared understanding, but as the application of such rich languages can be quite complex, will it also save time? And will less-skilled developers be able to deal with this (additional) complexity, or does it require more proficient developers, therefore potentially limiting the wide acceptance of such design languages in the developer community?

Ultimately, the proposed research efforts should result in improved design languages and design documents, so less of the designers' intentions are "lost in translation," preventing the specification and production of sub-optimal products.

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Chapter 7.18

Pask and Ma Join Forces in an Elementary Mathematics Methods Course

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ABSTRACT

This chapter introduces conversation theory as a means of creating an active learning environment in an elementary mathematics methods course. It argues that such an environment, designed for undergraduate candidates in teacher education, will engage the learners in the task of developing deep conceptual understanding to support and give rationale to the procedural knowledge most of them already have. Furthermore, the authors hope that an understanding of conversation theory as applied to teaching mathematics will help instructors and instructional designers to facilitate preservice teachers' engagement in reaching a deep conceptual understanding of the mathematics they are preparing to teach.

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INTRODUCTION AND BACKGROUND

This chapter addresses issues and technologies arising from a consideration of conversation theory. The concepts covered include developing a mathematics methods course for preservice elementary teachers that focuses on conceptual understanding. Two strands are woven together to create the needed scaffolding for learning in this course. The work of Liping Ma, noted mathematics educator and scholar, and a proponent of deep conceptual understanding, suggests that a sophisticated understanding of measurement, functions, geometry, algebra, probability, statistics, and arithmetic can only be developed through strong conversation and reflection. The use of dialogue for learning is well supported by Pask's conversation theory, based on the use of high-level

cognitive question strategies, that begins with “why” questions and moves into “how” questions.

Most mathematics educators will agree that preparing mathematics teachers is a challenging and difficult assignment. A careful application of Pask’s conversation theory will facilitate the development of deep conceptual understanding of mathematics, as espoused by Ma.

CONVERSATION THEORY AND MATHEMATICAL DISCOURSE

According to Gordon Pask, “Learning depends upon the strategies used by a student” (Pask, 1975). Breaking the learning goals into separate and smaller subgoals allows students better to focus their attention on the learning tasks at hand. In this way, educational objectives are partitioned into smaller more manageable units to ease acquisition and mastery of the content. By splitting learning into these smaller units, students will not feel overwhelmed when trying to solve learning problems while working to gain proficiency. In breaking the learning goals into separate and smaller subgoals, it is essential that preservice teachers understand that the instruction should not jump directly to the selection of an algorithm or solution strategy—as can so easily happen if, for instance, the subgoal is “key words.” If a subgoal is to learn that “how many” means to add or that “how many more” means to subtract or that “of” always means multiplication, then instruction has neglected the steps of understanding and modeling. Jonassen (2003) cites research supporting the negative impact that a direct translation strategy (of key words) has not only resulted in a lack of conceptual understanding but the inability to transfer any problem-solving skills that are developed. Appropriate subgoals for problem solving, for instance, would include modeling the problem, determining the relationships among the elements of the problem, developing a meaningful repre-

sentation of the problem, using those elements to select a strategy, and then apply the strategy. Leaping to the strategy without conceptual understanding of the problem solving process also leads to students accepting solutions that do not make sense. A familiar problem illustrating this point is the one that goes like this:

A class is preparing to go on a field trip. There are 120 fifth grade students who will be going on the field trip. Busses have been hired to take the students. If each bus holds 36 students, how many busses will be needed?

Too frequently, students turn in the answer “3 $\frac{1}{3}$ busses.”

Pask also pointed out, “At the other extreme, the strategies may be imposed upon the student as teaching strategies” (Pask, 1975). The teacher directs the learning activities towards reaching desired learning goals, objectives, or benchmarks. Instructors implement teaching strategies in an effort to target specific learning deficiencies thus assisting students in successfully acquiring new content to be learned. In these situations, students who attempt to offer another way of solving a problem will be met with “that’s not the way you’ve been taught to do them” or something similar. A teacher with deep conceptual understanding of the mathematics being learned and who has an understanding of Pask’s conversation theory is much more likely to be a facilitator, “a guide on the side,” of students’ learning rather than imposing a “one way fits all” or “this is the right way to do it” strategy.

Pask commented, “Many real situations lie between these extremes. One of them is a tutorial conversation in which methods of learning are open to discussion and in which the strategy is selected as a result of a compromise between the student and teacher” (Pask, 1975). In this situation, learning becomes more of a matter of give and take, or a shared responsibility for learning, requiring efforts to be made by both the teacher and the student. Conversational instruction allows

students to participate in making choices in a “free-learning environment” (Pask, 1977). Students are able to ask questions and choose where to direct their attention by making comments or elaborating on topics of interest.

Since the introduction of the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989), the call for meaningful discourse has grown increasingly strong. The call for “more meaningful discourse (is) grounded in the social nature of mathematics learning, a vision of school mathematics practices that reflects both the essence of practices in the discipline itself and the need for students to be able to communicate their mathematical knowledge in a technological society” (Knuth & Peressini, 2001). Indeed, mathematics is increasingly seen as a field in which effective communication is essential as both a learning process and an outcome (Clark, Jacobs, Pittman, & Borko, 2005). Meaningful discourse flourishes in Pask’s free-learning environment. Conversation, or communication, is an essential part of mathematics and mathematics education because it is a “way of sharing ideas and clarifying understanding. Through communication, ideas become objects of reflection, refinement, discussion, and amendment. The communication process helps build meaning and permanence for ideas and makes them public” (NCTM, 2000).

To engage students in meaningful discourse, teachers must have developed a “profound understanding of fundamental mathematics” (Ma, 1999). Ma posits four properties of profound understanding—basic ideas, connectedness, multiple representations, and coherence. It becomes the challenge for the mathematics teacher educator to model this meaningful discourse and help preservice teachers often move from a superficial procedural knowledge (i.e., knowing *how* to perform an algorithm) to a profound understanding of fundamental mathematics (i.e., knowing *why* an algorithm “works”). Thus, in teaching the subtraction algorithm to second graders, a teacher would not use the rationale that you “can’t subtract

a larger number from a smaller number” as a reason for “borrowing” in a problem such as 84-69. For the teacher with a profound understanding of fundamental mathematics knows when his or her students reach the intermediate or middle grades they will study integers (the set of positive and negative numbers) where, in fact, it is not only possible to subtract a larger number from a smaller number, but is often required.

Listening to children’s discourse in a mathematics lesson and determining what they are saying or where they are heading requires a profound understanding of fundamental mathematics (Ball, 2000). However, it is too frequently the case that the conceptualization and organization of elementary teachers’ mathematics preparation in both content and methodology is on “how”—how procedures are performed or how manipulatives are used—rather than “why.” Where, then, do preservice teachers develop the context of profound mathematical understanding and insight that allows them to guide, probe, hint, or explain in such a way as to keep the discourse meaningful? This is a serious issue in light of the TIMMS 1999 Video Study of mathematics classrooms in the United States in which a survey revealed that the teacher-to-student word ratio was on average 8:1 and student utterances were generally five words or less (Hiebert et al., 2003). The ratio found by the TIMMS study implies a monologue rather than a dialogue.

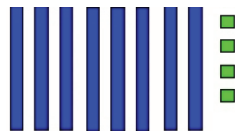
LEARNING STRATEGIES AND CLASSROOM CONVERSATION

When a specific learning strategy is implemented, it needs to align with the desired educational or curriculum outcomes. Learning is also more effective when the “... strategy is matched to the student’s existing competence” (Pask, 1975). Because not all learners are alike, there is a wide range of learning styles needing to be addressed. Through the use of dialogue, teachers discover

students' learning strategies and assist by making suggestions, as needed, to ensure students are successful in their learning efforts. As can be clearly seen, it takes a variety of instructional strategies to design and foster effective learning activities for students. Consider the situation where a teacher is introducing the topic of subtraction with regrouping. Today, many teachers will begin with manipulatives such as base 10 blocks or connecting cubes. Students will be directed to "take away" 69 from 84. Using base 10 blocks and left to his or her own devices, the student will proceed in a manner similar to the steps:

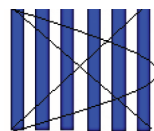
1. Here is 84 (8 ten sticks and 4 units):

Figure 1.



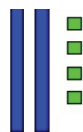
2. Take 60 away:

Figure 2.



which leaves:

Figure 3.



3. Now, in order to take 9 away, exchange one 10 stick for 10 units which gives:

Figure 4.



4. Taking 9 away leaves 15 for the answer.

Figure 5.

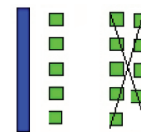


Figure 6.

$$\begin{array}{r} 7 \overline{)84} \\ - 69 \\ \hline 15 \end{array}$$

The student has arrived at the correct answer. If the teaching strategy is focused simply upon the algorithm, how does the student progress in developing deep conceptual understanding? What follows is not related to what the student has just done in any apparent or meaningful way (other than the original problem and the answer being the same!)?

Pask makes a distinction between performance and learning or teaching strategies. He views performance strategies as necessary to operationalize, demonstrate, or prove the skills are acquired. Performance strategies are considered to be "manifest in the hierarchical organization of problem solving procedures" (Pask, 1975). As a result, performance strategies represent a "very wide spectrum of the mental processes" (Pask, 1975). Differences in individual performance strategies become apparent when examining a variety of individuals, each with different ap-

proaches to solving problems. Performance strategies ultimately serve as the foundation upon which subsequent learning or teaching strategies are constructed. Examining the properties of problem solving requires one to look at “compatibility, incompatibility, consistency, inconsistency, reproducibility, and cognitive fixity” (Pask, 1975). When translating problem solving properties into conversational modes, as is found in classroom discourse, one must include “explanation, understanding, appreciation, and the like” (Pask, 1975). Thus, in teaching the subtraction algorithm to second graders, a teacher who asks if you can take a number in the sixties away from a number in the eighties, can then guide the discussion for students into a consideration of how that can be done. When students respond that it makes sense that you can take a number in the sixties away from a number in the eighties, and follow with “but you can’t take 9 from 4,” a teacher with a profound understanding of the concept of subtraction avoids the next pitfall—that “... the value of numbers does not have to remain constant in computation” (Ma, 1999). The next step in the subtraction algorithm for the problem $84 - 69$ is not to borrow 10 from the other number 8 in order to make 4 into 14 and thus “big enough” so that 9 can be subtracted from it. To do that, is to treat the problem as $4 - 9$ and $80 - 60$ rather than as a number in the sixties taken from a number in the eighties. Rather, the next step is to take something from *the other part of the number* that will enable us to subtract. As Ma explains, “The difference between the phrases ‘other number’ and ‘the other part of the number’ is subtle, but the mathematical meanings conveyed are significantly different” (Ma, 1999). In a similar vein, it can be questioned whether mathematical terms such as “fixed point” or “clockwise” have or will have any significance for students. “Fixed point” because the accepted meaning of “fixed” is “repaired” and yet a “fixed point” is considered one that does not move and “clockwise” because

digital timepieces are pushing “clocks and clock faces” towards oblivion.

One issue making it difficult for students to learn is “... cognitive fixity, a tendency to adhere to an originally selected strategy even in the face of evidence showing it to be inappropriate” (Pask, 1975). Once an individual invests his or her time, effort, and energy resources into a concept or project, it is not easy to let go and change. The longer the student maintains his or her position the more difficult it is to change. Students “... need to accumulate much evidence before they will autonomously change their minds and adopt a more appropriate strategy than the one they chose originally” (Pask, 1975). One of the great benefits of using dialogue for learning is that it allows students to be able to reduce their cognitive fixation and be more receptive to new ideas and concepts. Ultimately, the students should make adjustments and changes in thinking through the numerous contributions found in their classroom discourse. In fact, Pask states “... the major obstacle in the path of effective learning can only be reduced by an outside influence” (Pask, 1975). Through conversation, “students’ uncertainty decreases faster and more smoothly” (Pask, 1977). A second grader who learns to think of $84 - 69$ as taking away a number in the sixties from a number in the eighties will likely be more receptive to working with integers in middle school because he or she has a conceptual understanding of subtraction as well as a procedural understanding of the standard algorithm.

To return to learning and teaching strategies, one way to scaffold learners’ efforts is by providing clarity to the curriculum tasks. Students need to understand the educational objectives or learning outcomes to be able to demonstrate new skills or acquire new content knowledge. Modeling is one approach used for defining the learning objectives. One of the models often used in mathematics classes when introducing a new topic is a manipulative such as base 10 blocks when teaching operations. Taking the problem

84 – 69 once again, teachers with a profound understanding of the concept of subtraction will model taking a “ten stick” and exchanging it with 10 units. A key part of the conversation here is the discussion of the relationship between 8 “10 sticks” and 4 units and 7 “10 sticks” and 14 units. Has anything been added to or subtracted from 84? No, and so what happens when you take 69 (six tens and nine ones) from 7 tens and 14 ones? Students who have learned the subtraction process in this way can use modeling by serving as tutors or peer mentor facilitators supporting peer knowledge acquisition. Organizing content into logical sequences through careful instructional design helps students to encode new information into long-term memory. Analogies assist in retaining the subject matter by helping learners to make sense of what may be difficult to comprehend. As a result, discussions and projects are another way to further support learning efforts by helping students move new knowledge from short-term memory to long-term memory.

What about the students who suggest other ways of doing it? Suppose a student asks if it would be all right to represent 84 as 7 ten sticks, 10 units and 4 units because, “I can take 9 from 10 and add the one unit left to the 4 units and then take 6 tens from 7 tens. My answer is 1 ten and 5 units or 15.” Or what about the student who says, “69 is $60 + 4 + 5$, so I can take 4 from 84 and have 80 and then take 5 from 80 and have 75, and then take 60 from 75 and have 15?” A teacher with a profound understanding of the mathematics of subtraction will avoid the “that’s not the way we do it” response but will engage students in a conversation comparing the three different ways described for subtracting 69 from 84 and in what situations one way might be more helpful than another.

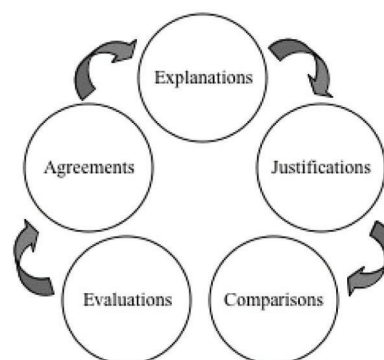
The conversations are descriptive of Boyd’s (n.d.) explanation of “... (t)he minimal requirement for teaching-learning conversations is that they occur at least two distinct levels: (1) the task level: ‘What are you doing/I am doing this’ and (2)

the explanatory level: ‘why are you doing this/I am doing this because...’” Another way to model the learning process can be perhaps best represented through a cycle of (1) explanations, (2) justifications, (3) comparisons, and (4) evaluations, until (5) areas of agreements are reached regarding the topic goal or clusters of topics covered (Figure 7).

Ma advocates a profound conceptual understanding of a mathematical topic whereas much mathematics teaching in the United States has for decades concentrated on procedural understanding. The parody of a line of poetry, “Ours not to understand why, just invert and multiply,” is descriptive of students’ typical learning of division of fractions. Without a profound conceptual understanding of any given mathematical topic, teachers cannot engage in the conversation theory of Pask as seen applied to learning strategies in Figure 7. Nor would teachers know whether or not the classroom conversation about students’ invented ways to “do” subtraction or “do” division of fractions was accurate and evidence of true learning.

When possible, learning activities should be aligned to “real-life tasks” (Pask, 1977). By making connections to real world, authentic learning, cognitive bridges facilitate the transfer of learning to long-term memory. Creative and academic learning is a part of “real-life decision making” (Pask, 1977). By finding ways of making the

Figure 7. Conversation theory applied to learning strategies



content personally relevant, students' attention, motivation, and engagement can be captured to further enhance learning opportunities and collaboration. One of the recommendations arising from the first publication of the National Council of Teachers of Mathematics (NCTM) *Curriculum and Evaluation Standards* in 1989 was the imbedding of mathematical problem solving in real-world situations and across curricular areas.

Pask's "theoretical superstructure" includes learning within the areas of (1) perceptual-motor skills, (2) cognitive knowledge, and (3) social processes. It is through combining the three domains that a more comprehensive understanding is fostered as illustrated in Figure 8.

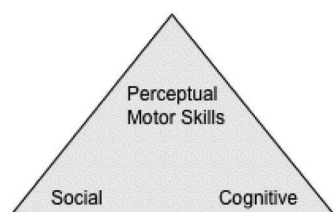
Learning through conversations allows for a "positive transfer effect" (Pask, 1975). Both teachers and students "profit from observing the learning strategies" (Pask, 1975). Making the processes known improves the ability to "learn how to learn" (Pask, 1975). The ensuing conversations include questions, responses, and interchanges used to develop methods for "probing, observing," and externalizing "cognitive events which normally remain concealed" (Pask, 1976). In addition to the academic pursuits of learning, there is a vital "interpersonal component" (Pask, 1976) needed to provide students with a socially rewarding experience. When students are socially satisfied and engaged in the learning community, participation increases, and learning opportunities naturally follow suit. In order for a teacher to engage students in the conversation that allows for a positive transfer effect, he or she must know

how to engage in a meaningful learning conversation and have a deep conceptual understanding of the mathematics being learned. Reflect back on the students proposing different ways of subtracting 69 from 84. If the teacher does not have a deep conceptual understanding of place value and the rate of composing and decomposing higher value units, that is, 84 is 70 and 14 or 69 is 60 and 4 and 5, then a conversation with and among the students and the teacher about why each method works and when one might be more appropriate to use than another, will not happen. The teacher will simply direct students to "do it the way I showed you."

CONVERSATION THEORY AND ASSESSMENT

Evaluation of learning is a critical component in assessing student progress, performance, and understanding. By providing feedback to learners on "indices of success and goal approximation" (Pask, 1977), corrective actions can be taken. Students in mathematics need to be introduced a modeling method as a systematic approach to the design of a mathematical problem, concept, proof, or theory. Modeling instruction expresses an emphasis on making and using conceptual models of physical phenomena as central to learning and doing mathematics (ASU, 1997). Too often, students see a mathematical problem but do not know how "what they know" aligns with the problem they are looking at. Students need to have a detailed knowledge of their assessment results to know if they are on target or need to make further adjustments to be successful in their learning efforts. To assist students in making those further adjustments, teachers can engage students in a systematic modeling method for all aspects of problem solving.

Figure 8. Pask's theoretical superstructure

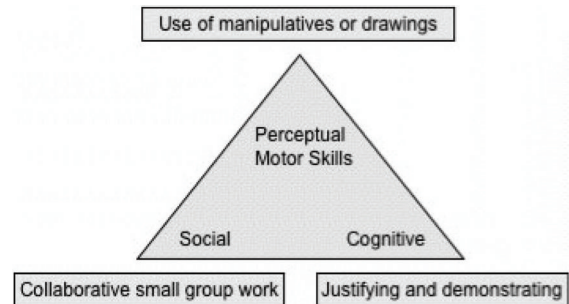


Consider how this might be used when students are faced with a problem such as:

Ms. Edwards has two yards of material. She is going to make doll clothes for her granddaughter. Each pattern Ms. Edwards is using requires $\frac{2}{3}$ of a yard of material for each outfit. How many outfits will Ms. Edwards be able to make for her granddaughter's doll?

The first step in the modeling method or cycle (ASU, 1997) is a conversation between the teacher and the class to insure a common understanding of the question being asked—that is, how many sets of $\frac{2}{3}$'s are in 2? The next step involves the students in small groups collaborating on the planning and solving of the problem. Students in the small groups may suggest a variety of ways to approach the solution—manipulatives such as fraction bars or fraction circles, drawings, or a “common denominator” approach to the division problem. For this step, the teacher who possesses a deep conceptual understanding of division of fractions will be able to serve as facilitator and guide but will not dictate the “right way” to solve the problem. Finally, the students are required to present and justify their strategy and solution to the class. Again, the teacher with a deep conceptual understanding of division of fractions will scaffold the student presentations—moving from the most concrete to the least concrete approach. There is a twofold reason for this scaffolding—it validates each approach and then presents another way of doing the problem that students can see and hear the process, that may enable them to say, “Oh, I understand. I think I can do that with the next problem.” Once all the strategies and solutions are provided, the students and teacher can engage in a dialogue that evaluates the strategies and solutions. That dialogue can also result in a comparison of approaches and a discussion of when it is more appropriate to use one rather than another. This modeling cycle is in keeping with Pask's theoretical superstructure, as illustrated in Figure 9.

Figure 9. Pask's theoretical superstructure and the modeling cycle



Competency can be assessed through performance activities or various quizzes or tests relevant to the learning task at hand. Assessments can be accomplished using instructors, students, or peers, using quality rubrics or guidelines. Acceptance of Pask's statement on providing feedback to learners provides additional support for teachers who want to change their assessment practices from “giving a grade” to greater use of more supportive formative assessments that enable teachers and students to develop an action plan for the pursuit of further learning. Again, without a deep understanding of fundamental mathematics, teachers will all too often label a careless error as “not understanding the procedure” or will not be able to identify the root cause of the error—a lack of conceptual understanding—and will simply review the steps of the procedure with the student. Assessment practices and feedback to students must shift from a focus on grades, credentials, and rank to those that integrate with learning activities, that support students' conversation in constructing their own knowledge and that reflect the diversity of learning outcomes found in the learners themselves.

Another approach to evaluation is through the use of “teachback,” a method used to ensure the “student understands a topic to the extent that he can teach it back to the teacher” (Pask, 1977). Teachback, the equivalent of the final step of the modeling cycle, provides a way to extend

learning even further by requesting students to reflect, explain, and justify how and why they came to the conclusion or solution they arrived at. The students who asked about different ways of doing the subtraction problem of $84 - 69$ are engaging in a form of “teachback” as they “teach” the teacher why their procedures also work. Restructuring helps learners to process and understand the concepts on a deeper and more personal level. Having students reformulate and teach the concepts is very effective because teachers know comprehension and retention is increased when teaching new material to others. So, when applied to the class discussion that occurs in student centered learning, the students benefit from viewing their classmates’ thinking processes. Dialogue transcripts are another way to confirm students’ content understanding, through a simple review of what was written. Thus, having students demonstrate their processes by the use of available classroom technology—whether an overhead projector or document camera (ELMO) or virtual manipulatives on the computer, is another way of sharing dialogue transcripts. Students in the class can review what another student is demonstrating either with manipulatives or drawings in order to confirm their content understanding.

FUTURE RESEARCH DIRECTIONS

Future research needs to address the components and methodology that mathematics content courses as well as the methods courses must consist of in order to produce highly qualified, effective mathematics teachers for elementary and secondary classrooms. How can teacher education and professional development for inservice teachers facilitate teachers reflecting critically on their views and acting on their understanding? In what ways can Pask’s conversation theory support and facilitate the “profound understanding of fundamental mathematics” that Ma espouses?

CONCLUSION

Instructors in higher education responsible for mathematics methods courses can benefit from an understanding and application of Gordon Pask’s conversation theory in conjunction with Liping Ma’s call for a profound understanding of fundamental mathematics to their instructional design. The use of tutorial conversations with preservice teachers can be effective in helping them engage in meaningful mathematical dialogue that leads to a deep conceptual understanding of mathematics. Until preservice teachers are engaged in true mathematical discourse, applying the tenets of conversation theory, they will most likely continue “to teach as they’ve been taught,” that is, with an emphasis on procedural rather than conceptual knowledge.

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Chapter 7.19

Assessing 3D Virtual World Learning Environments with the CIMPLe System: A Multidisciplinary Evaluation Rubric¹

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ABSTRACT

This chapter introduces an assessment rubric for virtual world learning environments (VWLEs) built from proven principles of user experience design, instructional design, interface design, learning theory, technical communication, instructional systems design (ISD), and VIE motivation theory. Titled the “CIMPLe System,” this rubric captures the ways that context, interactivity, motivation, presence, and cognitive load weave together to form a successful VWLE. The CIMPLe System offers an advance in how educators can assess the quality and predict the success of the VWLEs that they build. The holistic approach achieved in the CIMPLe System arises from the multidisciplinary approach represented in the

tool. As designers consider what to build into the environment, they can refer to the CIMPLe System as a checklist to ensure that the environment meets the needs that the cross-disciplinary theory suggests are necessary.

INTRODUCTION

Although the idea of virtual environments in education might seem radical, it is not new; rather, programs such as Quest Atlantis (Indiana University), River City (Harvard University) and SciCentr (Cornell Theory Center) have been in use for more than ten years. Research from these programs suggests that students exhibit gains in engagement, efficacy and achievement (Barab, et al, 2005; Ketelhut, et al, 2006). Additionally, a recent study (Hansen *et al*, 2004) noted that

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students actively involved in three-dimensional construction of computational models had a more sophisticated understanding of dynamic spatial relationships than students in a traditional classroom environment. Other studies (e.g., Kim, 2006) suggest a statistically significant effect of 3-D virtual environments on both achievement and on developing a positive attitude toward science.

Finally, Jones (2004) proposed that multi-user, 3-D, online learning environments demonstrate numerous important educational benefits such as engaged immersion, situated learning, multi-modal communications, breakdown of socio-cultural barriers, bridging the digital divide, problem solving, and the ability to create empathy and understanding for complex systems. Other advantages of virtual environments for learning include the ability to provide experiences that may not be available in real life, the ability to analyze phenomena from different points of view to gain deeper understanding, and the ability to work with virtual companions distributed over different geographical locations (Chittaro and Ranon, 2007).

Why do learners respond so well to virtual environments? In the late 1990s, researchers began hypothesizing, for example, that the level of presence in a virtual world—the feeling of being somewhere else—as well as the level of immersion—the feeling of interacting directly with the environment—account for the success of instructional virtual worlds (Witmer & Singer 1998). More recent studies investigate other aspects of successful virtual worlds for instructional contexts, including the role of social facilitation, or the degree to which having others “present” impacts performance (Park & Catrambone, 2007); (Bronack, Cheney, Riedl, & Tashner, 2008); the role of place metaphors in guiding action (Prasolova-Forland, 2008) and the complementary concerns of cognitive load and system adaptivity (Scheiter & Gerjets, 2007); (Kalyuga, 2007).

While these and many other studies analyze 3D virtual worlds from the perspective of one

discipline or another and offer recommendations about building these worlds from those perspectives, none of these studies have proposed a multidisciplinary method of evaluating the success of a virtual world learning environment (*VWLE*) that considers the complex interactions of context, interactivity, motivation, presence and cognitive load. Virtual worlds require simultaneous attention to a number of factors to ensure that they are successful and when we add the complications of instructional purposes, the range of considerations expands even further. Consequently, many of the approaches that focus on a single aspect of a virtual world, such as presence or interactivity, gloss over the complexity that these environments require. *To begin moving instructional designers, trainers, and researchers toward a more complex understanding of assessing these environments, this chapter introduces an assessment rubric for virtual world learning environments built from proven principles of user experiencedesign, instructional design, interface design, learning theory, technical communication, instructional systems design (ISD), and VIE motivation theory.* We have titled this rubric the “CIMPLe System” since it captures the ways that context, interactivity, motivation, presence, and cognitive load weave together to form a successful virtual world learning environment.

To arrive at the CIMPLe System rubric, the chapter first positions the rubric within the larger, more general context of instructional design theory. As a field, instructional design encompasses the requirements for building successful learning experiences regardless of the medium where those experiences appear. Therefore, we begin the discussion of instructional design by situating our chapter within the ADDIE framework (Gagne, Wager, Golas, Keller, & Russell, 2005)—a generally accepted instructional design method—and specifically within the “design” phase. The chapter then combines this framework with the principles of “user experience design” to demonstrate the three necessary parts of experience:

attraction, engagement, and conclusion (Shedroff, 2001). The majority of the chapter develops this framework, offering theoretical principles on what constitutes successful attractions, engagements, and conclusions within a learning context. Within this discussion, engagement—the most sophisticated component of the actual experience—assumes the bulk of the discussion. Finally, after theorizing the nature of a learning experience, we present the fully-developed CIMPL System, a multidisciplinary rubric for analyzing virtual world learning environments.

BACKGROUND: INSTRUCTIONAL DESIGN

Given all of the benefits that VWLEs can provide, but also given the relative complexity of implementing successful multimodal VWLEs, instructional designers need a complex, multidisciplinary frame that encompasses the entire process of designing an instructional element regardless of the medium (e.g. classroom, online, 3D virtual world). Although there are many instructional design models we could adopt that would meet the complex needs of VWLEs, we situate the CIMPL System within the ADDIE model (Gagne, Wager, Golas, Keller, & Russell, 2005) because the system is complete, yet not overly complicated. ADDIE orders the elements of instructional design into five stages: analysis, design, development, implementation, and evaluation.

The *analysis stage* consists of activities that determine the context in which the instruction will take place—the pre-existing conditions that must be considered in order to design the most appropriate and effective instructional element. In this stage, the designer determines what needs are driving the creation of the instruction and these needs lead to the delineation of the goals of the instruction, with consideration given to the cognitive, behavioral, and attitudinal changes desired. In addition, designers must determine what prior

knowledge and skills the learners will have when they begin the instruction. Finally, designers determine the time available for instruction.

The *design stage* is where the instruction unit is built. This begins with designers determining what learning objectives will address which instructional goals. From these objectives, a list of topics to cover is made, with an approximation of the time each topic will take. Designers then sequence the topics, with consideration given to the prior knowledge determined during the analysis stage. The topics are fully expanded, and mapped to the original learning objectives and activities are added to reinforce the learning. Finally, points for assessment are inserted, both those that inform the direction and progress of the instruction as well as those that assess the final achievement of the learning objectives.

The *development stage* includes those activities that will refine the instructional element. In this stage the materials are used with a group that represents the target audience. From the information gleaned from this initial use, designers revise the materials. Also in this stage, designers develop any required teacher materials and/or user manuals.

The *implementation stage* occurs when the instructional element is marketed and distributed. The target population is advised of the opportunity and resources are made available for solving any problems or confusions that arise as the instruction proceeds.

Finally, data gathered in the *evaluation stage* are used to fine-tune the instructional element. Evaluators compare the learning outcomes to the goals and objectives of the instructional element and plans are devised for ongoing revision and maintenance.

Understanding all stages of the ADDIE model are important for the quality of the instructional element because any element that is developed without reference to the entire system will likely be far less successful than one that was systematically constructed. While we recognize that following the entire ADDIE model produces the

best products, space limitations prevent us from fully exploring how to develop elements for virtual worlds against this model. Instead, as a sort of “quick start,” the CIMPL System presented in this chapter focuses mostly on the design phase of the process, outlining the characteristics of a successful VWLE. Even though the tool primarily focuses on the design phase and using the tool as a heuristic, it can nonetheless inform the development stage and the evaluation stage as a lens through which designers might assess their learning environments after they have been built.

EXPANDING THE VIEW OF THE DESIGN PHASE

As noted above, our chapter focuses on the “design” phase of the process for creating instructional materials because creating an optimal experience can occur only if designers begin with a solid process that is both well-theorized and reproducible. As noted user experience designer Nathan Shedroff argues, “the elements that contribute to superior experiences are knowable and reproducible, which makes them designable” (Shedroff, 2001). Shedroff himself suggests many of these elements (which we’ll take up later) but chief among them is the overall structure of the optimal user experience, an experience that progresses from *attraction* to *engagement* to *conclusion*.

Attraction represents the reasons a participant would begin an experience. Sometimes the attraction derives from necessity—we have to go the grocery store in order to buy food or a teacher tells students that they must do an exercise. Preferably, though, attraction is intrinsic, where learners choose to undertake the experience because they are drawn to it by their senses—it sounded interesting—or because they have an intellectual attraction—they wanted to learn about something—or because of an emotional appeal—it looks fun. Regardless of the specific reason for the attraction, each experience must draw learners

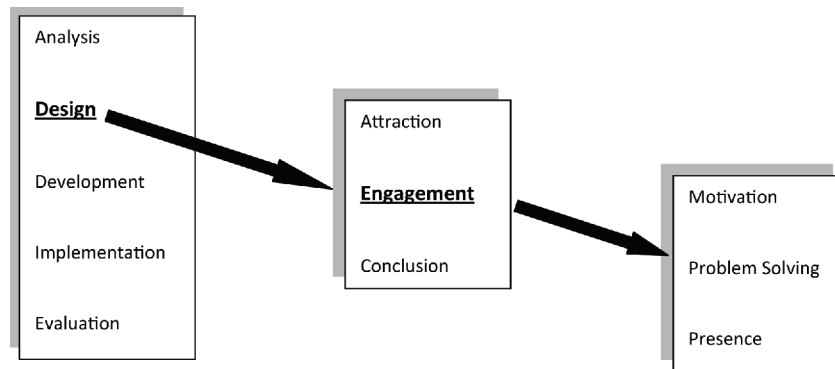
into the experience, setting the context for how and why learners would want to engage with the experience. Attraction gets learners “in the door,” so to speak.

Engagement represents the primary focus of the experience. After learners begin the experience, their interest must be maintained by challenging them in interesting ways, motivating them to continue exploring and solving problems of personal relevance, and providing them with feedback so that they can measure their progress. The engagement must also strike a balance between challenge and reward, taking care not to overload learners with complexity but must provide enough ambiguity to encourage continuing engagement. Finally, the engagement must enable social interaction where learners can reveal their image of “self” to others, learn about others’ views of the problems and environment, and build shared meanings with colleagues. Engagement keeps learners “in the house,” in other words.

Conclusion represents the moment when learners feel that they have completed the goal. Successful conclusions enable learners to see the experience in a larger context, where the meaning of the experience extends into future experiences as learners look back and learn lessons that they can apply in future settings. Good conclusions also bring closure to an experience, confirming that what the participant set out to learn or accomplish has in fact been learned or accomplished. In Shedroff’s terms, the conclusion presents learners with awareness that they have internalized the experience and can now count it as “wisdom” applicable across multiple settings, enabling learners to see themselves as more complex.

Engagement is chief among these components of the successful experience because learners spend the majority of their time with the engagement. The majority of our chapter, therefore, focuses on designing the characteristics of engagement, although our theoretical frame includes attraction and conclusions as well. Figure 1 visually represents the nested theoretical frames operating

Figure 1. The nested framework of the CIMPLLe system



in our chapter as instructional design and user experience design merge into a single approach for designing virtual world learning environments.

THEORETICAL FRAME FOR THE CIMPLE SYSTEM

As we introduced above, designing a 3-D virtual world learning experience—or really any experience—proceeds from attraction to engagement to conclusion. Each of these categories, though, contains several concerns that instructional designers must recognize as they build a world. These elements of successful design also lead to categories for evaluating the effectiveness of a 3-D virtual world learning environment. In what follows, we discuss the three major stages of an experience—attraction, engagement and conclusion—and within each of these stages outline the multiple concerns that must be considered within that stage. From these concerns, we derive the categories that we compile into the complete evaluation rubric presented later in the chapter.

Attraction: Inspiring Learners to Begin the Experience

Imagine it's about seven p.m. on a spring evening and you and a couple friends are walking down

a city street where cafes and restaurants have opened their doors to allow the aromas of their cooking to waft into the street. One particular restaurant catches your attention because the aromas carry spices you can't quite place, and so you glance over the menu posted in the window. You see that the meals are priced reasonably and that the restaurant offers an interesting variety of dishes you've never heard of, let alone eaten. Your group enters, a host seats your group, you order drinks, and then settle in to study the menu more closely. Music, maybe it's Ethiopian, plays in the background as servers weave effortlessly among tables carefully set with small oil lamps and silverware, speaking with smiles to customers in an accent you can't quite identify. Your group agrees on some appetizers and then orders the next time your server comes by your table.

This scenario metaphorically represents what happens in any context where learners are enticed to begin an experience. The learners have a need—they are hungry and need to eat—and following the enticing aromas, they are drawn into a particular experience—the restaurant—where they hope that their needs will be met. The environment of the restaurant also attracts their interest, with its oil lamps and hint of foreign culture. The scenario, then, demonstrates the two key features of an attraction: clear goals and contextual factors.

Clear Goals

In order for people to be attracted to an experience, they must be at least moderately aware of their needs and the experience must present clear steps for meeting those needs. Learners usually have a set of schemas for how things work, and if the initial encounter diverges too far from the schema, learners will be confused at best and frustrated at worst. Either way, if the goals aren't clear, then learners will disengage from the experience. Richard Saul Wurman, "father" of the field of information design, summarizes this idea in *Information Anxiety 2*, arguing that experiences must contain, among other things, a purpose, objectives, core steps, and periodic feedback (Wurman, 2000). In Wurman's terms, *purpose* is the overarching goal, why somebody is doing something, to fulfill hunger in our case. *Objectives* represent the ways people meet that purpose, in this case to eat. The *core steps* present the procedure, the small steps along the way to achieving the objectives, so entering the restaurant, being seated, ordering drinks, studying the menu, and ordering meals in our example. Finally, *feedback* alerts learners whether or not they are doing things correctly (a concept we'll discuss in detail later). Each of these steps represents a match between the learners' goals and the experience's goals: the learners' expectations have been met upon the initial encounter and so they continue with the experience.

Context Factors

However, in addition to the cognitive aspects of attraction where the experience initially meets the learners' goals and needs, the context itself attracts learners. First, as information processing theory teaches us, attractions must surprise us, must present us with something unique or out of place, something that dazzles us with bright colors and interesting sounds. These are called orienting stimuli (Howes, 1990). Several scholars

in the emerging field of user experience design make similar arguments, noting that the visceral level of an experience represents one of the most important aspects of attracting—and retaining—learners' attention as learners' bodies and senses become engaged in the experience (Norman, 2004). This "physio-pleasure," as Patrick Jordan (2000) calls it, or "sensorial design" as Shedroff (2001) calls it, is not just a property of the experience (or product); it represents an interaction between an experience and a person, where the experience engages multiple aspects of a person's body or senses. We build, in other words, this type of physio-pleasure by immersing learners in an environment with fantastic features, things that they wouldn't experience otherwise (Screven, 2000). Referencing our opening scenario, recall that the initial attraction was spices that the group couldn't quite identify and menu items that they hadn't eaten. Upon entering the restaurant, the environment itself pleased the group, with its smiling staff and oil lamps. These aspects contribute to a richness of the environment (Witmer & Singer, 1998) that bears a relationship to reality because the concept of eating at a foreign restaurant is a common schema, yet the experience also presents a certain lack of realism because of the novelty.

In addition to these visceral aspects, information designers frequently talk about the usability of the environment. In other words, the experience must work. If the experience initially promises to meet the needs of learners and draws them in with seductive sensorial input but then fails to deliver on the practical promises that the sensorial design only hinted toward, learners will immediately end the experience, either literally by discontinuing their work within the system, or figuratively by allowing their attention to wander elsewhere. Norman (2004) calls this the "behavioral level" of a product or experience because at this level, learners are concerned with how well a thing works. If, for example, the staff had not been attentive in our scenario, the experience would have failed on practical grounds: the group mem-

bers are hungry and want to eat and that major objective has not been realized. Additionally, the aspects of an experience must complement each other such that the system has a certain holistic integrity (Prasolova-Forland, 2008). The oil lamps provide “foreign atmosphere” (visceral level) but they also provide light (behavioral level); the wait staff speaks with accents (visceral level) but clearly interacts well in your native language (behavioral). Finally, the experience allows multiple ways to interact, yet constrains those possibilities within a closed system (Gasperini, 2000). In other words, the experience allows the participants multiple opportunities for realizing their goal of eating through the different menu items, yet the menu isn’t limitless. Similarly, in a VWLE learners need the opportunity to explore possibilities, but should be limited to only a finite number of possibilities.

Evaluation Rubric Items

Designers of virtual world learning environments must attend carefully to the attractions they build by integrating methods that confirm learners’ goals are being met and by constructing a context that maintains interest. Without this clear evidence that the experience and the participant share goals, a learner has no reason to continue the interaction. Why work through a system if the system isn’t going to meet your needs? Second, meeting learners’ instrumental goals represents just half of the picture because the system must engage learners’ bodies and emotions to attract them in the first place. As Norman (2004) writes, “Attractive things work better.” And attractive things work better both to attract learners in the first place and to maintain that interest throughout the engagement.

Based on these concepts of attraction, the following rubric items emerge:

- Promises a novel or unique experience
- Experience follows predictable schemas
- Attracts through initial sensorial pleasures

- Technologies and functions operate appropriately
- Presents multiple ways for learners to interact with the environment that correlate with the environment’s metaphorical/cognitive scheme.

Engagement: Immersing Learners in the Experience

Learners spend the majority of their time occupied in the actual task of learning, engaged in the experience itself, in other words. After learners have been attracted to an experience, several factors must be present to maintain the learners’ interest. *Motivation* is foremost among these considerations because learning will not take place if learners feel no need to continue, whether that motivation is extrinsic or intrinsic. Learners must also be engaged with *problem solving* in ways that lead to learning. Without seeing the actual rewards of their activity in terms of increased knowledge—and being made aware through feedback that they are, in fact, learning—learners will direct their attention toward other tasks that they feel are more rewarding. Therefore, learners must be consistently aware of their progress toward learning objectives as they learn but not in such a way that it causes cognitive overload. Finally, successful engagements rely on genuine interaction among learners that constructs a sense of community, even if that community is temporary. This synchronous *presence*, more than any other characteristic, distinguishes learning in 3-D virtual worlds from other virtual learning environments since the presence of avatars makes learners feel like others are “there.”

In what follows, we discuss each of these concepts in more detail and present the evaluation rubric items that emerge from each of these three essential areas: motivation, learning and problem solving, and social presence.

Motivation

Learning rarely takes place in the absence of motivation to learn. Motivation is the focus of time and effort toward performing a specific behavior. It is possible for this motivation to be intrinsic—to come from learners' personal interests and goals—but most instructional situations rely on extrinsic motivation, where the characteristics of the instruction entice learners to spend their time and effort on the task. VIE Theory (Green, 1992) provides a powerful theory for conceptualizing the complexities associated with motivation by decomposing motivation into three essential elements: *Valance*, *Instrumentality*, and *Expectancy*.

One concern that occurs across all three characteristics of VIE theory is the result learners expect to achieve by performing the activity. The goal can be simple and short-term: if I do this, I expect to feel joy. Alternatively, the goal can be complex and long-term: if I do this, I will be more likely to get a job promotion next year. Learners must be aware of the goals toward which their behavior is directed for motivation to occur. Motivation in learning, therefore, can only be reviewed in reference to a particular goal, whether that goal is extrinsic or intrinsic. This mirrors the concept of optimal experience called "Flow" (Csikszentihalyi, 1990) in which individuals voluntarily participate in activities that stretch their capacities as they attempt to accomplish something difficult because they believe that activity is worthwhile.

Valance, the first characteristic associated with this type of optimal experience, represents the value associated with the behavior. This value can come from the behavior itself—the activity is fun or interesting by itself—or it can come from the value of the goals associated with the behavior. Valance is additive—the more learners enjoy the situation, the more it piques their interest or satisfies their curiosity, the more goals they associate with the task, and consequently, the higher the overall valance for the behavior will be. Because each individual will perceive the valance of a

situation differently based on personal values and interests, designers of virtual world learning environments must provide multiple sources of valence by anticipating what goals individual learners might have, both intrinsic and extrinsic. Without meeting these goals—without providing the necessary conditions for valence—VIE Theory states that there will be no motivation.

Instrumentality represents the strength of a connection learners perceive between the behavior and its associated goal. If learners do not see the utility of the behavior at moving them toward a goal, then there will be no instrumentality. Providing an articulated, written contract delineating the behavior-consequence connection often proves to be a good way to increase the perceived probability that the behavior will lead to the goal. In other words, if learners know upon entering an activity how particular actions lead to particular goals—the rules of the game, so to speak—the learners are more likely to feel a higher sense of instrumentality. Within the conceptualizations of both VIE Theory and Flow, this goal-directed, rule-bound system enables the learners to gather regular feedback on their progress toward the goal which increases the instrumentality present in the experience. Unless a system contains boundaries and unless learners receive commentary upon their progress toward goals within those boundaries, they will not develop a sense that they have made progress toward achieving those goals. Therefore, the concept of instrumentality requires that a VWLE provide opportunities for learners to review their progress at consistent intervals based upon their performance against a set of expectations established by the experience itself. Without these items, instrumentality does not exist and where there is no instrumentality, there will be no motivation.

Expectancy provides the final conceptual thread in VIE theory and measures learners' confidence in their ability to perform a behavior successfully. In order to have this confidence, learners must believe that they possess the knowl-

edge, skills, and resources necessary to perform the behavior. To adopt an example from the concept of Flow, if a certain person believes that they can play tennis well, they are more likely to engage in the activity (Csikszentihalyi, 1990). However, the tennis player must also feel that the experience challenges their skills, although not too much, so that the experience matches—or perhaps slightly exceeds—their skill level. In this case, the tennis player's game improves as the quality of the competition increases. In terms of a VWLE, learners must believe that they possess skills adequate to cope with the task at hand. Conversely, the tasks must continue to challenge the learners to retain their engagement (we'll discuss more on this topic below in the section on problem solving and cognitive load) and not be so easy to accomplish that learners' confidence levels remain static in spite of accomplishing the goal. Some ways to increase expectancy include building on the learners' past successes on similar tasks, observing others being successful at the task, observing that others believe you can be successful at the task, and receiving constructive feedback on your behavior. Like the other features of VIE Theory, expectancy is a necessary condition for motivation. If learners are not confident that they will eventually succeed in the tasks or behaviors, then there will be no motivation.

The discussion above has hinted at a subtle, but extremely important, component of VIE Theory: its multiplicative nature. If any of the three terms, valence, instrumentality, or expectancy, equals zero then no motivation will be present. One single zero cancels whatever gains might exist in the other terms. However, as the quantity of any of the three items increases, the overall motivation increases. Consequently, having some success in each term becomes necessary for a virtual world learning environment and having great success in any one term creates profound impacts across the entire system.

Based on the elements of motivation discussed here, the following rubric items emerge:

- Provides resources to build learners' confidence with tasks
- Provides feedback to learners' actions
- Checks on learner perceptions of goals as achievable
- Checks that the learner values the goals
- Checks on learner perceptions that the environment provides necessary resources.

Learning and Problem Solving

Learning means storing, or encoding, new information into long-term memory in such a way that learners can retrieve the information for later use. Information Processing Theory (IPT) offers a model that incorporates much of the research about this process of moving information from our experiences to long-term memory. IPT organizes the learning process into a chronological structure that includes sensory input and the sensory registers, attention and perception, working memory, and encoding into long-term memory. This process mirrors the “data to wisdom” transfer where learners first interact with unstructured information known as *data*, then construct some order for that data transforming it into *information*, then relate that information to a context of use transforming it into knowledge. The final step moves knowledge from a single context of use to broader, cross-context understanding where learners view the knowledge in flexible ways that transforms it into *wisdom* since the knowledge has been internalized as a general principle for understanding the world (Shedroff, 2001). Schematically, the transformation looks like this:

Data→Information→Knowledge→Wisdom.

Combining Information Processing Theory (IPT) with the data to wisdom transfer, we begin to see how the process of learning and problem solving works. Specifically, we have five senses (seeing, hearing, touching, smelling, and tasting) that continually pull data into the sensory registers.

Although the registers will hold a lot of data, they do so for a very short period of time (a matter of a few seconds, at best), and so the processes of attention and perception are critical to understanding how data continues through the system to become information. Attention represents the stage in the process, then, where we notice specific data in the sensory registers and then begin to organize it into meaningful structures. Attention is a learning bottleneck, because although there are huge amounts of data in the registers, we can attend to only a few pieces at a time as we attempt to transform it into information. Expectations and prior experiences participate in giving meaning to the data at this stage, essentially determining how we process what we are seeing and hearing. Each participant comes to our VWLE, that is, with a unique set of knowledge and experiences, and therefore a potentially different perception of the information there. That is why it is important to test regularly that the VWLE participant is processing their experience in the same way that designers intend. Once perceived, the new information continues to the working memory as it moves from information to knowledge.

In the working memory, learners transform information into knowledge by giving it conscious consideration. We commonly understand this stage as thinking, problem solving, and decision making. The working memory adds to the processing bottleneck because it is a very small space and this small “processing capability”—what the working memory can consider at any one time—is referred to as cognitive load (Sweller, 1988). There are three types of cognitive load (CL): extrinsic, intrinsic, and germane. Extrinsic CL includes information that takes up space in the working memory, but is not necessary for the task at hand. For example, consider a conversation you are having with a person you have just met in which you are hearing several new facts and are trying to determine which facts might be false. *Extrinsic CL* would be the part of working memory that holds the person’s name as you converse with the person.

Although their name is held in working memory, it probably is not necessary for solving the problem of sorting fact from fiction. *Intrinsic CL*, by comparison, includes all the useful facts and tools that can be used to solve the problem at hand. In the conversation example, intrinsic information would be the facts that have come up during the conversation that you are attempting to sort. In order to complete the task, all of these facts must be held in working memory. Finally, *germane CL* results from actually doing the processing required by the problem. In the conversation example, germane CL would consist of comparing and contrasting the facts from the conversation to uncover the false statement.

These three types of CL vie for working memory space at the same time as learners attempt to transform information into knowledge. Efficient use of working memory requires that potential extrinsic CL be ignored, and intrinsic CL be practiced until it can be stored in long term memory to the point of automaticity (retrievable with little effort), leaving a maximum amount of working memory available for germane CL. In a VWLE, this means that learners need to be trained to ignore potentially useless information such as the complex visual architecture of spaces, and that they need to practice skills like manipulating virtual objects and avatars. Once learners can operate in the environment with little conscious effort, a maximum amount of working memory space can be used for processing relevant information and solving problems.

The final stage of the transformation moves knowledge to wisdom as learners permanently store information in long-term memory—the core of learning. Research tells us much about how to enhance the encoding process (e.g. Baddeley, 1990) and this research leads to specific design strategies for 3-D virtual world learning environments. We know, for example, that when information is presented both visually and verbally, learners are more likely to retain and understand the material. This concept, called “media redun-

dancy” (Markel, 1998), suggests that the visual texture of a VWLE should be supplemented by corollary verbal exercises since the combination enables learning greater than either individual part. Additionally, VWLEs favor problem-based learning where learners engage in real tasks that require manipulating objects and navigating within the environment (Prasolova-Forland, 2008). Many tactics for building problem-based learning into VWLEs come to us from the field of Museology, where researchers have demonstrated the success of these tactics:

- Incorporating leading questions in verbal displays
- Including animated and simulated processes
- Noting contradictions between presentations or objects
- Allowing learners to act on the environment to see cause/effect relationships
- Reporting findings to colleagues (Screven, 2000).

Encoding knowledge as wisdom is also enhanced when learners make meaningful connections to prior knowledge. This elaboration of knowledge enables learners to construct a type of cross-context understanding by building flexible networks of knowledge that bend and morph as new knowledge joins that knowledge already present in long-term memory. This prior knowledge, then, serves as a hook for incoming information because it allows learners to understand the new knowledge in context of existing knowledge. We should attempt, in other words, to see things in the next larger context—to consider a chair in a room, a room in a house, a house on a block—and connecting new knowledge with existing knowledge enables learners to achieve this vision, a state we previously referred to as “wisdom” (Wurman, 2000); (Shedroff, 2001).

The transformation to wisdom, though, is only complete when learners become aware of their

own learning. This concept, called metacognitive skill, allows learners to see their own learning in terms of larger contexts and applications, making the learning more meaningful to them. And as we know from VIE Theory, when learners know the learning objectives, and those objectives meet instrumental goals, motivation to learn increases. The increased motivation leads to becoming a more sophisticated learner, which itself increases expectancy—the belief in ability to accomplish tasks. Consequently, knowing how to learn—learning metacognitive skills—empowers learners to regulate their learning and take ownership of the learning tasks. The more metacognitively sophisticated a learner can become, the more they can automate learning and problem solving strategies, leaving more room for germane tasks.

As Information Processing Theory and user experience design show us, learning occurs when learners move information from their experiences to long-term memory. This transformation of data to wisdom enables learners to begin reflecting on learning itself, to build metacognitive skills where they can think about their own thinking in a context larger than the individual experience. We also know that learning is constrained by the concept of cognitive load at each stage of the process and that certain learning strategies, like simulations and reporting to colleagues, enhance the encoding of experiences.

Based on the combination of these theories, the following rubric items emerge:

- Provides supplemental instruction for gaps in prior knowledge
- Makes learners aware of the learning goals
- Organizes information according to a consistent scheme
- Presents context that aids in remembering key information
- Challenges learners through problems or puzzles to solve
- Articulates strategies for learning the information

- Uses modalities (verbal, visual, sound) that do not require simultaneous attention.

Presence

The concept of “presence” represents the key differentiator between 3-D virtual world environments and other types of online environments (Bronack, Cheney, Riedl, & Tashner, 2008). Presence can be compared to the idea of immersion that many researchers have discussed over the last 20 years or so where learners “perceive that they are interacting directly with an [online] environment” (Witmer & Singer, 1998), although VWLEs add the component of people interacting with other people through avatars. Consequently, while the prior descriptions of immersion for web-based virtual environments still pertain, the newer, interactive 3-D environments require a more complex understanding than environments where a single individual interacts with an environment, for example in a flight simulator. Heeter conceptualized this broader definition even before the massive deployment of virtual worlds that we currently experience by proposing that presence within virtual worlds contains three components: environmental presence, personal presence, and social presence. We address each of these in turn below (Heeter, 1992).

Environmental presence relates to the ways that a system enables learners to interact with each other by building those functions into the system components itself (Heeter, 1992). For example, the environment must create opportunities for learners to share their thoughts through chat or voice—to leave traces, that is, of human activity within the system. We can further refine this concept by dividing interactivity into six separate types of functions that include

- *Feedback* where the system or individuals acknowledge that others have initiated action;
- *Control* where the learners are able to act on the environment and leave traces of their actions for others to see;
- *Productivity* where learners can utilize the system and interactions with others to solve real problems;
- *Communications* where the system enables bi-directional communication between individuals and between the system and learners;
- *Adaptively* where the system “learns” on its own about participant needs and changes to better suit those needs (Shedroff, 2001).

Each of these six components contributes to the environmental presence that a VWLE demonstrates and when they combine with compelling metaphors of location (Prasolova-Forland, 2008), learners understand exactly what is possible within the environment.

Research on *personal presence*, the second presence concept, possesses a long history in computer science, human factors and instructional technology (Heeter, 1992). Often thought of as “immersion,” personal presence refers to a participant’s sense of “being there” in the virtual environment, or the degree to which learners forget that they are interacting with something artificial. In detailed studies of personal presence conducted for the U.S. Army, Witmer and Singer (1998) discovered that four factors contribute to the success of these artificial worlds:

Control factors: or the naturalness of activity within the environment;

Sensory factors: or the environmental richness present through multiple interaction modalities like visual and aural;

Distraction factors: or the degree to which the interface forces itself in front of learners or uses novelty to divert attention from the interface;

Realism factors: or the correspondence between the artificial world and the lived world.

These factors certainly weave closely together with environmental presence components. How-

ever, the personal presence components focus on individual learners' sense of being "there" rather than the functionality of the environment. The difference, then, rests on the distinction between form—personal presence—and function—environmental presence.

The third presence factor, *social presence*, represents the key distinguishing feature of 3-D virtual worlds. While most online environments can build environmental and personal presence to lesser or greater degrees, the real sense of sharing an environment with other people in real time is felt most strongly in 3-D VWLEs. Learners feel a significant difference between working synchronously with an avatar that lets learners "see" their collaborators and working synchronously with others through Skype or IM (Bronack, Cheney, Riedl, & Tashner, 2008). The idea that learners can see collaborators causes learners to make a metaphorical jump to the real world where people can only be in one place at a time. In other words, if you're here with me now, then you can't be somewhere else at the same time—you are present with me. In addition to this sense of being able to see those we interact with, avatars enable certain non-verbal cues that approximate physical presence between real people which further strengthens the sense of social presence. For example, avatars enable learners to approximate cues such as gaze, gestures and proximity (Bailenson, 2006). Bronack et. al. (2008) expand on this notion, offering these components of social presence:

Personal space: where avatars' positions indicate their involvement with one another;

Appearance where the way an avatar is presented reflects, in theory, an aspect of a person's identity (whether real or experimental);

Modeling behavior: where real world non-verbal cues such as eye contact or expressions are purposely used to engage others;

Emotional impact: where avatars can imitate real expressions and articulate feelings beyond simply saying or typing the corresponding emotions.

In all of these cases, the ultimate purpose is to lead learners to feel like they are interacting with other real people rather than just computer-generated "bots." Everybody knows when it's just a bot—like on the telephone voice response systems so common today—even when those bots are good. However, social presence aims to present the real person behind the avatar to other real people represented by avatars in real time because research shows that the more human-like our interactions with computers become, the more engaging learners find those experiences to be (Andre, Rist, & Muller, 1999).

Building environments based on the notion of presence will significantly enhance the outcomes because "the factors that appear to affect presence are known to enhance learning and performance" (Witmer & Singer, 1998). Classroom teachers certainly know that better physical environments, better-structured activities, and genuine interaction all lead to positive learning outcomes. Three-dimensional virtual environments for learning present many of the same opportunities as face-to-face learning when these environments are conceived well.

Based on the discussion of presence in 3-D VWLEs, the following rubric items emerge:

- Uses multiple modalities (verbal, visual, sound)
- Adapts to learner activity
- Employs compelling metaphors to create an environment with fantastic features
- Reflects some correspondence to the real world
- Uses avatars to establish presence of others
- Enables communication in real time
- Allows learners to alter or add to the environment to enhance its meaning
- Enables learners to collaborate
- Enables learners to personalize an avatar.

Summary of Engagement Items

Clearly, the engagement aspect of a 3-D virtual world built for learning should occupy the most time for an evaluator since the learners themselves spend the majority of their time in the actual engagement. Returning to our restaurant metaphor, compare the amount of time that you might spend actually IN a restaurant compared to the amount of time that you might spend ENTERING the restaurant and initiating the dining experience. Attraction certainly bleeds over into engagement, particularly in a well-designed experience, but the engagement components nonetheless comprise the major part of a learning experience. Similarly, the components of the engagement blur into one another as *motivation* factors blend with *learning and problem solving* since learning usually only occurs if people maintain their motivation to learn by remaining challenged but are not overburdened by the *cognitive load* of the challenges. *Presence* factors lean into motivation because as learners begin to feel immersed in an environment by interacting with others and realizing that their actions have an impact on the VWLE, motivation increases. Social presence also leads to effective learning and problem solving because one of the most effective methods of learning—one facilitated particularly well by 3-D virtual worlds—is collaborative work on real problems. Successful engagement in a learning experience, then, becomes circular as *motivation* leads to *learning*, and *problem-based learning* comes from *presence*, but *presence* leads to *motivation*: it's a large interdependent ecology of concerns.

In summary, these three components characterize a successful engagement, the major part of a learning environment:

- Motivation
- Learning and problem solving;
- Presence

CONCLUSION: EXITING THE EXPERIENCE

Let's return for a moment to our restaurant fable. Your group was attracted to the restaurant, was engaged in dining at the restaurant, and now you've had dessert and coffee and have motioned for the server to bring the check. The check arrives, your group pays, rises from the table, and you exit to the street chatting about the good food and how you'd like to come back another time. The experience has concluded.

Conceptually, learning experiences should follow the same pattern. Learners should know when they have accomplished what they set out to learn; they should be able to exit the experience confident with their new knowledge; and they should be able to reflect on their knowledge and its applications for the future. If the conclusion doesn't satisfy learners, the future implications of the experience will be unclear and rather than feeling satisfied or pleased with the experience, learners might feel dissonance or confusion. In either case, as Norman (2003) reminds us, the negative emotions dampen retention. In other words, without a successful conclusion, learning might not have taken place at all.

A conclusion to an experience, therefore, has at least three components that designers must enable.

An announcement of the exit: The end of an experience must be clear to those within it so that learners know that they have just a little time to explore any areas that remain (Siegel, 1997). Learners shouldn't be rushed out, but they should have a limited opportunity to explore things that interest them. Within a VWLE, this means that connections to the "outside" should be clearly marked, either by geographical features such as doors or by instructors (perhaps bots) who are present in the environment. However, because virtual learning environments are often self-directed, the exit should also be a station where learners are questioned about the experience and their learning outcomes because quite possibly the

learners wouldn't be aware that they've "seen" everything they need to.

A request for something from the learners: In our restaurant example, we might be tempted to see the check as the request for something and indeed it is. However, the check really serves more as the signal of the ending rather than a request. A more appropriate example would be completing a card to evaluate the dining experience. And in VWLEs we can do exactly the same thing: ask learners to complete assessment tasks to gauge their learning (Screven, 2000). What better way to confirm that learners have, in fact, accomplished their goals than to allow a test or survey or final activity to confirm that the learners have achieved something? As implied above in the discussion of the announcement, the exit serves also as a checkpoint, a spot where learners can confirm that they have accomplished their goals and the goals of the learning activity.

An opportunity to reflect on the experience in a larger context: Metacognition requires that learners become aware of their learning and place that learning into a new, more broadly applicable, schema. Just as your dinner companions reflected on their experience in relationship to other dining experiences, virtual environments should encourage learners to place any particular experience within a larger context of related activities (Wurman, 2000). Recalling our discussion of the data to wisdom transformation, the final transformation occurs only when learners can broadly apply what they've learned in novel contexts. In VWLEs this means that learners should be given opportunities within the system to reflect on their learning, quite possibly leaving "traces" of their learning for others in the future. These traces, then, become part of the environment, enhancing the sense of presence for future learners while enabling present learners with an opportunity to reflect.

Based on these concepts related to conclusions, the following rubric items emerge:

- Provides feedback to learners' actions
- Enables learners to assess their learning
- Enables learners to reflect
- Enables learners to leave traces of their understanding of their experiences
- Signals the conclusion/exit.

THE COMPLETE EVALUATION RUBRIC

Attraction, Engagement Conclusion: these items represent the key features of an experience and when placed within the ADDIE instructional design frame, we see that designers of 3-D virtual world learning environments must understand not just experience design, not just instructional design, and not just learning theory. Rather, a successful 3-D virtual world for instruction must combine features of all these components. Drawing on the principles that we've outlined so far, we offer below the compiled evaluation rubric for assessing a virtual world learning environment.

The rubric presented below distills the concepts presented above in the more complex theoretical frame into twenty-eight key components. We have dubbed this approach the "CIMPLe System" (pronounced "simple") because we have grouped items according to our fundamental categories: Context, Interactivity, Motivation, Presence, and cognitive Load. The "e" stands for "evaluator." The CIMPLe System arranges the evaluation items in a slightly different order than they are presented above in the theoretical discussion to enable users of the tool to more readily remember the key parts of an effective virtual world learning environment by using the acronym for the key parts—context, interactivity, motivation, presence, and load. Finally, in Appendix A, we provide a reproducible version of the instrument that individuals can actually use to assess VWLEs.

Context, Interactivity, Motivation, Presence and Load Evaluator (CIMPLe)

Context: Factors that characterize the “physical” construction and function of the environment:

- C1. Attracts through initial sensorial pleasures.
- C2. Promises a novel or unique experience
- C3. Employs compelling metaphors to create an environment with fantastic features.
- C4. Uses multiple modalities (verbal, visual, etc.) that do not require simultaneous attention.
- C5. Technologies and functions operate appropriately
- C6. Signals the conclusion/exit.

Interactivity: Factors that characterize the ways that learners affect the environment and other learners within the environment:

- I1. Presents multiple ways for learners to interact with the environment that are consistent with the environment’s scheme.
- I2. Enables learners to collaborate.
- I3. Challenges learners through problems or puzzles to solve.
- I4. Allows learners to alter or add to the environment to enhance its meaning.
- I5. Enables learners to leave traces of their understanding of their experiences.

Motivation Factors that impact learners’ desire to achieve the goals built into the environment:

- M1. Makes learners aware of the learning goals.
- M2. Checks that the learner values the goals.
- M3. Checks on learner perceptions of goals as achievable.
- M4. Checks on learner perceptions that the environment provides necessary resources.
- M5. Provides resources to build learners’ confidence with tasks.
- M6. Provides feedback to learners’ actions.

Presence: Factors that give learners a sense of immersion in the environment:

- P1. Enables learners to personalize an avatar.
- P2. Uses avatars to establish presence of others.

P3. Enables communication in real time.

P4. Adapts to learner activity.

P5. Reflects some correspondence to the real world.

Load: Factors that help the environment strike a balance between cognitive overload and challenging tasks that increase learning:

- L1. Organizes information according to a consistent scheme.
- L2. Experience follows predictable schemas.
- L3. Provides supplemental instruction for gaps in prior knowledge.
- L4. Presents context that aids in remembering key information.
- L5. Articulates strategies for learning the information.
- L6. Enables learners to reflect on their learning.

CONCLUSION

The CIMPLe System presented in this chapter offers an advance in how educators can assess the quality of the virtual world learning environments that they build. Most prior literature on 3D virtual worlds focuses on a single aspect represented in the CIMPLe framework as researchers have discussed, for example, the importance of the context, interactive features, or presence. Instead, the CIMPLe framework combines multiple concerns present in virtual worlds into a single, sophisticated system that demonstrates concerns for the interactions among the various components of a virtual world. In other words, this short tool based on relatively complex theories enables instructional designers to begin thinking holistically about their constructions rather than compartmentalizing the components of a successful virtual world learning environment

The holistic approach to evaluating VWLEs achieved in the CIMPLe System arises from the thoroughly multidisciplinary approach represented in the tool’s theoretical backing. Research in user experience design, instructional design, interface design, learning and motivation theory, technical

communication—to name the most dominant traditions—combine in the CIMPLLe System to present evaluators with a perspective that works across different types of virtual environments. Our concern here has been primarily with 3D worlds, but the CIMPLLe System could be used across a variety of virtual learning environments, whether they are three-dimensional or not, because of the system's cross-disciplinary nature.

Finally, one limitation of the approach presented here, of course, is that it cannot measure or suggest content or goals. Instead, the CIMPLLe System suggests generic types of activities or categories of features that must be present in a successful virtual world learning environment. For this reason, we want to draw attention, once again, to the importance of positioning the evaluation offered by the CIMPLLe System into a larger instructional design framework that includes all five stages of the ADDIE paradigm: analysis, design, development, implementation, and evaluation. The CIMPLLe System fits primarily within the “design” phase because at this stage instructional designers can use the rubric as a heuristic for building the type of environment that will succeed. In other words, as they consider what to build into the environment, designers can refer to the CIMPLLe System as a sort of best practices checklist to ensure that the environment meets the needs that the cross-disciplinary theory suggests are necessary. What the rubric cannot do, however, is suggest content or learning goals. That must be left to the individual designer and specific learning situation.

A second limitation arises because the CIMPLLe System has only recently been introduced and no research record exists to validate the construct. However, since the CIMPLLe System combines components of approaches that other researchers have already validated such as the ADDIE framework, the system has a strong theoretical grounding that we believe will most likely prove valid in future case studies. That is not to suggest that specific items on the rubric might not be modi-

fied or that new items won't be added. It is to say, though, that we believe the primary conceptual structure of the system—context, interactivity, motivation, presence, and load—will withstand empirical validation. Indeed, a case study that uses the system for a cohort of teachers designing materials for seventh graders is underway as this chapter goes to press.

Even with these limitations, the CIMPLLe System can be used to diagnose usability issues and suggest why an environment might be successful or why it might fail. For example, at the evaluation stage—the final stage of the ADDIE paradigm—designers can determine how successfully the VWLE employs interactive features. Perhaps those interactive features appear but maybe they don't seem to enable learners to grasp the concepts appropriately. The CIMPLLe model tells us that we need to have these interactive features and what they should look like in the abstract, so designers can go back and revisit whether or not those interactive features actually are the best ones to achieve the learning goals. The fact that the interactive features must be present doesn't change; the way those features are enacted in the system might need to change. Perhaps future case studies that investigate VWLEs built according to the CIMPLLe System will point us toward the most effective ways to implement such features.

We hope that instructional designers will take away some practical guidelines for developing virtual world learning environments from our chapter. The practical guidelines found in the CIMPLLe System evolve from a substantial, cross-disciplinary theoretical approach and we hope that these discussions proved useful for demonstrating the genesis of the CIMPLLe System. We also hope that researchers will interrogate the system and that those investigations will combine with feedback from instructional designers so that the CIMPLLe System can continue to evolve and be refined into an exceptional tool for assessing virtual worlds designed for instruction.

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KEY TERMS AND DEFINITIONS

Virtual World Learning Environments:

Electronic learning spaces, usually available through the Internet, that use computers to simulate aspects of the real world with the intention of teaching users some particular topic or content.

Context: The factors that characterize the way a virtual experience operates, including the experience's construction and functionality.

Interactivity: The factors that characterize ways that individuals can affect the environment or other participants within the environment including the opportunity to provide feedback, control the experience, produce something, or have the system adapt to their individual needs.

Motivation: The set of characteristics—valence, instrumentality and expectancy—that helps learners to maintain interest in learning activities, to succeed at learning, and to assess their degree of gain.

Presence: This often refers to the level of immersion that a person feels when the participate in a virtual experience. Presence consists of environmental presence that enables interaction with the system; personal presence that gauges the level of immersion a person feels; and social presence or the degree to which one can interact with others synchronously.

Cognitive Load: The processing capability individuals possess as they consider information in the environment, the relevance of that information, and the application of the information to problems they attempt to solve.

User Experience Design: A method of planning, designing, building, implementing and testing products with a focus on the user's complete experience. The approach is used for computer-based products such as websites, but also for product design of items such as phones.

Attraction: In user experience design, this represents the reasons that a person might begin particular experience. Reasons for undertaking the experience are either intrinsic or evolve from the user's own needs, or extrinsic in which case the user must be meet

Engagement: In user experience design, this represents the major portion of an experience, the thing that a user seeks in the experience. The engagement occupies the bulk of the time a user maintains contact with a particular experience.

Conclusion: In user experience design, the actions that signal the end of the experience or

when the end is announced, assess participants' opinions or learning, and provides an opportunity for learners to reflect on the experience.

Data to Wisdom Transfer: This means moving receiving information, processing that information according to its usefulness for solving problems, and ultimately storing that solution in long term memory as a schema for future use in a novel context.

Problem-based learning: Experiences that place learners in situations where they have to think through concepts and apply them to solve meaningful problems rather than reciting information from memory.

ENDNOTE

- ¹ We'd like to express our thanks to the Carolina Virtual Worlds Consortium (CVWC) and the National Science Foundation for supporting the research and instructional activities from which this chapter has evolved.

APPENDIX A: THE CIMPLE SYSTEM FOR REPRODUCTION AND USE

Table 1. Context

	C=Complete	I=In Process	A=Absent
Attracts through initial sensorial pleasures.			
Promises a novel or unique experience.			
Employs compelling metaphors to create an environment with fantastic features.			
Uses multiple modalities (verbal, visual, etc.) that do not require simultaneous attention.			
Technologies and functions operate appropriately.			
Signals the conclusion/exit.			

Table 2. Interactivity

	C=Complete	I=In Process	A=Absent
Presents multiple ways for learners to interact with the environment that are consistent with the environment's scheme.			
Enables learners to collaborate			
Challenges learners through problems or puzzles to solve			
Allows learners to alter or add to the environment to enhance its meaning.			
Enables learners to leave traces of their understanding of their experiences			

Table 3. Motivation

	C=Complete	I=In Process	A=Absent
Makes learners aware of the learning goals.			
Checks that the learner values the goals.			
Checks on learner perceptions of goals as achievable.			
Checks on learner perceptions that the environment provides necessary resources.			
Provides resources to build learners' confidence with tasks.			
Provides feedback to learners' actions.			

Table 4. Presence

	C=Complete	I=In Process	A=Absent
Enables learners to personalize an avatar.			
Uses avatars to establish presence of others.			
Enables learners to communicate in real time.			
Adapts to learner activity.			
Reflects some correspondence to the real world.			

Table 5. Load

	C=Complete	I=In Process	A=Absent
Organizes information according to a consistent scheme.			
Experience follows predictable schemas.			
Provides supplemental instruction for gaps in prior knowledge.			
Presents context that aids in remembering key information.			
Articulates strategies for learning the information.			
Enables learners to reflect on their learning.			

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Section VIII

Emerging Trends

The final section explores the latest trends and developments, and suggests future research potential within the field of instructional design while exploring uncharted areas of study for the advancement of the discipline. Introducing this section are chapters that describe some of the most recent issues in technology-assisted education, followed by new topics on adult education and virtual inquiry. Of special note to those looking for the design portion of instructional design, two of the final chapters discuss aesthetics and new practices in instructional design. These and several other emerging trends and suggestions for future research can be found within the final section of this exhaustive multi-volume set.

Chapter 8.1

Contemporary Issues in Teaching and Learning with Technology

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INTRODUCTION

To speak of contemporary issues in instructional technology is like counting wave crests in a stormy ocean: they are changing quickly all the time. New technologies and new issues present themselves daily. Educators struggle with both the instructional integration of computing and developing the skills and knowledge necessary to use technology effectively (Lipscomb & Doppen, 2005). Why, after over 30 years of having computers in schools, are educators still having such difficulties?

Today's population is much more accustomed to electronics, yet knowledge is weak, concepts are misunderstood, and the difficulties of teaching

with technology seem as serious and convoluted today as ever before. The great physicist and thinker, Richard Feynman, offered some critical comments about the challenges of educators. "What happens is that you get all kinds of statements of fact about education, about sociology, even psychology — all kinds of things which are, I'd say, pseudoscience" (Feynman, 1999, p. 242). Today, we understand "more about education [but] the test scores are going down... we just don't understand it at all. It just isn't working" (p. 243). Being critical of how the scientific method is applied to education, Feynman's comments highlight how the study of teaching and learning yields limited or questionable results. Teacher trainers take their best guess on how to prepare teachers to use technology.

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BACKGROUND

Educational computing is a relatively new discipline compared to mathematics and science. While the earliest uses of computers might have been by departments of mathematics, it quickly became important for virtually all teachers to become computer literate. But what exactly that entails was not exactly clear (Galloway, 1985) for learning and in society (Beaty & Tucker, 1987).

Microcomputer technology, primitive by today's standards, lacked user-friendly applications, any sort of consistent user interface, or easy-to-use telecommunications and interconnectivity. There was an early division between those who learned to program computers vs. those who focused more exclusively on applications software. Conceptual development, improvement of problem solving, and higher-order thinking skills in computing have been directly linked to the inclusion of Logo programming (Allen, 1993; Battista, 1994; Borer, 1993; Dalton & Goodrum, 1991) and BASIC programming (Overbaugh, 1993). Yet, in spite of an overwhelming need to operate early microcomputers through programming, educators focused instead on the actions and procedural tasks of specific applications (Galloway & Bright, 1987).

With this as a foundation, decades of training have followed in which educators have tried to master new devices and software. So, how long does it take to reach a point of nationwide competency, to develop the protocols of effective use, to establish the knowledge of how best to learn computing? Compared to centuries of science and mathematics, perhaps our 30-plus years do not seem so long.

EDUCATORS LEARN COMPUTING: A PROBLEM OF PERSPECTIVE

Our collective perspective on what it means to learn computing affect what goals we pursue and how we proceed. For example, the use of rubrics

or portfolios were not commonly emphasized in education 30 years ago. Today, they are an accepted or at least popular tool for preparing educators (Galloway, 2006; Rural School and Community Trust, 2001). Does this represent progress or perhaps just a symptom of changing fads? Is this a function of real knowledge or mere opinions? This is again reminiscent of a Feynman (1999) criticism, as he suggests that professionals 30 years ago have as much right to a correct opinion as we have today, "to equally unscientifically come to a conclusion" (p. 243)—even if wrong.

Preparing Teachers

It is unlikely that educators younger than their mid-40s graduated high school without having computers in their education. There has been, since the late 1970s, a continual focus on the needs of teachers to learn and adapt to a technology-based profession.

Our attempt over the years to change educators into computer-literate professionals essentially failed. Many will argue the point, as clearly there are countless success stories. But, with the exception of the techies and innovative pioneers, educators across the profession a generation ago did not, have not changed their basic approach to integrate technology.

Compared to in-service classes, college courses, training, or other options, an overwhelming majority of teachers maintain that their primary methods of learning computing was through self-study and personal experimentation (Galloway, 1997). It can be argued that teachers must assume a responsibility for advancing their technological knowledge and be engaged learners.

When taking a computer class, one must go beyond the prescribed activities. For example, it is not likely that one would be assigned the experience of losing a file or opening a file with the wrong program. These frustrations can be a very necessary part of learning. Far too often educators are passive and restrict their involvement to oc-

casional and discrete enrichment offered through someone else's initiative. Delays and intermittent and partial commitments inhibit learning.

As an analogy, when this author was young, rock-n-roll music was still the choice of the young, but grandfather did not relate and found it quite distasteful. In elevators in 1968, one would hear music from Lawrence Welk and such. This author believed that if elders could simply understand and learn about rock-n-roll and what the artists were attempting to express musically that society could change and the music would be accepted. Today, one is likely to hear McCartney, Dillon, The Beatles, Buddy Holly, or many of the other artists that were objectionable in those earlier years. One might think that, indeed, things changed.

However, the point is that this did not occur because the elders were influenced or convinced. The younger, rock-n-roll generation did not change anyone. The elders were not convinced. No metamorphosis occurred. The young simply grew older and brought their music with them. As the elders died off, the young with a new culture replaced the old.

The same seems true for the computer-using generation. Our efforts a generation ago were ineffective. We have simply waited around while a new generation grows older bringing their technology-based lifestyle with them. Until our children have time to take their place, today's teachers are still introduced to computing as beginners.

Training vs. Education

What do current educators expect from computer training? If we accept that it is difficult to teach someone who does not want to learn, what do students expect from their training? Unfortunately, the most popular notion in instructional technology is that teachers are to be trained, not educated. More than mere semantics, teaching tends to emphasize *showing teachers how to use technology* — rather than facilitating insight, understanding, and conceptual development. In-

service programs and college curricula emphasize only what teachers are expected to use rather than what might develop good concepts. Omitting programming is a classic example where teachers as end users of software never see the construction process or design methods behind what they are supposed to learn. Today's design tools (for Web pages and such) are a modern example of where these issues still apply.

Teaching for conceptual understanding and higher-order thinking skills should not be only a part of teaching programming (Tu & Falgout, 1995), but also a fundamental goal of instruction for beginners in computing. Skills and even performance standards can still fail to generate important understandings, perspectives, concepts — integrated knowledge — that all contribute a fundamental and critical basis for problem solving and adaptability.

Focusing on conceptual development will still involve procedures and tasks just as focusing on discrete skills will likely yield some insights and discoveries. But instruction should yield a more complete, fundamental understanding of computing. Most programs and perspectives fail to recognize this important viewpoint and instead pursue skills and competencies to the detriment of understanding, insight, and problem solving.

It is common in other disciplines to speak of *education* rather than *training*. Conceptual development is often the primary focus in the study of science (Trumper, 1997). Even when the preparation of teachers is described in terms of training, science concepts are emphasized, not skills (Thompson & Schumacher, 1995). In spite of the procedures and skills inherent in science and mathematics, students are guided toward the development of a conceptual understanding as they are educated — not trained.

A training model targets activities and the software teachers will use. Much like an airline reservations clerk must learn the keystrokes and procedures for prescribed tasks, educational computing is similarly conceived. An education

model, on the other hand, calls for activities and experiences that will yield a deeper kind of learning. Keystrokes and software familiarity would be incidental to the more important yield of experiences, much like those in science and mathematics, that develop understanding, concepts, problem solving, and critical thinking skills. An education-based program would provide experiences because of their educational value regardless of whether they are part of an anticipated skill set. Skill sets, tasks, and the procedural rituals of training will inevitably change and evolve far beyond the scope of any training experience.

Student teachers can be part of the problem as they, very often, prefer the training model. Contrary to any real value or longevity of such an approach, a more involved education presents an undesirable challenge. They prefer to simply be shown what to do. Guided tasks, prescribed procedures, and discrete tasks are all a matter of doing, not becoming. However, an education calls for change.

Acquiring mindless task sequences is often viewed by educators as success. Improved teaching is then viewed as having more complete checklists for more tasks. This *recipe mentality* of discrete procedural rituals ignores the need for discovery learning, transfer, and adaptability, and could be responsible for continuing the inhibited progress of the past 30 years.

Integration

Limiting factors for the integration of technology include funding, professional development, support for experimentation, and inadequate technology planning (Mehlinger & Powers, 2002). As Galloway (1997) examined technology adoption, it was learned that effective usage is related to the combination of both professional and personal adoption of technology. Virtually no one used technology in their classrooms where personal adoption was not combined with professional use.

It has been said that teachers exist only for the children. They express the sentiment that student needs are the primary, if not the only mission of teachers. It is easy, however, to draw the wrong conclusions from such a self-evident premise. For instructional technology, consistent with this perspective, trends have been directed away from empowering teachers, focusing instead on classroom integration. This may seem justified, but a serious problem remains: it is not reasonable to teach non-computer users to use technology in the classroom. Educating teachers to become computer-using, technology-competent professionals would more likely yield classroom integration as a matter of natural consequence.

While there are training programs targeting classroom integration, what success can be had if teachers are not computer literate or have never adopted computing in their lives? In other words, one must adopt technology as a life-changing metamorphosis. The approach of the past, training over education and rituals over holistic adoption, may likely continue the inhibited progress in integration and technological mastery.

Learning and Working

Everyone agrees that students must be prepared for a technological future, but perceptions vary widely on exactly how to achieve that. This is a challenge of pedagogy.

Computers have been perceived as tools (Beaty & Tucker, 1987) and have been used in that fashion. An alternative view might suggest that the computer is not a tool at all. As a tool might be selected or discarded based on a particular need, technology is too often viewed as independent from everyday life powered-up if the need is sufficiently demanding. Instead, computers are perhaps best viewed as a complete *environment*. It is where we live, work, and play. It is the medium of our planning, our creativity, and an extension of both our short-term and long-term memory.

This thinking places different expectations on educators than has traditionally been made. The notion that one can remain a non-computer-using person while merely executing discrete tasks as needed must change.

FUTURE TRENDS

How has learning changed and what is *learning* in the modern tech-based world? Learning is far too often viewed by teachers as a matter of acquiring information. Teachers deliver information to the students who in turn sit on it for a period of time only to hand it back to teachers again in some form of quiz or standardized test. If students regurgitate and return the information accurately, they are said to have *learned*. In fact, students assume this is what is expected of them and resist anything more personally demanding. The notion that they must change, must invent, or synthesize is foreign to them.

Learning is no longer about the acquisition of information. We have information. It is possible to find the average price of a hang guilder, the architect of the Brooklyn Bridge, design plans for a new home, or a translation of the Dead Sea Scrolls in mere minutes — all while sitting in a hotel lobby or even lying in bed in a dormitory room. Acquisition of information is neither the problem nor the goal. Learning to think is the real challenge. Education has become about skill development with demonstrable competencies rather than about becoming smarter or learning to think. Education, as distinct from training, should improve problem-solving abilities, critical thinking abilities, developing an understanding, learning to discriminate and make good choices, and developing a contextual intuition.

Computing students do not want to have to explore and discover, wanting instead to be shown how to execute procedures. Alluded to earlier, this amounts to distributing recipes for subsequent replication. Being ready for tomorrow's computing

world depends on understanding, problem-solving skills, and the ability to adapt to the unknown, not on knowing procedures in some software program.

Technology continues to develop faster than anyone can sufficiently learn it. Merely being able to operate the functions and tools in a program is usually considered a success. But achieving a deeper knowledge of how best to adopt, integrate, and teach in a world of technology is quite a different thing.

The Distant Future

Does today's science fantasy help to create the reality of tomorrow? That is of course debatable, but at least imagination does its part on one side of the evolution equation. Clearly, our children will experience amazing and incredible advancements that today seem like science fiction.

So, extend your vision to consider the following: a kind of futuristic electronic *bubble* as a kind of spherical energy shell that would surround one's head and face. The shell might not be spherical and could instead extend vertically downward in front of the face and chest somewhat like a large energy shield in front of the body. Generally, it may be maintained and kept active throughout the waking hours.

The shell or *e-bubble* would be generated by a multifunctional microchip and would act like a virtual outer skin or electronic membrane extending perhaps 10 to 12 inches in front of the body. Perhaps the orientation of the membrane (up/down, sections, areas, etc.) could be determined by detecting and interfacing with an electrical field from the heart or brain, much like an electrocardiogram or electroencephalogram. This would be important to establish a directional configuration since a microchip might be located more on convenience or medical necessity. The e-bubble should maintain a functional orientation to the body. The membrane can function in sections, quadrants, or areas, as well as operating as a whole or singular entity.

The e-bubble would serve as a communications interface for all sorts of input and output in work, learning, and recreation. The microchip and power supply might be worn as external hardware, like in a necklace, belt buckle, or collar. Perhaps the electronic membrane might exist in the form of a mere hologram projection from specialized glasses. Today's military pilots see electronic projections of critical data superimposed on their natural view of their environment during flight. Some hardware today can feed visual information into one eye, leaving the other eye normal as the brain integrates the two views. The integration of visual and auditory hardware with the body has already begun its prosthetic progression from the separate and independent technologies of yesterday's cathode-ray tube (CRT) and today's plasma flat screens.

Eventually, the development of the e-bubble would evolve beyond the independent device carried in hand. Even with the convenience of a wristwatch or techno-necklace, such devices are external and thus their service to our lives is an add-on not truly integrated and natural. The e-bubble will evolve beyond a separate prosthetic to such a size and state that it becomes an implant no more intrusive than an inner ear replacement.

Images displayed in the membrane fields would include all of the variations we know of today: pictures, graphics, text, color, and of course, full-motion video. One can imagine that these fields appear from the back side, viewed by others, as opaque with no detail or instead translucent with imagery appearing in reverse.

One can imagine interactive fields for drawing, writing, or other tactile manipulations. Perhaps an image might be relocated in the field matrix to open or power another area for a secondary purpose. The various fields might provide a multi-tasking experience of work and play, business and entertainment, or integrated learning and study experiences.

It is really an extension of what has already occurred. Star Trek and many other sources of imagination today illustrate not just an exciting possibility but an inevitable reality.

CONCLUSION

Are we to continue passively as followers of our children or step up as leaders, which the nobility of our profession demands? The overwhelming theme of the past 30 years is that training for discrete tasks must be replaced by holistic adoption and education. Being successful at computing is not a function of memorized procedures or specific skill sets. Procedural rituals, however conveniently arranged or exhaustively accounted, cannot substitute for intuition, problem solving, and a deeper understanding of computing.

The future depends on adaptability and learning transfer, which again attest to the inadequacy of mere training. It will be an exciting future, but challenging to us all. To quote Peter Drucker, 20th-century business pioneer, "The best way to predict the future is to create it."

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KEY TERMS AND DEFINITIONS

Computer Literacy: The ability to effectively use computer technology to solve problems and efficiently meet personal and professional needs.

Education: Contrary to mere training, the process engaging in supportive and generative experiences for acquiring the broader understanding and mastery.

Educational Computing: Full range of uses of computers pursuant to conducting the profession.

Instructional Technology: The broader field of studying the use or related issues of all technologies in education.

Integration: The effective, instructional use of technology in the classroom.

Learning: Contrary to the acquisition of mere facts, and more than acquiring discrete skills and competencies, learning is the development of knowledge, conceptual understanding, and critical thinking abilities in a prescribed context.

Science Fiction: Imagining future developments in technology and the human-machine interface, including living and working in virtual worlds.

Training: Limited and highly specific instruction for learning discrete tasks and procedural rituals.

Chapter 8.2

New Directions in the Research of Technology–Enhanced Education

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ABSTRACT

This chapter presents the results of a systematic review of literature in which the authors examined instructional technology integration in career and technical education, mathematics, language arts, social studies, and science. Three lenses were used to examine the literature: a research design framework, a teacher knowledge framework (CFTK), and a technology integration framework (TPACK). The research design framework revealed a low percentage of papers that were actually research studies (41.2%), favoring qualitative design (70% of the 41.2%). Consequently, educators may have difficulty sifting through high proportions of non-research to find the most informative,

up-to-date instructional technology research. Three CFTK aspects of teacher knowledge were addressed less than others in the research studies: Individual Context (16%), Subject Matter (33%), and Discernment (29%). Pedagogical Knowledge was addressed the most (65%). The TPACK developmental framework revealed an emphasis on the lowest three levels of instructional technology integration (60%), indicating a gap in the research at the upper two levels. Mathematics studies accounted for almost half of all research addressing TPACK developmental stages (47%). From these findings, the authors conclude that pedagogical knowledge alone is not enough to ensure high levels of technology integration and offer recommendations for improving the disjointed nature of research on instructional technology.

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INTRODUCTION

Teachers use instructional technology for online courses, video conferencing, electronic portfolios, and other exploratory projects. Literature reviews are important tools that teachers can use to evaluate instructional technology and develop strategies for its effective use. A systematic review of literature can make such evaluations far easier and more effective by synthesizing the results of the studies on a given topic using well-articulated methodological processes. The purpose of this chapter is to provide a systematic review of the impact of technology on teaching and learning and to propose a framework for looking at teacher knowledge from which gaps in the literature can be addressed. In this paper, the term “technology” refers to digital technology as opposed to other forms of instructional tools (e.g., overhead projectors, manipulatives).

Means, Wagner, Haertel, and Javitz (2003) identified two major issues regarding the use of technology for instruction: the pedagogical value of specific technology tools and the cumulative effects of technology exposure over time on student learning. In order to address these issues, educators need to assess specific sub-questions to gauge the effectiveness of technology as a teaching tool (e.g., What conditions foster learning with technology; what pedagogical strategies promote learning with technology; what teacher qualifications are related to content, technology, and implementation of pedagogical strategies; and to what internal and external classroom constraints must teachers attend when incorporating technology?). The complex nature of these questions requires multiple types of research and design.

Bell, Schrum, and Thompson (2009) suggested that the types of research needed to adequately address these issues include: (1) experimental or quasi-experimental studies, (2) large-scale studies, (3) studies with sufficient statistical information to be included in meta analysis and mixed-methodology studies, (4) studies with rich analysis of student content knowledge, and (5) studies that

address the complexities of learners, classrooms, and schools. Recently, federal funding agencies such as the Institute of Education Sciences (IES; Whitehurst, 2003) have emphasized large scale experimental studies as the gold standard for scientific research. One such study, *Effectiveness of Reading and Mathematics Software Products: Findings from the First Student Cohort* (Dynarski et al., 2007), found that the technology programs used showed no significant improvement in student test scores in mathematics and reading. However, the results from a single study, even a large scale experimental study, are not conclusive in and of themselves. For example, Fitzer et al. (2007) challenged the generalizability of the Dynarski et al. (2007) study, noting that “this study oversimplifies the case by pushing aside these complicated relationships, and treating all the software programs as members of the same generic set of ‘mathematics software’ (or ‘reading software’)” (p. 3). Ronau et al. (2008) added that “The absence of teacher considerations along with a seemingly accepted view of a transmission model of learning with technology left the door open for better and richer technology research — research that addresses the complex situations occurring when various technologies are used in the mathematics classroom” (p. 19). From this example, we see that no one study or type of study can answer every pertinent question; small-scale empirical studies and qualitative studies fulfill an important role for research by answering focused questions in more detail than is feasible on a large scale. We suggest therefore that researchers seek a balance between various methodologies to better answer the multiple facets of key questions asked by stakeholders regarding the integration of technology in the classroom.

FRAMEWORKS FOR TEACHER KNOWLEDGE

In addition to research design, this chapter is also interested in how previous studies have taken into

account the impact of teacher knowledge on the effectiveness of the integration of technology in the classroom. Within the past few years, two new teacher knowledge frameworks have been proposed with the potential to support the research community in responding to questions on the impact of technology on learning. The Comprehensive Framework of Teacher Knowledge (CFTK) provides a three-dimensional model of teacher knowledge (Ronau et al., 2009). The Technology, Pedagogy, And Content Knowledge (TPACK) framework focuses on teachers' interconnected and interrelated knowledge of content, pedagogy, and technology (Mishra & Koehler, 2006; Niess, 2005a). Both structures emanate from the pedagogical content knowledge (PCK) framework proposed by Shulman (1986) as the specialized knowledge that teachers need for teaching.

Comprehensive Framework for Teacher Knowledge

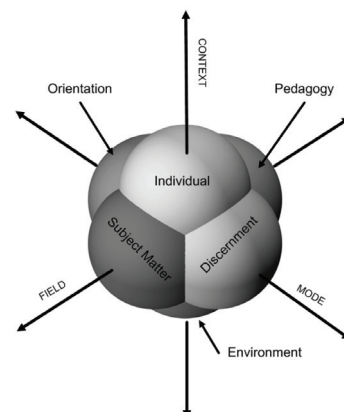
CFTK organizes teacher knowledge into a three-dimensional model, each dimension comprised of two aspects: Field, comprised of the aspects Subject Matter Knowledge and Pedagogical Knowledge; Mode, consisting of the aspects Discernment and Orientation; and Context, composed of the aspects Individual and Environment. This framework, depicted by the model in Figure 1, integrates multiple frameworks that address components of teacher knowledge to create an all-encompassing structure for studying and understanding the complex nature of knowledge required for the teaching profession (Ronau et al., 2009).

The first dimension of CFTK, Field, incorporates a broader scope and a more complex construct than simply the merging of pedagogy and subject matter as PCK (An, Kulm, & Wu, 2004; Davis & Simmt, 2003; Groth, 2007; Marks, 1990; Mishra & Koehler, 2006; Peressini, Borko, Romagnano, Knuth, & Willis, 2004; Wittmann, 1998; Zurita & Nussbaum, 2007). Instead, CFTK represents

PCK as only one possible interaction within teacher knowledge. Subject matter and pedagogy also interact with teacher knowledge of Mode and Context to better capture the complexity of interplay between all three dimensions.

The second dimension of CFTK, Mode, describes the knowledge teachers rely on as they are engaged in their teaching profession; that is, knowledge about what to teach, how to teach, the ways students learn, and ways for a classroom to meet the needs of every student. The Orientation and Discernment aspects characterize knowledge of Mode. *Orientation* describes the knowledge of beliefs, dispositions, values, goals, and other personal qualities that embody and define an individual's views and actions toward learning and teaching. Teachers access this knowledge to understand and manage the way all affective issues impact a learning situation. *Discernment*, on the other hand, illustrates the knowledge lens through which teachers understand the impact of the cognitive domain (e.g., reflection in action, reflection on action, on-the-spot decision making). The interaction of these two aspects creates a dynamic knowledge base with which teachers can effectively manage multiple internal influences on student learning.

Figure 1. CFTK framework of teacher knowledge as a three-dimensional structure



The third dimension of CFTK, Context, explains the knowledge teachers need of external factors that influence a learning situation. Two aspects of Context describe its sources: Individual and Environment. Contextual factors have a significant impact on the teaching and learning process, making knowledge of these factors essential to both teachers and researchers (for the importance of Context to teaching, see Bryk & Driscoll, 1998; Eraut, 1994; Felner et al., 1995, 2001; Scribner, 1999; for the importance of Context to research, see Cobb & Bowers, 1999; Datnow & Stringfield, 2000; diSessa & Cobb, 2004; Rossi & Stringfield, 1995a, 1995b; Stringfield, 1995; Teddlie & Stringfield, 1985; Wayman, Stringfield, & Yakimowski, 2004). *Individual* describes the knowledge of individual characteristics such as socioeconomic status (SES), gender, age, background, learning styles, and other contextual factors that impact an individual's approach to learning that teachers must understand and manage to be effective in a given learning situation. *Environment* describes knowledge on the impact of external factors on learning such as school climate, classroom climate, student teacher relationships, classroom organizational structures, school procedures, and other classroom, school, and community factors.

The understanding of learning contexts has evolved from simple considerations of individual characteristics and classroom environments to that of more all-encompassing, dynamic learning systems (Davis & Simmt, 2003; Davis & Sumara, 1997, 2001; Ding & Sherman, 2006). The interactions of the two aspects of Context with each other and with those of Field and Mode are able to more completely capture the complexity of learning under different demands and within a variety of situations.

Technology, Pedagogy, and Content Knowledge

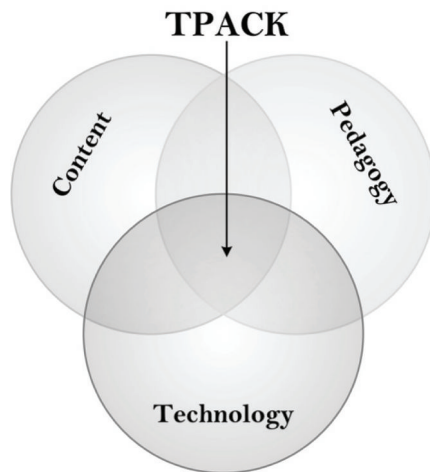
TPACK provides a basic framework for more research attention to specifically address the role

of technology in changing teacher behavior and in impacting student learning. TPACK is a response to the failure to actively integrate technologies in education during the 1980s and 1990s. During that period, many believed that increasing teacher awareness of the potential benefits of technology to learning would be enough to engender high levels of integration. Thus, teacher education programs were configured to provide teachers with opportunities to explore technology uses in the classroom. Yet, despite these educational supports, little active, meaningful, and continued integration of technology in learning environments occurred. With little evidence to suggest a reason for the lack of progress, multiple researchers began examining how teachers' understanding of technologies and PCK interact with one another to produce effective teaching with technology (Koehler & Mishra, 2008). Initially, the knowledge framework of Technological Pedagogical Content Knowledge (TPCK) was proposed as a complex interaction among three bodies of knowledge – technology, pedagogy, and subject matter content (Mishra & Koehler, 2006; Niess, 2005a). Late in 2007, TPCK was recast as TPACK, or the “total package” required for integrating technology, pedagogy, and content knowledge in the design of instruction for thinking and learning with technology; this recasting acknowledged the importance of the interactions between the individual constructs of the model technologies (Niess, 2007, 2008; Thompson & Mishra, 2007). Figure 2 shows the model used in visualizing this framework.

The TPACK framework provides a structure to guide research into the nature and development of teacher knowledge for teaching with technologies. Niess and colleagues (Niess, 2006; Niess, Lee, & Sadri, 2007; Niess et al., 2009) described teacher growth for technology integration in the classroom through five progressive stages:

1. **Recognizing (knowledge):** in which teachers are able to use the technology and recognize the alignment of the technology with

Figure 2. Venn diagram of TPACK as the intersection of content, pedagogy, and technology knowledge (adapted from Niess, 2008, p. 9)



subject matter content yet do not integrate the technology in the teaching and learning of subject matter.

2. **Accepting (persuasion):** in which teachers form a favorable or unfavorable attitude toward teaching and learning subject matter content with an appropriate technology.
3. **Adapting (decision):** in which teachers borrow from their prior experiences with the technology and implement the ideas in their classroom instruction, leading them to a choice to adopt or reject teaching and

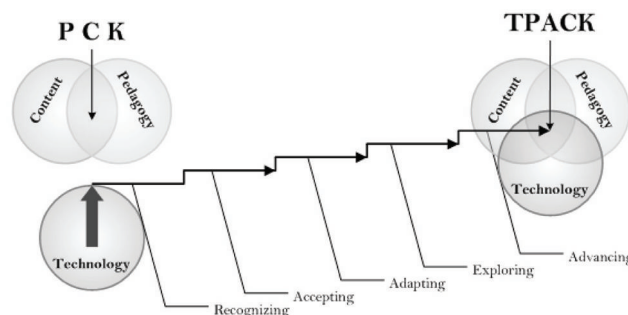
learning subject matter content with an appropriate technology.

4. **Exploring (implementation):** in which teachers actively integrate teaching and learning of subject matter content with an appropriate technology, designing their own ideas that allow more student-directed actions as they think about and plan their curriculum and instruction.
5. **Advancing (confirmation):** in which teachers make revisions in their curriculum as a result of the technology capabilities and evaluate the results of the decision to integrate teaching and learning subject matter content with an appropriate technology.

The Association of Mathematics Teacher Educator's (AMTE) Technology Committee then created a visual description for thinking about these TPACK levels as they began the process of drafting a TPACK framework for mathematics teachers (Niess et al., 2009). Figure 3 portrays the levels that teachers engage in as they expand their knowledge and understandings in ways that merge multiple knowledge bases - technology, content, and pedagogy.

On the left side of the graphic, the figure highlights PCK as the intersection of pedagogy and content. As the knowledge of technology expands and begins to intersect with pedagogical and content knowledge, the teacher knowledge

Figure 3. Model of teacher thinking and understanding as their knowledge develops toward the intersection identified as important by TPACK (from Niess et al., 2009, p. 7)



base described as TPACK emerges: This is a space in which teachers actively engage in guiding student learning of mathematics with appropriate technologies. The Committee's work in developing the framework considered the ideas provided by the National Educational Technology Standards for Teachers (NETS-T). These NETS-T standards were developed in 2002 and revised in 2008 by the International Society for Technology in Education (ISTE, 2008). The NETS-T standards were described for all teachers, regardless of content area. The Committee provided a content-specific view for mathematics teachers; Appendix A contains AMTE Board approved Mathematics TPACK framework.

Integrating the Frameworks

These two frameworks may seem to be competing images of the knowledge base teachers need for teaching with technology. However, a combination of the two frameworks may enhance our understanding of how technology integration and teacher knowledge interact in a learning environment. TPACK defines a framework that describes a series of levels for technology integration while CFTK provides insight into the teacher knowledge aspects and their interactions needed to implement the guidelines within that framework. For example, the first AMTE guideline for developing TPACK in the classroom, *Designing and developing digital-age learning environments and experiences - Teachers design and develop authentic learning environments and experiences incorporating appropriate digital-age tools and resources to maximize mathematical learning in Context* (Appendix A; Niess et al., 2009) requires more than just the knowledge of Subject Matter and Pedagogy, but also the knowledge of Orientation (for both teacher and student) and knowledge of individual and environmental contexts. In like fashion, the implementation of the second guideline (Teaching, Learning, and Curriculum) requires teacher knowledge best described by the

knowledge of content and pedagogy (i.e., Field), student orientations and cognitive dynamics (i.e., Mode), and group dynamics (i.e., Context) integrated into a single construct. In a similar way, meeting the third AMTE guideline (Assessment and Evaluation) also requires the interaction of all six aspects of CFTK, particularly with the alignment of assessment tasks and procedures with that of classroom activities and expectations. Finally, the fourth guideline (Productivity and Professional Practice) incorporates the "Professional Identity" interaction described in the CFTK model (Ronau et al., 2009), originally defined by Peressini et al. (2004) and others.

In addition to these guidelines, the identification of the five developmental levels within TPACK for integrating technology into the classroom aligns easily with the interactions of the CFTK aspects, providing a way to gauge the degree or sophistication with which individuals incorporate technology into their teaching and learning. Treating technology as an interaction in CFTK expands the notion of TPACK from the one-dimensional foundation of PCK to a three-dimensional base that includes six aspects of teacher knowledge. For example, in moving from the Recognizing to the Accepting levels of TPACK, the teacher must not only merge Pedagogical knowledge with Subject Matter Knowledge but in the process, allow them to interact. They must also begin to tap into knowledge of Orientation.

To move from Accepting to Adapting, more sophisticated knowledge of subject matter is needed to facilitate the recognition of the fundamental differences of conceptual versus procedural knowledge. More development of pedagogical knowledge is also needed in order to construct new assessments and recognize the value of these new assessments over the old, procedural-based assessments. To progress from Adapting to Exploring, teachers develop their knowledge of student orientations and personal orientations further, recognizing the benefits of enhancing curriculum with technology-based instruction. Concurrently,

the blending of subject matter and pedagogical knowledge continues through the Exploring stage. In order to begin exploring technology enhancements, teachers must also begin to tap into their knowledge of individual and environmental contexts. During the Exploring stage, teachers begin to mature in their understanding of the aspects of Field, and they begin to incorporate components of Mode and Context. As Exploring gives way to Advancing, the aspects of Mode and Context are further clarified and begin to interact. As teachers develop into higher levels of the Advancing TPACK stages, all six aspects of CFTK must be fully engaged and interacting.

The natural alignment between the TPACK and CFTK frameworks makes their integration uniquely capable of enabling researchers and practitioners to more fully understand the teacher knowledge required for the integration of technology into the classroom.

Methods

This study uses three frameworks (research design, CFTK, and TPACK) to interpret instructional technology research. We began by asking what types of research designs were used and how well the CFTK and TPACK models explained the teacher knowledge needed to integrate technology effectively in different content strands. To attend to these questions, we conducted a broad review of the research literature.

Study Inclusion Criteria

Three criteria were used to select the studies examined in this review: (1) Studies were found in scholarly, peer-reviewed journals, reports, dissertations, or conference proceedings, (2) Studies involved the use of technology in an educational setting, and (3) Studies focused on one of five specific fields (i.e., mathematics, science, career and technical education, language arts, or social studies).

Electronic Literature Search Strategy

In order to locate studies that met the criteria for this review, several electronic databases related to education and psychological sciences were searched. For mathematics, science, and career and technical education, these included the EBSCOhost databases: Academic Search Premier, Education Administration Abstracts, ERIC, Middle Search Plus, Psychology and Behavioral Sciences Collection, PsycINFO, Sociological Collection, and Teacher Reference Center; two H.W. Wilson databases: Education Full Text and the Social Sciences Index; JSTOR; five ProQuest databases: Career and Technical Education, Dissertations & Theses, Ethnic NewsWatch, GenderWatch, and Research Library; the IEEE Electronic Library; and three ISI Web of Knowledge databases: the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts and Humanities Citation Index. Because some databases are specific to the language arts, extra H.W. Wilson databases were included when searching for literature in that field: Art Abstracts, Art Retrospective, Essay & General Lit, Humanities Index, and Short Story Index. Due to the overlapping nature of some social studies and language arts journal indexing, these extra databases were also used for searching social studies publications.

Keywords varied for each content area and database. Basic search terms were used to begin searching keywords and subject indices in each database (e.g., language arts, technology, education, social studies, history, geography, science, mathematics, career and technical education). Each database uses different keywords and search terms, so for each search, the basic search terms were altered to maximize the number of results and their relevance. For example, EBSCOhost databases used the subject term "Career and Technical Education," whereas ProQuest used the term "Vocational Education" (see Appendix C for full list of search terms).

Random Sample

The literature search identified a population of journal articles, reports, dissertations, and conference papers dating from 1967 to 2009. For the remainder of this paper, the term “study” refers to any one of these categories. To ensure equal representation, a stratified random sample of approximately 30 studies was extracted from the population of each content area using random number generator software from Minitab Version 15 (see Table 1).

Sample Coding

The coding instrument was developed by the team at the University of Louisville (Appendix B). The developers then tested and revised the instrument and eventually distributed it to the coding team. The coding protocol for this instrument captured information about the study itself (e.g., author, year the paper was published or the study was carried out), type of research design where applicable (e.g., qualitative, quantitative, theory development, or practitioner resource), the type of technology being examined or described, the type of knowledge being described/developed by the study, and TPACK level(s) supported by the study.

To code the sample studies, we began by screening titles and abstracts for eligibility based on the study inclusion criteria, as previously described. For studies that met inclusion criteria, we recorded all applicable information on the coding instrument.

Studies identified with a quantitative research design were also coded as being either randomized or quasi-experimental. We also recorded their outcome measures, reliability measures, and validity measures as well as their selection mechanisms and use of measures to control pre-existing differences. Studies identified as qualitative, were coded by their research design (e.g., narrative/historical, biography, design study, phenomenology, ethnography, grounded theory, or case study), the methodology employed (e.g., covert/overt observation, interview, or focus group), alignment of the study methodology with outcome(s) of interest, and evidence of trustworthiness. For studies with the purpose of theory development, we recorded as much applicable information as possible and marked the rest as “not applicable.” In some fields, studies were intermingled with presentations of pedagogical strategies. These studies were not excluded if they were found in a peer-reviewed, scholarly journal. In these cases, the lack of research foundation was noted, and all other relevant information was coded.

Inter-rater reliability. In order to reduce the variation in coding decisions, we developed coding tables with closed response systems. Furthermore, coders began by examining exemplar studies with various research designs. Due to the expected variation across the five subject areas and the low degree of commonalities, we chose to rely on coordinated discussions with each coder to maintain uniformity of decisions. These discussions centered on difficulties deciding how a particular study’s characteristics fit into the coding rubrics, mostly resulting from the emergent nature of the

Table 1. Stratified random sample of studies

Subject Matter	Number of Published Papers	Final Sample Size
Mathematics	309	30
Science	335	29
Career and Technical Education	497	28
Language Arts	179	30
Social Studies	465	28
Total	1785	145

coding process (Patton, 2002). For example, every coder encountered a surprising number of papers that did not report research findings. We decided to add a non-research category to the coding results to fully report those findings. Another example of the evolving nature of this review surfaced as the types of qualitative inquiry from each content area were cross-checked. Specifically, the mathematics sample contained no narrative methodology studies, but the social studies and language arts fields did. Therefore, the mathematics sample was re-examined through that lens to ensure uniformity across the five content areas.

RESULTS

Summary of the Literature

Coders noted the distinctly low percentage of literature in scholarly, peer-reviewed journals actually dedicated to the presentation of research findings: 46% in career and technical education,

29% in social studies, 31% in science, 23% in language arts, 44% in mathematics, and 34% across all five subject matter areas (see Table 2). Of the non-research articles, 41% provided anecdotal descriptions of specific strategies used in classrooms for integrating technology. Only 20% of the non-empirical articles were dedicated to the development of theoretical models based on prior research. A few scholarly articles only offered opinions (9%). In Table 2 and in the descriptions that follow, studies may be counted more than once in the subcategories, so the totals in the subcategories may be greater than the number of studies in that category. For example, in the mathematics area, the 10 qualitative studies register as 12 subcategories.

Career and Technical Education (CTE). CTE research carried a distinctly international flavor. Studies included the use of email and discussion groups by rural farmers in Australia (Mulcahy, 1998), the introduction of Information and Communication Technology (ICT) into all of the schools in Estonia (Toots & Lanpere, 2004), the

Table 2. Breakdown of research designs

Research designs	Career & Technical Education	Social Studies	Science	Language Arts	Mathematics	Total ^b
Quantitative	2	0	4	0	5	11
Mixed Methods	0	1	2	1	0	4
Qualitative Overall ^a	10	7	3	5	10	35
Narrative/Historical	0	2	0	0	0	2
Case Study	2	3	1	0	2	14
Multi-Case Study	0	0	0	0	2	2
Ethnography	1	1	0	0	0	2
Action Research	0	0	1	0	1	2
Survey	3	1	0	1	0	5
Interview	1	0	2	4	0	7
Focus Groups	2	0	0	1	0	3
Observation	1	0	1	2	0	4
Non-Research	16	20	20	24	15	95
Theory Development	3	5	3	3	5	19
Instructional Strategy Description	2	7	6	3	6	24
Anecdotal Description	4	7	11	14	3	39
Book Review/Article Commentary	3	0	0	0	1	4
Opinion Papers	4	1	0	4	0	9
^a Some studies used more than one method, so sub-scores may not add up to the overall number of studies using qualitative design. ^b N = 145.						

introduction of interactive whiteboards into African schools (Slay, Siebörger, & Hodgkinson-Williams, 2008), and the use of on-line discussion groups (De Smet, Van Keer, & Valcke, 2008; Steinkuehler & Duncan, 2008). These studies focused primarily on upper middle grades through adult education. Of the 28 studies in this sample, 57% were categorized as non-research, 36% qualitative, 7% were quantitative, and 0% were mixed methods (see Table 2). The non-research papers were mostly composed of anecdotal description (25%), opinion papers (25%), and theory development (19%).

Social Studies. The social studies sample also included an international scope. For example, in the United Kingdom (UK), studies have explored the impact and potential of web-based technologies (Fernandez-Cardenas, 2008; Richards & Wrigley, 1996; Selwyn, 2007); in Canada, researchers have viewed information technology as a vector for enhancing collaborative learning (Reed & Mitchell, 2001); in Japan, the use of geographic information systems has evolved far enough to be considered a distinct field (Sasaki, Oguchi, Okabe, & Sadahiro, 2008).

Approximately 33% of the sample literature of technology in social studies focused on the learning of history, 23.3% on bridging theory and practice, 20% on the learning of geography, 16.7% on the understanding of culture, and 6.7% on teacher education. These percentages indicated a potential gap in the area of teacher education and over-representation of practice related pieces.

These practice-related pieces often provided the description of one or two technology products and described how they could be applied in educational settings (e.g., Bodson, 2008; Lynch et al., 2008). These articles advocated for the versatility that was possible through technology for teaching geography, although the authors often failed to provide specific illustrative examples that would move the discussion about technology innovations forward. One promising work described the use of computer simulations as a tool for replicating

real-life phenomenon through the exploration of visual interactions within artificial societies (Berson & Berson, 2007). Such models may hold the potential to assist students understanding of the complex dynamics that influence how societies evolve and adjust.

The paucity of research publications in social studies obscured potential trends in research design and methodology. The majority of this sample reported using qualitative methodologies (88%), primarily depending on interviews (e.g., Hess, 2007) and to a lesser extent, observations as the primary data collection tools. Ethnographic methods were also used to explore the communicative acts in the collaborative creation of web pages (e.g., Fernandez-Cardenal, 2008). Case studies using the class as the unit of analysis were also found (e.g., Reed & Mitchell, 2001), though some studies involved multiple sections of specific courses at different universities. Surveys were employed in several studies (e.g., Longhurst, 2003); however, the method of analysis varied widely, from the use of simple descriptive statistics to more sophisticated inferential techniques. Several studies offered ideas on a research agenda for the field (e.g., Defazio, 2006; Ely, 2008), lending support to the belief that current literature lacks the ability to link instructional theory to practice.

The 28 studies in the social studies sample were categorized as 71% non-research, 25% qualitative, 4% mixed methods, and 0% quantitative (see Table 2). The 20 non-research papers were mostly composed of instructional strategies (35%), anecdotal description (35%), theory development (19%), and opinion papers (5%).

Science. The science sample included studies from multiple fields of science education (e.g., middle school science, high school science, computer science education, and first-year engineering learning communities). These studies varied widely in focus. For example, Lawrence (2000) developed a framework for curriculum development in science education using apprenticeship activities with high school students.

Bowman, Koirala, and Edmonds (2000), on the other hand, investigated how one teacher altered her pedagogy to include graphing calculators. Boulet, Boudreault, and Guerette (1997) compared the effects of distance education versus the traditional classroom in computer science education and found a slight advantage for distance over traditional education. Jenkins (2006) reported on the attitudes of students in England toward their secondary school science education. Min (2005) examined the effect of a hypermedia-enhanced problem-based learning environment in astronomy on sixth-graders' science knowledge, attitudes toward learning science with technology, and motivation toward learning. The 29 studies in the science sample were categorized as 69% non-research, 14% quantitative, 10% qualitative, and 7% mixed methods (see Table 2). The 20 non-research papers included anecdotal description (55%), instructional strategies (30%), and theory development (15%).

Language arts. A review of the literature in language arts revealed that many of these studies also did not present research findings. These studies discussed the integration of technology through multiple tools and strategies (e.g., interactive whiteboards, computer-assisted instruction, computer-assisted discussions, computer-aided peer review, use of the internet, multimedia presentation of museum education, and digital technology to enhance literacy).

The six studies reporting research findings represented three distinct types of inquiry: (1) investigating teachers' perception of the use of case methodology for instruction in a graduate level course (Baker, 2005; Gray, 2001); (2) examining the nature of English language arts teachers' learning during technology professional development activities and the impact on their later technology-supported pedagogy (Hughes, 2005); and, (3) studying language arts teachers from the United States, Canada, and Australia and their use of literature-based collaborative Internet projects in their elementary classrooms

(Karchmer-Klein & Layton, 2006; Malloy & Gambrell, 2006; Siegel, 2006).

The 30 studies in the language arts sample were categorized as 80% non-research, 17% qualitative, 3% mixed methods, and 0% quantitative (see Table 2). The non-research papers were mostly composed of anecdotal descriptions of experiences with technology use in the classroom (58%), followed by opinion pieces (16.7%), theory development (13%), and instructional strategies (13%).

Mathematics. The mathematics sample studies investigated and discussed a wide variety of technology (e.g., computers, computer software, online courses and course materials and grading, web-based learning environments, multimedia, and interactive whiteboards) with over half of the studies focusing on computers and the Internet. With the emergence of new web-based technologies and the rise of java- and flash-based applications (i.e., virtual manipulatives as in Cavanaugh et al., 2008; Suh & Moyer, 2007), this new emphasis caused little surprise or concern. However, we also expected that the large number of debates surrounding the effectiveness of calculators and graphing calculators (e.g., Ellington, 2003, 2006) would have resulted in another cluster of studies reporting such research. In this sample, none of the articles discussed the use of calculators in the classroom. Although the absence of such research in the sample does not translate into a complete absence of the topic from the greater population of studies, it does raise a concern about a potential weak point or gap in the mathematics research literature.

Finally, in three studies, approximately 10% of the sample, methodology was either not addressed or lacked sampling information such as sample sizes (Hayes & Mayerick, 2001; O'Connell & Phye, 2005; Zucker, Tinker, Staudt, Mansfield, & Metcalf, 2008). Other reviews have called for better reporting of standard information such as methodology, sample sizes, and standard deviations (e.g., McCoy, 1998; Mervielde, 1977; Nowak, 1969; Triandis, 1976). In light of these

calls, we concluded that these studies may be indicative of a general weakness in the research literature. So, not only are there gaps in the existing literature, but the studies that have been completed in this area may be limited by their design and the information they provide. As a result, educators are left to evaluate the effectiveness of some types of instructional technology on their own without a dependable research foundation.

We identified 50% of the 30 mathematics sample studies as non-research, 33% as qualitative, 17% as quantitative, and 0% as mixed methods (see Table 2). The non-research papers were mostly composed of instructional strategies (40%), followed by theory development (33%), anecdotal description (20%), and book reviews (7%).

RESEARCH DESIGNS

An examination of research designs revealed an imbalance across all five subject areas. Quantitative designs accounted for only 22% of all studies; mixed methodology was only 8%, and qualitative designs accounted for the remaining 70% (see Table 2). These research methodologies represent fundamentally different beliefs. Quantitative methodology, seeks to capture the essence of reality, setting the researcher as a dispassionate, objective observer. In this methodology, controls are set in place to isolate causal factors in a system (Hewitt, 2006). Qualitative methodology, on the other hand, recognizes the need to understand the unquantifiable factors that influence the way people behave in different settings. Postmodernist, constructionist, and advocacy researchers tend to gravitate toward these methodologies (Cresswell, 2007; Patton, 2002). Rather than attempting to create generalizability or lay claim to causal inference, qualitative inquiry seeks to understand why something happens in a particular setting. In both cases, the research question should drive the methodology rather than the reverse (Tashakkori & Teddlie, 1998). Researchers need to be well-

versed in both types of methodology so that the types of questions they can ask are not limited by methodological concerns.

Alternatively, pragmatists choose whatever methodologies fit the question, taking advantage of the power of both quantitative and qualitative methodology (Cresswell, 2007; Patton, 2002). Tashakkori and Teddlie (1998) and Datta (1994) described several practical reasons for using mixed methodology (historical use of both quantitative and qualitative methods, support of research community and funding agencies for both methods, the influence of both methods on educational policy, and the demonstrable effectiveness of both methods). Shadish (1995) also made a case for the complementary nature of quantitative and qualitative methods. With such important advantages to mixed methodology, its low representation in every subject matter reveals a significant weakness in educational technology research.

TEACHER KNOWLEDGE

We used the CFTK framework to identify aspects of teacher knowledge in technology studies across the five fields. Of the 145 studies, 48 addressed teacher knowledge in some manner (see Table 3). Only eight of the 48 addressed knowledge of Individual Context. In fact, the samples for language arts and science failed to address Individual Context at all. Surprisingly, only one third addressed knowledge of Subject Matter. Finally, less than one third included knowledge of Discernment.

Individual Context represents the aspect of knowledge related to understanding the way student characteristics affect a learning situation. Distinct from the internal factors of Orientation (e.g., beliefs, affect, efficacy), these Contextual factors (e.g., gender, culture) may influence the way students react to cooperative learning, mastery learning, and peer tutoring or to technology or the Subject Matter (Ronau et al., 2009). Because technology tools often rely heavily on each of

Table 3. Aspects of teacher knowledge addressed

CFTK Aspects	Career & Technical Education	Social Studies	Science	Language Arts	Mathematics	Total
Subject Matter	2	5	1	1	7	16
Pedagogical Knowledge	3	6	5	4	13	31
Orientation	2	6	4	4	10	26
Discernment	3	4	1	3	3	14
Individual Context	1	2	0	0	5	8
Environmental Context	5	6	7	4	7	29
Total Number Relevant	11	8	9	5	15	48
Note. Some studies addressed more than one aspect, so aspect numbers may not add up to the overall number of relevant studies.						

these strategies, the lack of research to address the effect teacher knowledge of contextual differences limits the ability of that research to adequately address the needs of educators wishing to integrate technology effectively.

STAGES OF TECHNOLOGY INTEGRATION

Table 4 reveals a large imbalance in the number of studies across each subject matter area addressing the stages of TPACK favoring the mathematics field. Because TPACK has been more actively pursued in the mathematics field, it came as no surprise to see that this field demonstrated a more comprehensive examination of each stage of tech-

nology integration, accounting for a minimum of 60% of all studies addressing any particular aspect.

Although 65% of the sample studies addressed pedagogical knowledge, very few studies addressed TPACK stages of integrating technology, explicitly or implicitly, in any area besides mathematics. By blending CFTK and TPACK developmental views, a new understanding of instructional technology emerges: Pedagogical knowledge alone will not ensure effective technology integration. Tankersley, Landrum, and Cook (2004) suggested that one reason teachers fail to make instructional changes may be a lack of support. In the case of instructional technology, support may simply mean providing access to technology tools. It may also include professional development that familiarizes teachers with the TPACK

Table 4. TPACK stages addressed

TPACK Stages	Career & Technical Education	Social Studies	Science	Language Arts	Mathematics	Total
Recognizing	4	7	3	3	21	38
Accepting	4	4	0	3	21	32
Adapting	4	2	5	3	21	35
Exploring	1	0	0	2	17	20
Advancing	0	0	1	3	18	22
Total Number of Studies	5	8	9	5	25	53
Note. Some studies addressed more than one stage of TPACK, so studies addressing a particular stage may not add up to the total number of studies addressing TPACK.						

framework and methods of integrating technology into instruction.

DISCUSSION

This chapter endeavored to provide a systematic review of the literature about instructional technology. The authors hope that this information increases the ease with which teacher educators can synthesize research findings to integrate the most effective instructional technology tools into their courses. We also hope that the three frameworks presented here inform future instructional technology studies regarding the needs of the research community and educators. To summarize, we consider the limitations of this review along with the findings and the utility of our three research lenses: research design, teacher knowledge, and technology integration. We conclude with some final recommendations.

LIMITATIONS

The subjective nature of much of the coding constituted the greatest limitation to this study. Although great effort was made to coordinate responses through the use of coding tables and discussions for each ambiguous decision, some variability was unavoidable. However, we did attempt to ensure a systematic process through coordinating discussions to increase the possibility of replication and verification.

A second limitation arose from the use of a single random sample from each subject area. The randomization process is the most robust way to ensure representativeness and lack of sampling bias (Shadish, Cook, & Campbell, 2002), and each subject area had a large enough sample size to achieve sufficient power to realize that representativeness. However, multiple samples could have been used to cross-validate our findings.

The new design of using the CFTK and TPACK models together as a lens for examining research designs created a third limitation to this study. With the relatively new nature of each framework (TPACK from Niess, 2005a, 2008; CFTK from Ronau et al., 2009), a certain degree of misalignment between the vocabulary of the sample studies and the frameworks was inevitable.

FINDINGS

The use of the research design lens revealed a surprisingly low percentage (34%) of research studies. Of these research studies, qualitative research designs constituted a disproportionate amount of the methodology types (70%). Mixed methodology, on the other hand, was nearly nonexistent (8%). Finally, rather than an even 20% for each field, the breakdown of studies indicated an imbalance in the number of papers on instructional technology across the fields (mathematics, 17%; science, 19%; CTE, 28%; language arts, 10%; and social studies, 26%), highlighting a lack of focus on language arts technology education.

THE RESEARCH LENSES

As a byproduct of the review, we also considered the degree to which the lenses of research design, teacher knowledge, and technology integration interacted to contribute to understanding of the depth, scope, and balance of the available research in educational technology. The research design lens allowed us to compare published papers and study methodologies. The CFTK lens contributed an understanding of the types of teacher knowledge addressed by the sample literature. The TPACK lens offered insight into the way papers addressed technology integration in education. Taken together, these three frameworks revealed significant bias toward the use of certain designs, aspects of teacher knowledge, and only moderate

levels of technology integration. Broad research interests and findings exist; however, the large percentages of anecdotal descriptions and opinion papers disguise the lower number of research reports and theoretical models. The continuation of such a trend only hinders the ease with which teacher educators and researchers can integrate existing theory into practice.

RECOMMENDATIONS

The results of this study indicated that 65% of the sample studies on educational technology did not actually report research, and 70% of the research studies employed qualitative designs. This finding does not address the relative value of qualitative or quantitative studies or of research versus non-research studies: All of these designs have the potential of being valuable for understanding the role and impact of technology in education. On the other hand, if the assumption is that all of these study types are of equivalent value, then a reasonable conclusion would be a call for a balance among these designs in order to provide a broader lens to increase the understanding of educational technology. Currently, the evidence suggests that an imbalance exists in our research data that is biased toward non-research papers and qualitative designs among the research studies. Furthermore, as Whitehurst (2002) suggested, all types of evidence are not equal; their value to compare, evaluate, and monitor progress of the target of study forms a hierarchy of evidence or of study designs that are ranked from 1 (high value) to 6 (low value): (1) randomized trial (true experiment), (2) comparison groups (quasi-experiment), (3) pre-post comparison, (4) correlational studies, (5) case studies, and (6) anecdotes. Using his hierarchy as a lens, we see from the present study that the trend in educational technology study designs is to emphasize these methodologies in reverse order. Therefore, we recommend that the

educational community work toward a balance of evidence quality.

One way to address this imbalance is to use more mixed methodology designs. Tashakkori & Teddlie (1998) rejected the notion that qualitative and quantitative research designs are opposing sides of a long-standing argument; instead, they adopted a pragmatic viewpoint that uses each as a complementary tool to answer the complex educational questions that researchers are being challenged to answer today. They developed mixed methodology models that structurally employ both qualitative and quantitative designs at various stages of a research project. Only four papers out of the 145 papers analyzed in this chapter contained mixed methodology reports. As the research community strives toward balance in research design, mixed methodology should become a predominant design.

Further use of the CFTK and TPACK frameworks combined with a consideration for design and methodology may also help increase balance in educational technology research. TPACK offers a balance of developmental levels of technology integration by providing a structure for focus and scale, whereas CFTK contributes balances six different aspects of teacher knowledge. Taken together, educators have a robust tool for analyzing the effectiveness of instructional technology methods and bringing the best tools to the classroom.

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APPENDIX A

American Mathematics Teacher Educators Association Guidelines for Implementing the TPACK Framework (Adopted June 19, 2009)

I. Design and develop technology-enhanced mathematics learning environments and experiences.

Educators use their knowledge of technology, pedagogy, and content to design and develop learning environments and experiences to maximize mathematics learning. They:

- a. Establish and utilize mathematical environments, tasks, experiences and resources to integrate technology tools that support learners' individual and collaborative mathematical learning and creativity;
- b. Design challenging and engaging mathematical learning experiences that utilize appropriate technologies to support the diverse needs of learners; and
- c. Identify and utilize strategies and activities that promote equitable access to and facility with technology resources.

II. Facilitate mathematics instruction with technology as an integrated tool. Educators implement curricular plans that integrate appropriate technology to maximize mathematical learning and creativity. They:

- a. Incorporate knowledge of learner characteristics, orientation, and thinking to foster learning of mathematics with technology;
- b. Facilitate technology-enriched, mathematical experiences that foster creativity, develop conceptual understanding, and cultivate higher order thinking skills;
- c. Promote mathematical discourse between and among instructors and learners in a technology-enriched learning community;
- d. Use technology to support learner-centered strategies that address the diverse needs of all learners of mathematics; and
- e. Encourage learners to become responsible for and reflect upon their own technology-enriched mathematics learning.

III. Assess and evaluate technology-enriched mathematics teaching and learning. Educators assess and evaluate mathematics teaching and learning using appropriate assessment tools and strategies. They:

- a. Assess learning of mathematics applying technologies when appropriate, reflect upon the assessment results, and communicate those results using a variety of tools and techniques;
- b. Assess learners' appropriate and ethical use of technology resources in learning and communicating mathematics;
- c. Use formative assessment of technology-enriched lessons and activities to evaluate mathematics learning and adjust instructional strategies accordingly;

- d. Align the technology expectations for assessment tasks and practices with that of mathematics instructional activities; and
- e. Evaluate and reflect on the effective use of existing and emerging technologies to enhance the mathematical learning of all.

IV. Engage in ongoing professional development to enhance technological pedagogical content knowledge. Educators seek, identify, and use technology to enhance their knowledge, productivity, and professional practice. They:

- a. Collaborate with others in ongoing professional activities to promote excellence in learning mathematics in technology-enriched environments;
- b. Promote social justice for access to and facility with technology in learning mathematics;
- c. Advocate, model, and promote safe, legal, and ethical use of technology for learning and exploring mathematics with learners, families and caregivers, and colleagues;
- d. Communicate and collaborate with families and caregivers, colleagues, and the larger community using appropriate technologies in order to nurture mathematical learners; and
- e. Exhibit leadership by demonstrating a research-based vision for integrating technology in teaching mathematics.

Appendix B

Coding instrument

Report Characteristics	Description
Author(s)	
Year	
Title	
1. Journal	
2. Volume	
3. Pages	
4. Content Area	
5. Content Topic	
6. Grade Level	
7. Description of Technology Tool:	
8. Description of the Outcome of Interest (Mark all that apply)	a) Student Achievement b) Teacher Knowledge c) Teacher Orientation d) Student Orientation e) Knowledge Transfer f) Other _____ g) Can't Tell

Appendix B continued

Report Characteristics	Description
9. Was the study population well described?	a) Yes b) No c) Can't Tell
10. Did the authors specify the sampling frame or universe of selection for the study population?	a) Yes b) No c) Can't Tell
11. Were the exposure variables valid measures of the intervention under study?	a) Yes b) No c) Can't Tell
12. Were the outcome and other independent (or predictor) variables reliable (consistent and reproducible) measures of the outcome of interest?	a) Yes b) No c) Can't Tell
13. Did the authors conduct appropriate analysis by conducting statistical testing (where appropriate)?	a) Yes b) No c) Can't Tell d) Not appropriate for this study e) Explain: _____
14. Did at least 80% of enrolled participants complete the study?	a) Yes b) No c) Can't Tell
15. Did the authors correct for controllable variables or institute study procedures to limit bias appropriately?	a) Yes b) No c) Can't Tell
16. Describe all potential biases or unmeasured/contextual confounders described by the authors.	
17. Other important limitations of the study not identified elsewhere?	
18. CFTK Aspects Explicitly Addressed for teachers	a) Subject Matter b) Pedagogical Knowledge c) Orientation d) Discernment e) Individual Context f) Environmental Context g) Can't Tell
19. CFTK Aspects Explicitly addressed for students	a) Subject Matter b) Pedagogical Knowledge c) Orientation d) Discernment e) Individual Context f) Environmental Context g) Can't Tell
20. TPACK Stages described (teachers only)	a) Recognizing b) Accepting c) Adapting d) Exploring e) Advancing f) Can't Tell
21. What type of research does this study conduct?	a) Quantitative b) Qualitative c) Theory Development/Literature Driven d) Other _____

continued on following page

Appendix B continued

Report Characteristics	Description
For Quantitative Studies	
22. Research design	a) Randomized experiment b) Non-equivalent control group c) Other _____ d) Can't tell
23. Group assignment mechanism	a) Random assignment b) Haphazard assignment c) Other nonrandom assignment d) Can't tell
24. Selection mechanism	a) Self-selected into groups b) Selected into groups by others on a basis related to outcome (e.g., good readers placed in the expectancy group) c) Selected into groups by others not known to be related to outcome (e.g., randomized experiment) d) Can't tell
25. Equating variables	a) None b) Prior achievement c) Other _____ d) Can't tell
26. If equating was done, was it done using a statistical process (e.g., ANCOVA, weighting) or manually (e.g., hand matching)?	a) n/a, equating was not done b) Statistically c) Manual matching
27. Sample Sizes	
28. Achievement measure used in study	a) Researcher Designed Assessment b) Teacher Made Assessment c) Standardized Assessment d) Other _____ e) Can't tell _____
29. Score reliability for achievement measure (note: if a range is given, code the median value)	
30. Metric for score reliability	a) Internal consistency b) Split-half c) Test-retest d) Can't tell e) None given
31. Source of score reliability estimate	a) Current sample b) Citation from another study c) Can't tell d) None given
32. Is the validity of the achievement measure mentioned?	a) No b) Yes
33. If yes, was a specific validity estimate given?	a) No b) Yes
34. If yes, what was the estimate?	
35. If a validity estimate was given in the report, what was the source of the estimate?	a) Current sample b) Citation from another study c) Can't tell d) n/a, validity was not mentioned in the report

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Appendix B continued

Report Characteristics	Description
36. What was the nature of the validity estimate?	a) Concurrent validity b) Convergent validity c) Predictive validity d) Other e) Can't tell (e.g., simply asserted that the measure is "valid") f) n/a, validity was not mentioned in the report
For Qualitative Studies	
37. Type of Study	a) Narrative/Historical b) Biography c) Design Study d) Phenomenology e) Ethnography f) Grounded theory g) Case Study
38. Describe the methodology. (Mark all that apply)	a) Covert Observation b) Overt Observation c) Interview d) Focus Group e) Other _____ f) Can't Tell
39. Was there alignment between the nature of the data collected and the questions posed?	a) No Describe Issue: b) Yes Summarize: c) Can't Tell
40. Did the author proceed systematically (with the logic of decisions addressed)?	a) No b) Yes c) Can't tell
41. Was trustworthiness addressed?	a) No b) Yes Describe: 1) Persistent observation 2) Use of triangulation techniques 3) Peer debriefing 4) Negative case analysis 5) Referential adequacy 6) Member checks 7) Thick description 8) Dependability audit 9) Confirmability audit 10) Reflexive journal c) Can't tell
42. Any gaps in the coherence of the methodology?	a) No b) Yes Describe: c) Can't Tell

Appendix C

Subject terms used in literature search

Databases	Career & Technical Education	Social Studies	Science	Language Arts	Mathematics
EBSCOhost	CTE or "Career and Technical Education" or "Career Education" or "Technical Education" or "Workforce Education" or "Adult Education" or "Agriculture" or "Information Technology" or "Health Science" or "Human Services" or "Communications" or "Construction" or "Manufacturing" or "Public Services" or "Transportation" or "Business Education" or "Marketing Education" and "Educational Technology" or "High Technology & Education"	Technology, Education, and ("Social Studies" or "History" or "Geography" or "Political Science" or "Politics")	(Technology or "Educational Technology") and Education and (Science or "Science-Study & Teaching")	Technology And (Education or "Educational Technology") and ("Language Arts" or "Reading" or "Writing")	(Technology or "Educational Technology") and Education and Math
ProQuest	(Vocational Education or Vocational Schools or Vocational Training or Workforce Planning or Information Technology or Agriculture or Agriculture Teachers) and (Technology or Technology Assessment or Technology Education or Technology Standards or Technology Transfer or Technology Acquisition or Technology Adoption or Educational Technology) and (Education or Education & Schools or Education Discrimination or Education For All Handicapped Children Act 1975-Us or Education History or Education Philosophy)	(Social Studies or Social Studies Education or History or History Education or Geography or Political Science) and (Education or Education & Schools or Education and Schools or Education Discrimination or Education For All Handicapped Children Act 1975-Us or Education History or Education Philosophy) and (Technology or Technology Assessment or Technology Education or Technology Standards or Technology Transfer or Technology Acquisition or Technology Adoption or Educational Technology)	(Science or Science Activities or Science Centers or Science Education or Science Fairs) and (Science & Technology Policy or Science and Technology or Technology Assessment or Technology Education or Technology Standards or Technology Transfer or Technology Acquisition or Technology Adoption or Educational Technology) and (Education or Education & Schools or Education Discrimination or Education For All Handicapped Children Act 1975-Us or Education History or Education Philosophy)	(Language Arts and Education or Education & Schools or Education and Schools or Education Discrimination or Education For All Handicapped Children Act 1975-Us or Education History or Education Philosophy) and (Technology or Technology Assessment or Technology Education or Technology Standards or Technology Transfer or Technology Acquisition or Technology Adoption or Educational Technology)	(Mathematics or Mathematics Ability or Mathematics Education or Mathematics Teachers or Mathematical Programming) and (Science & Technology Policy or Science and Technology or Technology or Technology Assessment or Technology Education or Technology Standards or Technology Transfer or Technology Acquisition or Educational Technology Adoption or Educational Technology) and (Education or Education & Schools or Education and Schools or Education Discrimination or Education For All Handicapped Children Act 1975-Us or Education History or Education Philosophy)

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Appendix C continued

Databases	Career & Technical Education	Social Studies	Science	Language Arts	Mathematics
JSTOR	((Education and (Science) and (Technology))) and ("Educational Technology")	((Education and ("Social Studies" or "History" or "Geography" or "Political Science")) and (Technology))) and ("Educational Technology")	Education and (Science) and (Technology)	((Education and ("Language Arts" and (Technology))) and ("Educational Technology"))	((Education and (Math) and (Technology)))
IEEE Explore	Education and Mathematics and (Technology or "Educational Technology")	("Education" and ("Social Studies" or "History" or "Geography" or "Political Science")) and (Technology or "Educational Technology")	("Education" and Science and (Technology or "Educational Technology"))	("Language Arts" and "Education" and (Technology or "Educational Technology"))	Education and Mathematics and (Technology or "Educational Technology")
H.W. Wilson	Education and (Technology or "Educational Technology") and "Educational Technology / Use" or "Educational Technology / Teacher Education" and Mathematics or "Mathematics Education"	(Technology or "Educational Technology") and ("Social Studies" or "History" or "Geography" or "Political Science")	Education and (Technology or "Educational Technology") and "Educational Technology / Use" or "Educational Technology / Teacher Education" and Science or "Science Education"	Education and Technology and "Language Arts"	Education and (Technology or "Educational Technology") and "Educational Technology / Use" or "Educational Technology / Teacher Education" and Mathematics or "Mathematics Education"

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Chapter 8.3

Emerging Edtech: Expert Perspectives and Design Principles

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ABSTRACT

Design principles are universal and may be translated onto the newest trends and emergent technologies. In this research study, the authors combined the perspectives provided by two sources to create a set of recommended design principles for technology-enhanced learning environments. One source was the *How People Learn* framework (Bransford, Brown, & Cocking, 2000). The second source was a series of interviews conducted with pacesetters in the field of educational technologies. With the knowledge gained from these two sources, the authors created our own set of design principles. These principles may be used to guide evaluation, instructional design efforts, or best

practice models for exemplary use of educational technologies in the classroom.

INTRODUCTION

Hundreds of millions of dollars have been spent in recent years to improve and maintain technology infrastructure for schools. Now policymakers and the public want to know what impact this technology has had on student learning. To answer that question, states and school districts need parameters for evaluating their technology-related activities and using the data to guide their decision making. However, researchers have cautioned against drawing inappropriate cause-and-effect conclusions based on experimental studies (Olson & Wisher, 2002; Russell, 2001). What scientific

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cally based evidence is available on the impact of educational technology often is focused on the degree to which a particular technology leads to changes in learning or teaching (Lawless & Pellegrino, 2007). In fact, a better way of judging the impact of new technologies is to examine how they are used and the context in which the use occurs (Schifter, 2008; Zhao, Byers, Pugh, & Sheldon, 2001).

Instructional designers and researchers have stressed the need for robust design principles to guide the production of products and programs (e.g., Kali, 2006; Kali, Spitulnik, & Linn, 2004; Underwood et al., 2005). In this research we also chose to emphasize design principles because they are universal, and they translate to the newest trends and emergent technologies. To do so, we set out to combine the latest research perspectives with the most current leadership perspectives. We began by summarizing key perspectives of the How People Learn (HPL) framework for learning environments. The HPL framework is widely respected and provides recommendations that can be applied to the design of technology-enhanced learning environments. We interviewed pacesetters in educational technologies and reported emerging themes based on the thoughts of those pacesetters. These sources provided the foundation for creating our own set of recommended design principles for technology-enhanced learning environments. This approach combined the best of the past with fresh perspectives from the present.

IMPORTANT PRINCIPLES ABOUT LEARNING AND TEACHING

The National Academy of Sciences *How People Learn* book synthesized decades of research on how people learn to develop a framework for understanding the connections between cognition and instruction (Bransford, Brown, & Cocking, 2000). This report is widely embraced as a seminal work for educators and researchers alike. In fact,

How People Learn (HPL) is becoming widely accepted as a theoretical framework, and that is how we use it here. That work provided the theoretical foundation for designing and conducting the interview study of the pacesetters.

Although the HPL framework provides many important teaching and learning implications, we highlight four of the principles that have particular importance in the design of technology-enhanced learning environments. Each has a solid research base as well as important implications for how teachers teach. Each principle also helps designers think about technology's role in the design and delivery of effective learning environments.

One important principle about the way people learn is that “students come to the classroom with preconceptions about how the world works” (Bransford et al., 2000, p. 14), which include beliefs and prior knowledge acquired through various experiences (e.g., Lin, 2001; Pressley et al., 1992). This learning principle suggests that students start to make sense of the world at a very young age. In many cases students already hold multiple conflicting views before learning new information, as a result, they create their repertoire of views without reflecting on their existing knowledge. This principle implies that designers of effective technology-enhanced learning or instruction should build on students' preconceptions and learning styles, allow decision making, and foster students' multiple intelligences.

Another HPL principle is that “to develop competence in an area of inquiry, students must have a deep foundation of factual knowledge, understand facts and ideas in the context of a conceptual framework, and organize knowledge in ways that facilitate retrieval and application” (Bransford et al., 2000, p. 16). Numerous studies comparing performance by experts and novices have shown that experts not only obtain richly structured knowledge bases that allow them to plan a task, notice patterns, generate reasonable arguments, and draw analogies to other problems,

but they also exhibit more organized conceptual frameworks that allow for greater transfer.

This learning principle suggests effective learning environments are knowledge centered and based on developing richly structured information foundations. Instructional designers should center the learning environment on what is taught, why it is taught, and what competence or mastery looks like.

A third principle from the HPL framework is that “a metacognitive approach to instruction can help students take control of their own learning by defining goals and monitoring their progress in achieving them” (Bransford et al., 2000, p. 18). Most educators agree that metacognition is one of the most important cognitive skills among intelligent human activities. Good teachers provide the time, space, and materials necessary to promote metacognitive skills such as self-regulated learning. Reciprocal teaching, for example, is a technique designed to improve students’ reading comprehension by helping them explicate, elaborate, and monitor their understanding as they read (Palinscar & Brown, 1984). This learning principle suggests designers must incorporate metacognitive activities into the subject matter that students are learning in order to improve understanding and help students transfer learning to new settings and events.

The fourth principle of the HPL framework is that “learning is influenced in fundamental ways by the context in which it takes place. A community-centered approach requires the development of norms for the classroom and school, as well as connections to the outside world, that support core learning values” (Bransford et al., 2000, p. 25). Learning is a collaborative process in which students actively construct and receive explanations and ideas and negotiate meanings. Such collaboration can help students engage in deeper cognitive processing, such as clarifying thinking, reorganizing information, correcting misconceptions, and developing new understanding. This principle suggests that designers must

incorporate a collaborative mechanism in the design process for students to experience cognitive conflicts, hear different perspectives, and ultimately accomplish the learning tasks with the help of their peers or experts.

METHOD

Participants

For this study we identified key pacesetters in educational technologies from a multitude of specialties. These pacesetters were also directly or indirectly at the forefront of the newest initiatives. We sought representation from the following categories at the highest level of management or peer reputation: the U.S. Department of Education Educational Technology Office, program officers for federal educational technology initiatives, grant awardees, state government technology directors, educational technology professional organizations, educational technology futurists, gaming and simulation experts, educational technology journal editors (both peer-reviewed and trade journals), and university professors. We wanted a widely representative group to eliminate single-field bias. The pacesetters’ diversity added depth to the information and insights we collected from them. Their experiences, from both their personal use of various technologies and the individual circumstances of their experience, informed their perspective.

Procedure

We began our research by recruiting three educational technology experts as advisors and developing a list of possible interview participants. These advisors have been involved in large educational technology initiatives and represent broad perspectives: national initiatives, curriculum development, teacher professional development, professional organizations, and the academic

Table 1. Interview questions

<i>Question 1. What makes an educational technology or its use exemplary?</i> This question sought the criteria that experts consciously or subconsciously use to rate educational technologies. We phrased the question to show that the choice of technology and the way it is used matter.
<i>Question 2. Based on your criteria from question 1, identify which technologies on the list below you would consider exemplary. Please note that this list is not exhaustive.</i> Here we wanted to prompt the interviewee to provide perspective on a wide range of technologies. We were concerned that without the list interviewees might not think broadly or that many of them would focus too narrowly on topics that were highly salient at the time, such as videogames or the latest social networking site. By the same token, we also were concerned about skewing their perspective by providing a list. To address this concern, we eschewed a categorization scheme for now and listed the items in random order.
<i>Question 3. Now that you have identified which technologies from the list that you feel are exemplary, please select at least three of those technologies to discuss with us. We would like two types of information about each technology: Identify the features you like about that technology, and give the advantages and disadvantages of using that technology.</i> We wanted to focus the discussion on the design features that make a technology or its use particularly effective. From this information we hoped to generate a list of <i>exemplars</i> , which are discussed elsewhere in this special issue.
<i>Question 4. In your opinion, which technologies show the most future promise for educational use?</i> We wanted to focus on the idea of “promise” here. Perhaps there are existing technologies that are underutilized or could be ported over to education. Perhaps there are some that have had an impact in other areas, such as business, which should be considered for educational uses. Perhaps some are being used in extraordinary ways somewhere but have received little publicity.

world. The research team teleconferenced with these advisors multiple times. We sought consensus on the study method and interview items.

We also conducted interviews with three people not on the research team to test the item wording and length of interview. We then made minor revisions to the protocol. The group consensus and initial interview process were themselves informative to our overall research study. Table 1 shows the final four questions with a rationale for each.

Recruitment consisted of calling or e-mailing participants to request interviews. When a candidate agreed to participate, we sent a follow-up e-mail to confirm participation, scheduled an interview, and mailed or e-mailed a cover letter, consent form, and the interview protocol. We interviewed 18 pacesetters; however, two declined to consent. Therefore, this paper features the perspectives and insights of 16 pacesetters. We conducted the interviews by phone; the calls typically lasted about 40 minutes. One team member took notes, while another guided the interview and asked the questions. Interviewees also had opportunities to comment about topics or technologies not included in the interview protocol. For each interview the notes were typed into summary format, and both team members

revised them until it was agreed that the summary fairly represented the conversation. In many cases the interviewee either e-mailed or faxed follow-up details.

Data Analyses

The interviews consisted of four questions. In the present article we report on the findings for questions 1 and 4. The results for questions 2 and 3 are described elsewhere in this special issue. From the interview data we conducted a content analysis to identify thematic patterns for each question. We first did this vertically within individual cases before moving across cases, using the constant comparative technique outlined by Miles and Huberman (1994). Then we refined analytic categories and tested for reliability between coders and used the categories to examine data from all interviews.

RESULTS

Pacesetters generally provided detailed, specific comments about what makes an educational technology or its use exemplary. They typically reiterated their initial comments from various angles

throughout the interview. Here we present the seven major themes that arose from the interviews along with pertinent comments from pacesetters.

Technology Theme 1: Create a Learner-Centered Environment

Technology itself is not an answer in education. The technology must have a purpose, such as to enhance teaching or learning or to promote problem solving. Pacesetters considered a technology exemplary if it resulted in substantial gains for the learner. To that end, technology that emphasizes a learner-centered environment and allows learner control has a significant potential to result in more substantial learner gains, making the technology exemplary. Pacesetters also recommended that the focus be on the learning, not the technology. Furthermore, pacesetters said technology that employs experiential or situated learning has significant impact on increasing student learning, motivation, and retention of content. Additionally, they considered technology that supports individualized learning and fits students' needs as highly effective. Here are some comments from pacesetters:

To get at what helps people learn, use four broad areas: Who is the learner, how do they learn, what are their intellectual capabilities, and what are their strengths and weaknesses? If we're going to envision a future of technology and learning, we should use this framework for thinking.

Technology is exemplary if you can tie it to student achievement. There are a lot of tools thrown out into the classroom, but if you can't tie it to student objectives, it's meaningless. A tool without a task has no context using technology. Until we can help schools with methodology, it is ineffective.

Good educational technologies engage learners (scaffold learners) toward meaningful problem solving. Exemplary technology use is a function

of the alignment between the specific problem-solving/reasoning and the technology tool used to assist that reasoning. Exemplary lessons with technology would be those which allow students to make discoveries for themselves, such as a scientist would.

When you talk about exemplary learning, you aren't really talking about the technology at all... It's when the technologies are applied to certain circumstances that makes all the difference. For instance, in some cases the laptop is effective; in some cases it's not. It depends on many factors, such as the school districts and principals. We should be looking at what is going on in the classroom—get away from the discussion on technology, and focus on teaching and learning.

Experimental educational technologies are the new paradigm in learning, as they are interactive. The outdated 20th century paradigm involves passive technologies where you click on something and read information.

Technology Theme 2: Support Engagement, Interactivity, and Motivation

Educational technology must be engaging, interactive, and motivating. Pacesetters said engagement was extremely important for getting students interested in further learning. Thanks to videogames and communication tools, technology already is prevalent in many students' lives, and can be highly motivating and conducive to student learning. Likewise, interactive technology that allows students to exchange work, ideas, and data and that also allows for multiple platforms provides exemplary educational experiences, pacesetters said. Students who use technology to see and analyze real-time data are much more engaged and interested in what they are learning. Here's what pacesetters said:

Education technology moves away from text-based to engaging game and simulation education.

I think technologies that allow kids to experiment in a dynamic environment are exemplary. Kids can “push” in one place and “see what happens” in another place. It’s not static. Google Maps are an exemplary technology because they are not static and you can experiment.

Technology provides firsthand experience rather than reading (the material) from a textbook, and therefore becomes a more memorable and exciting learning experience. Students are more likely to remember and retain this information. When students see real-time information and real events happening, they are much more engaged and interested in what they are learning about. More learning takes place, students remember more, and dig deeper. Students are actually learning more in the situated learning perspective.

Technology Theme 3: Promote Ease of Use and Cost Effectiveness

Pacesetters said exemplary technology is easy to use and versatile. Several reasoned that a technology that works consistently and is simple to implement would naturally reach a larger audience. Cost is also a consideration. Cost includes production, training, use, maintenance, and the need for updates. Several pacesetters said technology must be “lower end” enough to work in the school and within the school’s resources. One pacesetter said the iPod was an exemplary educational technology:

The iPod is ...a technology that has gained success because of pervasive use and ... it could be easily adapted to the classroom...Ease of use is an important feature for exemplary technology because it can make a big impact when it is used on a widespread basis.

Technology Theme 4: Provide Assessment

Exemplary technology features automated ongoing assessment and formative feedback embedded in the technology for quicker and more sophisticated reinforcement. Learners should be able to receive feedback and assessment in all contexts or lessons, pacesetters said. An exemplary technology works for teachers too, the pacesetters noted. If teachers can integrate a technology effectively into their teaching—even if that means a realistic amount of professional development—the technology ultimately has a better chance of impacting student achievement. Add to that teachers’ ability to combine a technology with another in their teaching, and you’ve got an exemplary technology, pacesetters said. Here’s what one pacesetter—a technology expert representing a state department of education—said:

...feedback needs to be quicker and can be quicker via use of technology and to also get more sophisticated feedback. If we’re going to envision a future of technology and learning, we should use this framework for thinking. Add up everything, but if it doesn’t help someone learn, even if it’s great, it doesn’t really make someone better or help them learn. So we need quick assessment and feedback.

Technology Theme 5: Support Social and Community Building

An educational technology that incorporates a high degree of social and community-building opportunities is effective, pacesetters said. This type of tool lets students access current data and information and build a social network around their learning task. The pacesetters predict technologies that effectively use communication and collaboration will have a significant impact on education. Communication technologies that enable students to access information and resources from global

intelligence pools will quickly revolutionize how students work through academic courses, obtain information, and collect their own data. Students will communicate with mentors and peers in other countries, unconstrained by geography. Social networking technologies will provide students with invaluable expertise and support as they take advantage of greatly increased options for attending classes and as they make better use of distance human interactions and artificial intelligence. Here are some insights from pacesetters:

The vast number of interactions made possible through technology, including application sharing, tools for chat rooms, bringing people together for sharing models, and roles, and addressing the different aspects of community coaching are exemplary features of educational technologies.

The social and community building aspect is an overall advantage of technology. Social network is crucial to learning. Technology that connects people is what's needed to get learning communities going.

Technology Theme 6: Promote Scalability, Utility, Dissemination, and Portability

Pacesetters said scalability, utility, dissemination, and portability are important criteria for exemplary educational technology. A technology should be able to handle a large number of students and reach a large audience, but it should also adapt easily to other contexts and across different platforms. Future educational technology must be portable too, pacesetter said, so students can take a tool with them outside of school to learn anywhere, any time. Here are some other pacesetter comments:

Some technologies have one primary use, and the user can't get beyond that one use. An example of this is using a graphing calculator to graph a mathematical equation. This technology doesn't

apply to other contexts; if there are a dozen ways in which the technology can be used, there will be more educational opportunities.

The content delivery platform will always change; there will always be new software and new hardware. The educational assets should not go obsolete when you go from a tablet to a handheld. Ideally, what you have in your educational initiative is a set of learning experiences that cuts across different technologies.

Technology Theme 7: Foster Knowledge Construction/Integration

Embedding components of knowledge construction within a technology has potential for helping students develop a deeper conceptual understanding of the material they're learning. Pacesetters said knowledge construction tools could promote immersive environments in which students not only create their own environments or genres, but share them with other students. Here are some comments from pacesetters:

Argumentation tools and virtual reality technologies are potentially effective approaches to developing a deeper conceptual understanding.

Technologies that have potential as concept builders and problem-solving scaffolders would be future exemplary technologies. Immersive environments have this potential as well as knowledge construction programs such as STELLA or Wikis.

The technology is enabling multiple paths to exploring information. Computer offers you interesting ways to do research- structure information.

StorySpace is a hypermedia construction program. This is a non-linear and promotes student construction of their understanding. If the technology is non-linear, students can make more links to the concepts involved.

DESIGN PRINCIPLES FOR EXEMPLARY EDUCATIONAL TECHNOLOGIES

In this section, we describe six design principles that resulted from clustering learning principles from HPL with the technology themes from pacesetters. In Table 2 we illustrate the connection between HPL, pacesetters, and design principles. Examples for each design principle are also included.

The Technology-Based Instruction Should Promote Learner-Centered Experiences

According to Callahan and Switzer (2001), technology plays an important role in facilitating quality education. They also wrote that the very first dimension of facilitating a quality education is that students should be at the center of their own learning. Pacesetters agreed in theme 1. Thus, designers should pay close attention to the knowledge, skills, and attitudes that students bring to their understanding of knowledge. How much the technology impacts students and their learning depends on the instructional strategies that accompany its use (Russell, 2001; Summer-ville & Reid-Griffin, 2008). To create a learner-centered environment, designers must integrate effective instructional strategies and recognize students' prior knowledge, skills, and attitudes and a variety of approaches to their own learning (Trinidad, 2003).

The Technology-Based Instruction Should Scaffold Knowledge Construction

According to the theory of HPL, learning occurs when a learner actively builds meaningful cognitive representations and mental models. An educational technology should help students make sense of new materials. For example, a technology-

supported argumentation tool engages students in constructing scientific knowledge claims, evaluating the claims constructed, and establishing the objectivity of scientific explanation (Duschl, Ellenboger, & Erduran, 1999).

The Technology-Based Instruction Should Support Problem-Solving and Metacognitive Skills

Technology can provide numerous representational tools that expand and strengthen human cognitive capacities such as problem solving. The problem-based learning framework uses a real-world problem to create a cognitive connection to complex, real-world problem solving. To that end, instructional designers should incorporate meaningful problems with appropriate goals central to subject matter concepts.

The Technology-Based Instruction Should Support Assessment

Technology that facilitates cycles of ongoing assessment is considered exemplary. An online threaded discussion forum, for example, lets students post their work where they can get feedback from a wider range of critics, reflect on what they've learned, and compare their work with peers' products. Such technology supports ongoing assessment, has the potential to promote meaningful learning, and contributes significantly to teaching and learning for understanding (Wiske, 2006).

The Technology-Based Instruction Should Provide a Community of Learning

Communication and collaboration are two important components that an exemplary educational technology offers students. For instance, students use digital media and environments to communicate and work collaboratively, includ-

Table 2. Illustrative connections between HPL, pacesetters, and 21st century educational technology design principles

Important Principles from HPL	Pacesetter Perspectives	21st Century Educational Technology	
		Design Principles	Examples of Learning Environment Features
Build on student preconceptions and learning styles: Students come to the classroom with preconceptions about how the world works.	Emphasize a learner-centered environment: Technology should allow students to investigate and make discoveries for themselves.	The technology-based instruction should promote learner-centered experiences.	Support learners' preconceptions, prior knowledge, beliefs, and experiences. Offer learners choices. Foster learners' multiple abilities. Reinforce multiple distributed intelligences. Support both visual and verbal learners. Encourage learners to investigate personally relevant problems.
Support development of richly structured knowledge foundations: Students must have a deep foundation of factual knowledge, understand facts and ideas in the context of a conceptual framework, and organize knowledge in ways that facilitate retrieval and application.	Foster knowledge construction/integration: Technology should provide multiple paths for students to explore information.	The technology-based instruction should scaffold knowledge construction.	Enhance organized content knowledge. Provide knowledge construction or organizational tools. Create a cognitive conflict that contradicts learners' intuition. Encourage learners to reconsider their repertoire of ideas. Enable manipulation of factors in models and simulation.
Provide metacognitive activities: Students should take control of their own learning by defining goals and monitoring their progress in achieving them.	Support engagement, interactivity, and motivation: Technology should use real-time data and live events to encourage students to be more engaged and interested in what they are learning.	The technology-based instruction should support problem-solving and metacognitive skills.	Promote self-regulated learning. Help learners engage in expert-like thinking processes. Provide ample times for decision making. Provide learners with opportunities to practice real-world situations. Present options for learning skills in a virtual world for application to real-world situations. Allow the transfer of pragmatic learning changes to real-world environments. Support learners in articulating complex scientific ideas.
Encourage cognitive conflicts and hear different perspectives: Learning is influenced in fundamental ways by the context in which it takes place.	Support social and community building: Technology should allow students to build a social network around their learning task.	The technology-based instruction should provide a community of learning.	Support social/community building. Facilitate communication and collaboration among learners or with experts. Allow multiple platforms of communication. Employ multiple social activity structures. Enable multiple ways to participate in online discussions. Provide opportunities for learners to serve as instructors of their peers. Scaffold the development of classroom norms.
n/a	Promote scalability, utility, dissemination, and portability: Technology should be able to handle a large number of students, reach a large audience, and adapt easily to other contexts and platforms. Promote ease of use and cost effectiveness: Technology should be easy to use and affordable for the general public.	The technology-based instruction should support versatility.	Support utility. Allow dissemination. Allow learners to learn everywhere. Incorporate features for ease of use. Reach a large audience. Provide multiple opportunities for use. Enable virtual navigation for exploring complex physical systems.

continues on following page

Table 2. continued

Important Principles from HPL	Pacesetter Perspectives	21st Century Educational Technology	
		Design Principles	Examples of Learning Environment Features
n/a	Provide assessment. Technology should offer ongoing feedback and automated assessment to enhance student achievement.	The technology-based instruction should support assessment.	Support assessment. Provide feedback. Provide subsequent review. Enable just-in-time evaluation. Remedy weaknesses or skill deficits. Enable learners to evaluate the work of their peers.

ing from a distance, to support their own learning and contribute to the learning of others. Such processes also encourage students to develop cultural understanding and global awareness when they communicate and work with students from other cultures.

The Technology-Based Instruction Should Support Versatility

Although HPL does not explicitly address versatility, several pacesetters said educational technologies should be widespread, easy to use, and portable.

DISCUSSION

In conducting this study, we were faced with the familiar question of how to define educational technology and the relative importance of a technology versus its use. The pacesetters provided us valuable perspectives. In future research we must grapple with how educational technology research is actually used for decision making. One end of the spectrum proposes it is really not about the technology, it is solely about the context. Studies from this perspective are fundamentally so context bound that you can't generalize their findings. The other end of the spectrum portrays a tidy world in which an input equals a measurable output and how dollars are spent can predict with certainty the outcomes achieved. Although the *No Child Left Behind*-like need for accountability prefers the latter, reality may be closer to the former.

The interviews yielded many intriguing themes, the most often cited being the importance of engagement and interactivity in a technology. Implementation variables such as cost, ease of use, and teacher receptivity and adoption were also important. Pacesetters gave input on how exemplary technologies enhance teaching and learning, with problem solving and collaboration

being notable. Moreover, community networking and social networking technologies were most often cited for future education impact. As some sociologists accuse technology of isolating students and decreasing social skills, our findings make it increasingly apparent that students (and teachers, mentors, and educational technology leaders) recognize that technology has the power to bring people together and that collaboration via technology can greatly enhance learning.

CONCLUSION

Wager (1992) claimed that “the educational technology that can make the biggest difference to school and students is not the hardware, but the process of designing effective instruction” (p. 454). Our pacesetters delivered a similar message: It is not technology *per se* that improved student outcomes, but rather how the technology was used and integrated into instructional processes. The pacesetter interviews support the importance of the classroom context and the role of teachers rather than the technology itself.

In this study we searched for answers as to what constitutes good practice in the use of educational technology. Continued research will refine those answers. We recommend conducting ongoing dialog among the experts who see students and teachers on a day-to-day basis. We think their unique perspectives would further the knowledge base we’ve laid out. Future studies could also substitute an online survey for the live interviews. Regardless of the approach, we think the study of best practices in educational technology must be ongoing. After all, in the time it took you to read this chapter, a new technology has likely been developed or used in a different way by an educator.

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KEY TERMS AND DEFINITIONS

Design Principle: A descriptor or characteristic which can be used by educators and designers to structure the content and features of an education technology and its implementation into curriculum.

Pacesetter: A person who is a leading influence in his or her field of study or work.

Educational Technology: The use of technology to improve teaching, learning and the school environment.

Learning Environment: Place or setting where learning occurs; not limited to a physical classroom and includes virtual settings in which learning takes place.

Instructional Design: A systematic approach to the design and development of instructional materials and products using objectives, teaching strategies and evaluation to meet learning needs.

Metacognition: The study of thinking and learning.

Criterion: The standard by which an evaluation is made

How People Learn: A book by the National Academies Press which describes a framework for understanding the learning sciences.

Chapter 8.4

Rapid E-Learning in the University

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DEFINITIONS OF RAPID E-LEARNING

Rapid e-learning (REL) is a phrase in common use since 2003. This article defines REL, describes types of REL authoring tools, discusses management and instructional issues surrounding REL in corporate and academic settings, and summarizes the experience of the National University of Singapore (NUS), an early adopter of the concept of REL since 2004.

Almost all current literature on the topic focuses on REL applications in corporate e-learning. There is very little academic research into issues surrounding REL because this is a recent development. At this stage of implementation of REL, the literature on the topic is limited. The following three definitions are commonly used:

1. Josh Bersin defined REL as a category of on-line training content, which can be developed in weeks, can be authored by subject matter experts (SMEs), and maintains instructional focus and quality (Bersin & De Vries, 2004). REL tools leverage on common software such as PowerPoint and then convert that to Flash or other formats for Web delivery with options to add audio and simple quiz. Content is published, edited, and republished by the SMEs with little or no assistance.
2. Patti Shank, President of Learning Peaks, broadened the definition to include rapid instructional design, development, deployment, and evaluation (Shank, 2006). REL is no longer just synonymous to the rapid authoring and development of content, but also to the streamlining of the entire project management process and production cycle.

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3. Another possible definition of Rapid E-learning is when the phrase is used to indicate how rapidly e-learning is being adopted or embraced by an organization. (Tan, Lee & Goh, 2004).

The definitions by Bersin & Associates and Patti Shank, which include process and product, are widely accepted as the main definitions of REL.

TOOLS FOR CONTENT AUTHORING

Rapid e-learning tools can be classified into two types of applications: synchronous, real time, and asynchronous, any time software. Synchronous applications include virtual classroom tools like WebEx, Centra, Elluminate, Breeze Live, Interwise, and other software in this category. Presentations recorded during live lectures are reused in an asynchronous setting.

Examples of asynchronous applications include Breeze Presenter and Articulate, which convert PowerPoint slides with audio narration into Flash animations with options to include videos, animations, progress tracking, and assessment quizzes. Software such as Camtasia, Captivate, and Qarbon Viewlets capture screens along with mouse movements and clicks.

Contribute, a scaled down version of Dreamweaver, allows SMEs to author and edit HTML pages in an interface that resembles Microsoft Word. Wikis and blogs can also be classified as REL tools because they enable SMEs to publish and edit content in asynchronous mode.

MANAGEMENT ISSUES

In Spring of 2004, Josh Bersin & Associates surveyed 228 e-learning developers, mostly from the corporate sector in the United States, concerning challenges faced. Results showed that the greatest challenge was limited financial resources, followed

by tight deadlines. Time and cost savings are main reasons why organizations embrace REL. According to Bersin and De Vries (2004), a course developed under the traditional production cycle with a timeframe of 3-11 weeks costing between \$5,000 to \$30,000 per instructional hour to produce with a team consisting of the SME, instructional designer, programmer, graphic artist, video and sound editors, and so forth, can be produced in less than 3 weeks with little or no budget and developed by the SME with professional guidance and templates.

The traditional production cycle:

Needs Analysis → Instructional Design → Development with technical team → Deployment → Evaluation

The REL production cycle:

Needs Analysis → Rapid Instructional Design and Development → Rapid Deployment → Rapid Evaluation

The main difference between the two production cycles is that the instructional design and development phases in the traditional cycle are being combined. The SME is responsible for hands on development of the final e-learning product with little or no help from the programmer and graphic artist. The final product can be rapidly published with the click of a mouse button. Questionnaires with predefined categories are used to ensure that evaluations are carried out rapidly and efficiently. From a management perspective, REL frees up developers' time and they can be assigned to projects that require their skills. It also solves the problem of instructional designers needing access to SME time.

INSTRUCTIONAL ISSUES

The instructional issues discussed here encompass type, or level of learning, content change, instructor control, and quality.

The first issue to consider when considering use of REL tools is the type of learning required. Blooms taxonomy classifies cognitive learning outcomes into six cognitive levels arranged in the following hierarchy: knowledge, comprehension, application, analysis, synthesis, and evaluation. REL supports learning at the knowledge and comprehension stage and can be implemented effectively when PowerPoint is used to deliver content. As we move up the Bloom's taxonomy, REL is not a good option because REL tools lack sophisticated capabilities to assess student learning beyond setting up simple quizzes. The tools cannot author games, complex interactivities, and simulations. It is difficult to use REL to assess if a student is able to apply a learned skill to a new situation. In certain disciplines, understanding of abstract concepts is classified as "knowledge," level 1 on the Bloom's taxonomy, but this is best taught through simulations. Developments of such courseware will not be rapid. Patti Shank (2006) said that REL is best suited for level 1 of the Bloom's taxonomy and for information broadcast, news, and updates.

The second issue is how frequently content changes. Maintenance cost is significantly reduced when SMEs are independently able to record or edit content using REL tools.

The third issue to consider is the autonomy of instructors and the control they exercise in determining content and methods of delivery for instructional material and courses. This is probably more frequently addressed in the academic setting than in the corporate setting. For example, some SMEs are not comfortable with the use of technology. In addition to writing content, the SME plays an active role in development and editing, which could be overwhelming, adding to pressure and workload. New SMEs teaching a course for the first time and not familiar with content authored by someone else may not be able to rapidly record a presentation with audio.

A fourth issue to consider is the quality of instructional materials. This is both a technical and

a pedagogical issue. In projects requiring studio quality sound and video, traditional methods are recommended.

The Role of Instructional Designers in REL

With REL, the role of instructional designers is slightly changed. Instructional designers act as guides and facilitators, helping SMEs write and develop content using REL tools. REL is usually used to author content in small chunks of reusable learning objects (RLOs). The design of the course containing a sequence of RLOs, assessment, tracking, forum discussions, deployment, course evaluation, and revisions still require traditional instructional design skills. Hence, the role of the instructional designer is not diminished with the use of REL. When REL processes and methods are properly applied, it is possible to produce high quality courses for both blended and distance learning.

Worksheets, Checklists, and Templates

A research report on REL released in June 2006 by the eLearning Guild showed that 72% of respondents to the research survey who use REL tools also use templates to facilitate rapid design and the streamlining of the production process.

Instructional designers and project managers have always used worksheets and templates in the traditional production cycle, such as the ADDIE model. De Vries (2006) has successfully demonstrated how worksheets and templates can efficiently streamline the production process. Bersin calls this a "development toolkit" consisting of templates and guidelines on the use of color, font, lines of text per page and so forth. De Vries's toolkit consists of analysis and module development worksheets which enable instructional designers to work together with the SME to author content quickly in a framework guided by pedagogy.

De Vries also designed a set of development, deployment, and evaluation checklists consisting of project management tasks to help instructional designers work more efficiently.

AN EARLY ADOPTER: THE NATIONAL UNIVERSITY OF SINGAPORE

The National University of Singapore (NUS) is a traditional research university with about 30,000 students. Students attend on-campus lectures. E-learning focuses on blended learning rather than distance learning. The Centre for Instructional Technology (CIT) at the NUS was set up in 1999 with the mission to provide a supportive environment for the exploration, development, and application of digital technologies to enhance teaching and learning.

In January 2004, the courseware team began a pilot project involving the use of Macromedia Breeze Presenter. The software enables faculty to enhance their PowerPoint presentations with multimedia content with ease. By installing a plug-in onto the user's PowerPoint software, audio narrations and quizzes can be added. The presentation is saved as a Flash movie on a Web server. These presentations can be classified as a group of Learning Objects created with Breeze. The learning objects can then be accessed online without launching PowerPoint and can be played on any PDA, PC, and Macintosh.

There were three main reasons for implementing REL at the university. The first reason is cost effectiveness. The courseware team had been developing multimedia courseware since 1999, adopting the traditional production model that involves a team of content experts, instructional designers, programmers, and graphic artists. While this method produced high quality courseware, the cost of maintaining and updating courseware is high. REL could reduce maintenance cost.

The second reason was to provide an efficient software solution to the instructors, which would hopefully result in greater buy-in to e-learning. The team observed that professors are not prepared to get involved in the development of complex courseware. Because PowerPoint is used extensively by instructors, an easy to use software that enhances the features of PowerPoint is more practical for most instructors rather than the service of a team of software developers.

Third, the CIT team hoped to build a repository of Breeze created learning objects quickly and efficiently. Learning objects could be shared, packaged, used, and re-used by different instructors. With these in mind, the CIT introduced the concept of rapid e-learning (REL) in January of 2004. Because REL is not suitable for every project, traditional courseware development remains a core service and REL compliments that. In addition to Breeze Presenter, the centre implemented the e-learning XHTML editor (eXe) and Centra, which can also be classified as REL tools. This case study on REL focuses on the use of Breeze Presenter as the REL tool.

Breeze Presenter was introduced to faculty through newsletters, road show demonstrations, direct approach to selected faculty, and workshops. For the first few sessions, an instructional technologist guided faculty members as they prepared their learning objects with Breeze. Instructors were able to work independently after one or two guided sessions. Formal instructor surveys were not conducted on the use of REL, partly due to the popularity of the software and its smooth integration into the e-learning infrastructure of the university. However, regular qualitative feedback from instructional technologists working with professors on Breeze Presenter is very positive. Instructors embrace it because they have no problems learning the software, the user interface has not changed much since 2004, and Breeze enables them to add simple interactivity to PowerPoint presentations without technical assistance. Instructors like this

Table 1. What students like about Breeze

Reasons for liking Breeze Presentations	Percent
Ability to access presentation at low bandwidth	38.20%
Breeze characteristics such as design, layout, and UI	18.70%
Ability to selectively learn	19.50%
PowerPoint slide layout, graphics, and lecturer's presentation	11.40%
Other issues	2.50%
Dislikes Breeze	1.60%
No comments	8.10%

sense of independence and flexibility. As of July 2006, more than 800 learning objects have been created with REL. Instructors use these learning objects to complement classroom lectures, tutorials, and supplementary lessons.

The CIT team conducted student surveys in June 2004, and 200 students responded (see Table 1).

As Table 1 indicates, 38.20% liked Breeze because they can access the presentations using a low bandwidth Internet connection. 19.50% of respondents liked it because they can selectively learn, Breeze presentations come with standard toolbars that allow users to navigate between slides, view slide notes, control audio and video, play, pause, and stop the presentation and search the presentation for key words. 9.7% of students either dislike Breeze or have no comments. It would be interesting to find out more about the opinions of these students through qualitative feedback. 11.40% of respondents liked the slide layout and lecture presentation style. This figure measures content delivery and indicates that there is room for improvement in the design of PowerPoint slides and content presentation. It is also indicative that there are students who do not prefer lecture style presentations. The NUS team believes that there is a place for REL authoring tools in the university. Table 2 shows the IT infrastructure that supports e-learning. REL holds equal status to custom courseware.

Table 2. The e-learning IT infrastructure of the National University of Singapore

-Virtual Classroom and eMeetings	-Plagiarism -SELF	-Teaching Facilities Centre
Webcasts, Podcasts, Video Conference, Video Production and Events Coverage		
Custom Courseware		Rapid E-Learning
Learning and Content Management System and repositories of learning objects		
Client Consultation and Support		

The popularity of Breeze Presenter indicates that instructors find REL tools useful for performing certain tasks that once required the service of professional staff. Some professors became comfortable with using IT and continued to develop complex custom courseware after using Breeze. REL tools have increased the productivity of the CIT by increasing output and shortening production time. REL presentations require minimal maintenance support. The centre expects REL to become even more popular in the near future. Its place in the e-learning ecology of the university appears to be secure. The pilot project achieved positive results in all three areas except that cost savings cannot be confirmed because the initial cost of implementation and software licensing was too high.

CHALLENGES OF REL IN THE UNIVERSITY

Instructional designers will not dispute the usefulness of worksheets, checklists, and templates of the type suggested by De Vries (2006). These are essential in REL. However, the e-learning environment in a large university is different from that of an industrial corporation. While it is feasible to use project management worksheets and checklists in the university context, templates are almost impossible to implement. In a traditional research university, professors make the final decision as to

how a course is to be designed and taught, whereas instructional designers are restricted to offering suggestions. Imposing templates designed to ensure quality instructional design may be viewed as intrusive and could create tensions with faculty.

Other constraints on the use of REL in the university environment arise from the basic problem of quality. Poor presentation skills result in poor quality learning objects, no matter how sophisticated the technology employed. The university must find other ways to improve the quality of PowerPoint presentations without imposing templates. Fortunately, there are workshops designed to help instructors prepare PowerPoint slides and improve their presentation skills; it is important for SMEs interested in creating e-learning with REL tools to become well-versed on proper course design techniques (Boehle, 2005). By working with instructors, instructional designers can guide and make suggestions as to how a presentation can be improved without implementing templates. In this manner, both the specific skill sets of SMEs and instructional designers are maximized to create an optimal e-learning experience.

REL promises to reduce cost of production by shortening the production process and reducing the number of professional staff needed. The CIT is not able to confirm any cost reductions. The most recent eLearning Guild's research report on REL (2006) also could not conclude that REL reduces cost. In that report, 49% of respondents claimed REL reduces production cost, whereas 19% found the cost remained the same and 32% found it cost more. More research is needed to determine the reasons for this contradiction to cost reduction claims. The CIT found the cost of software licensing to be high. Moreover, there is a yearly software maintenance fee. For cost savings to be achieved, REL software must be reasonably priced, and some tools remain expensive.

The eLearning Guild's research report (2006) was unable to affirm that quality has not been sacrificed, despite the use of templates, worksheets, and checklists for quality control. In fact, the majority

of respondents indicated that quality—as defined by look and feel, interactivity, learner retention, and behavior—either remained the same or decreased when compared with courses authored by traditional methods. Similarly, the NUS experience also points to a need for some form of quality assurance. When asked what it takes for REL to succeed, 83% of respondents in the eLearning Guild's 2006 survey replied that the involvement of instructional designers was paramount. Therefore, when the latter become more involved, it is realistic to assume that processes and methods will become fine-tuned and that quality issues will be mitigated.

All the same, SMEs are embracing REL because the tools are easy to use and they can perform basic tasks without assistance. Students like the easy-to-access, self-paced presentations.

FUTURE TRENDS AND CONCLUSION

Despite challenges, REL development promises time and cost savings, and increased productivity. In 2003, Larstan Business Reports, conducted a survey of 85 Fortune 500 companies and more than 80% of respondents reported that REL strategies would make a significant contribution to training efforts in their organization. The eLearning Guild REL report (June, 2006) showed that demand for REL among its members increased from 70% in 2005 to 82% in 2006. The report claimed that REL is currently the fastest growing trend in e-learning project management and authoring. This trend is expected to continue.

REL software that can author complex games and simulations beyond the current one-way transmission of content is on the horizon. Currently, application developers are responding to demand in the market for new and better authoring tools. It is widely expected that desktop applications like Microsoft Office will become available online in the near future. When this becomes reality, online versions of REL tools are likely to follow. It may eventually become common to integrate

REL authoring tools into Learning and Content Management Systems, further integrating content development and knowledge management.

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KEY TERMS AND DEFINITIONS

ADDIE: Abbreviation for analyze, design, develop, implement, evaluate. A step by step structured procedure that helps instructional designers

use instructional material to create learning objects or e-learning courses.

Blended Learning: A combination of physical classroom instruction and online component of the course. Online components may supplement lectures and tutorials or they may consist of part of the curriculum which was previously taught in the physical classroom.

Bloom's Taxonomy: Classification system of the cognitive domain by Benjamin Bloom in 1956. Learning outcomes are categorized into six levels: Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation.

Distance Education: A course that is delivered without requiring students to attend lessons in a physical classroom.

LMS and LCMS: The learning content management system, or LCMS, allows users to share, search and reuse content (learning objects) for lessons. Learning objects can also be exported for use in another LCMS. LCMS manages content. The learning management system (LMS) manages the course and contains course information, assignments, schedules, and so forth. Today, commercial LMS includes the LCMS component and hence, LMS usually also means LCMS.

Rapid E-Learning (REL): A category of online training which can be developed in weeks, can be authored by subject matter experts (SMEs), and maintains instructional focus and quality.

Reusable Learning Objects (RLOs): Small chunks of content in digital form. RLOs are tagged with information, stored in a repository, shared, and reused for teaching. Several learning objects put together form a lesson.

SME: Subject matter experts or content writers.

Tools: Software used to perform certain tasks or to create something in e-learning. When used in the context of an LMS, it means a feature in the LMS that enables users to perform a specific task.

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Chapter 8.5

The Innovative Production Machines and Systems Network of Excellence

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INTRODUCTION

This article presents the essence of the Innovative Production Machines and Systems (I*PROMS) Network of Excellence. It gives the rationale for networks of excellence, outlines the scope and structure of I*PROMS, and summarizes its program of activities.

RATIONALE FOR NETWORKS OF EXCELLENCE

Manufacturing is a significant wealth generation sector, accounting for over 20% of the Euro-

pean Union's (EU's) gross domestic product. To compete successfully in the global market, the European manufacturing industry needs to be underpinned by well focused advanced production research. Because of the breadth of the field, commercial considerations, and the multinationalism of the EU, production research activities within it have been naturally fragmented.

There is the potential to coordinate precompetitive research for common benefit. Under its Sixth Framework Programme (FP6), the EU has introduced networks of excellence as a new "instrument" to overcome fragmentation of European research and help shape the conduct of research in Europe. The operation of these networks is based on a joint program of activities aimed principally

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at integrating the research activities of the network partners while also advancing knowledge on the topic.

THE I*PROMS NETWORK OF EXCELLENCE

The EU FP6 network of excellence for Innovative Production Machines and Systems (I*PROMS) was inaugurated in October 2004. I*PROMS integrates the production research activities of 30 research centers from 14 countries in Europe: MEC, Cardiff University (UK) (coordinator), Profactor (Austria), Czech Technical University in Prague (Czech Republic), VTT (Finland), CETIM (France), ENIT (France), INRIA (France), Robosoft (France), IAO Fraunhofer Institute (Germany), IPA Fraunhofer Institute (Germany), IPK Fraunhofer Institute (Germany), Schneider Electric (Germany), TUC (Germany), University of Hannover (Germany), University of Patras (Greece), Dublin City University (Ireland), CRF (Italy), FIDIA (Italy), University of Naples Federico II (Italy), PIAP (Poland), University of Minho (Portugal), Fatronik (Spain), Tekniker (Spain), TNO (The Netherlands), Sakarya University (Turkey), University of Warwick (UK), University of Cambridge (UK), University of Manchester (UK), University of Newcastle (UK), and University of Oxford (UK).

I*PROMS addresses production research in an integrated manner to help shape this research area and overcome fragmentation. By creating an EU-wide research community concentrating on future manufacturing concepts, processes, and systems, I*PROMS acts as the main research hub within the EU for the whole area of production machines and systems.

I*PROMS adopts the knowledge-based “autonomous factory” vision for delivering increased competitiveness for manufacturing in 2020. The network focuses on intelligent and adaptive production machines and systems that meet dynamic

business and value drivers through advanced information and communication technology.

I*PROMS promotes the development of common concepts, tools, and techniques enabling the creation and operation of flexible, reconfigurable, sustainable, fault-tolerant, and eco- and user-friendly production systems. Such systems should react rapidly to changing customer needs, environmental requirements, design inputs, and material/process/labor availability to manufacture high quality, cost-effective products.

THE CLUSTERS IN I*PROMS

I*PROMS addresses six manufacturing challenges: concurrent manufacturing, integration of human and technical resources, conversion of information to knowledge, environmental compatibility, reconfigurable enterprises, and innovative manufacturing processes and products. Work on those themes is prosecuted by four interconnected clusters (see Table 1): advanced production machines (APM), production automation and control (PAC), innovative design technology (IDT), and production organization and management (POM).

The following sections give an outline of the I*PROMS clusters and their scopes. Further information can be found in Pham, Eldukhri, Peat, Setchi, Soroka, Packianather, et al. (2004); Pham, Eldukhri, Setchi, Soroka, Packianather, Thomas, et al. (2004); Pham, Eldukhri, Soroka, Zlatanov, Packianather, Setchi, et al. (2005), and <http://www.iproms.org>.

Advanced Production Machines (APM) Cluster

Advanced production machines are the workmen of the factory of the future. These include machines for processing new/nano/smart/high-performance materials, micromanufacture (MEMS) machines, rapid manufacturing machines (rapid prototyping and rapid tooling), and manufacturing robots (sta-

*Table 1. Manufacturing challenges addressed by I*PROMS research clusters*

Manufacturing Challenge	Network Clusters			
	<i>APM</i>	<i>PAC</i>	<i>IDT</i>	<i>POM</i>
Concurrent Manufacturing	X	X	X	X
Integration of Human and Technical Resources		X	X	X
Conversion of Information to Knowledge		X	X	X
Environmental Compatibility	X		X	
Reconfigurable Enterprises	X	X		X
Innovative Manufacturing Processes and Products	X			

tionary and mobile). In addition to the challenging “stand-alone” research issues connected to these technologies, this cluster also considers two key issues that require cross-technology cooperation, multifunction machines, and reconfigurable machines.

Production Automation and Control (PAC) Cluster

Production automation and control represents the foremen of the factory of the future, responsible for overseeing the machines and for communicating between machines and management. The scope of the PAC cluster includes self-adaptive control, flexible/reconfigurable manufacturing, adaptive quality systems, agent-based distributed architectures, (machine) knowledge management, and human-machine interaction. The major research issue identified for this cluster is collaborative agent-based (or holonic) manufacturing automation and, related to that, self-adaptive control and human-machine interaction. There is considerable interaction between this cluster and the APM cluster in making these machines more “intelligent” and between this cluster and the production organization and management cluster in controlling these machines within the overall autonomous factory environment. It is the combination of these cluster areas that will ultimately provide the overall flexible/reconfigurable autonomous factory.

Innovative Design Technology (IDT) Cluster

Innovative design technology relates to the designers of the factory and products of the future, conceiving novel, customizable, value-added products, and the factory machines and systems required to manufacture them. The coverage of the IDT cluster includes product knowledge management, computer-aided innovation, and advanced computer-aided manufacture. It is with appropriate IDT that concurrency through the product life cycle, as well as across the extended enterprise, can be achieved, with huge potential impact on time-to-market and product development, manufacturing, maintenance, and disposal costs. Two key areas of work are identified: virtual product design technology and design complexity.

Production Organization and Management (POM) Cluster

Production organization and management concerns the management of the factory of the future. It covers advanced process control, enterprise/manufacturing simulation, (human) knowledge management, and human-computer interaction at the organizational, enterprise level. This cluster deals with the management of operations ranging from innovation, planning, organizing, scheduling, and controlling of production processes as well as the management of the interface with the ex-

tended enterprise and other supporting functions. Two key themes are identified: fit manufacturing enterprises (both individual and extended) and integration of human and technical resources enabling effective collaboration between man and machine. This includes effective human-computer interaction by means of multimodal/multimedia knowledge-based user interfaces with active knowledge access and adaptive, dynamic knowledge presentation.

I*PROMS ACTIVITIES

The work of the I*PROMS network and its clusters is laid out in a comprehensive joint program of activities (JPA). The JPA comprises the following components:

- A set of integrating activities aimed at structuring the way the participants carry out research on the topics considered. These activities include defining common research priorities within the scope of I*PROMS; creating and operating joint research platforms; preparing joint bids to government and industry for research grants; creating communication and collaboration facilities; training network researchers; and developing synergistic links with existing research capacities within the EU.
- A program of jointly executed research to support the network goals. The research undertaken by the four I*PROMS clusters covers a broad range of topics including new processes for new materials, miniaturization, mechatronic modules, nanotechnology, modeling and simulation, product life cycle planning, flexible manufacturing systems, process integration, new process control and sensors concepts, intelligent manufacturing process/near-net shape

processes, and substitution of harmful substances.

- A set of activities designed to spread excellence, including training of manufacturing engineers; promoting mobility and exchange of researchers from outside the network; transferring knowledge to teams external to the network through networking activities; networking with other research networks; transferring technology through Web-based advisory services; interacting with national and European Commission (EC)-funded technology transfer projects for industry including small and medium enterprises (SMEs); organizing events to increase public awareness and understanding of I*PROMS-related science and technologies; publishing the network's vision for the factory of the future; developing a program of industrial workshops, seminars, and conferences; and collaborating with other related centers of excellence outside of the network to ensure that knowledge and excellence is spread widely.

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Chapter 8.6

Aesthetic Decisions of Instructors and Instructional Designers

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ABSTRACT

The same qualities that make works of art beautiful, meaningful, or at times even transformative in our lives also underlie our best learning experiences. This study sought to better understand the relationship between art and instruction by looking at how aesthetics underlie the design decisions of teachers and instructional designers. Five instructional designers and teachers were interviewed about a course or online learning product they had recently designed. The interviews explored the design decisions they had made based on how they imagined learners would experience the instruction at its beginning, middle, and ending. Participants discussed the introduction of tension to enhance engagement, worked to achieve a coherent experience for learners through narrative

qualities, and demonstrated concern for the immediacy of their learners' experiences, discussing the expected thoughts and feelings of learners at each stage of the course or module.

INTRODUCTION

The primary purpose of all education and training professions is to make sure learners take away useful knowledge and skills. But some practitioners also realize that the way to ensure that deep learning will happen is to help learners become engaged in a process of self transformation. For this reason, many instructional providers focus on crafting learning *experiences*, not simply conveying content and assessing learning. For example, some instructional providers place “increased emphasis on the qualitative immediacy of experience, on its unity and wholeness, on its

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emotional underpinnings, on the temporal unfolding of events” (Jackson, 1998, p. 181), and put care in developing details of their instruction that may seem, on the surface, only peripherally related to its subject matter, and only minimally implied by standard instructional strategies. This chapter will show that some instructional providers use approaches that can best be described as *aesthetic* in their work to heighten the learning experience,.

Instructional design, coming from a tradition of applying scientific and engineering principles to instruction, can be seen as conflicting with the traditional craft-orientation of most educators (Rose, 2002). However, even in the work of many instructional designers there exists an artistic thrust that guides the design of products considered of high quality by clients and learners. This study will demonstrate that in the minds of the instructional designers who participated, the same qualities that make works of art beautiful, meaningful, and at times transformative also underlie the most successful learning experiences. The goal of this study was to understand the relationship between art and instruction by looking at the ways in which aesthetics underlie the design decisions of teachers and instructional designers. Its purpose is not to diminish the value of science for instruction, but to reconsider aesthetics as a core foundation for instructional practice, alongside science. In fact, the study relies on social scientific approaches in its attempts to uncover the underlying aesthetics of instructional practice.

AESTHETIC EXPERIENCE

In common parlance, *aesthetics* describes our experience of and passion for creating art, but John Dewey saw it as applying more broadly as a kind of everyday experience (1934/1989). Dewey argued that aesthetics described a prevalent and essential kind of experience, one that is particularly heightened and felt to be especially meaningful—one flush with transformative potential. It is this kind

of experience that artists seek to create or recreate in their work. In this sense, aesthetic experience can exist not only in our engagement with the arts, but in all activity, perhaps especially in activities involving learning. But the concept of *aesthetics* has had many interpretations, and Dewey’s is by no means representative. This section will first briefly describe some competing aesthetic theories before outlining his Pragmatist theory. This theory is worth significant discussion because it is important to move beyond clichéd and superficial conceptions of art and aesthetics in order to see its application to learning and instruction.

Aesthetics is commonly used in at least two senses, both of which are applicable to this study. In one sense, *aesthetics* describes the strategies or principles employed by artists in creating their work. Essays like Aristotle’s *Poetics* (trans. 1984) primarily explore this aspect. But *aesthetics* is also the name for the philosophical tradition that explores the impact of the arts on our lives, why we call some things art and not others, the relationship of artists to their work, and why humans have a passion for creating and engaging with works of art even when they have no apparent practical value. This philosophical tradition, especially in recent history, has led to many different interpretations. Some have said that art is our way of making certain things in our world “special” or distinct from everyday experience—an attempt to celebrate our humanity or to attach increased human meaning to things (Dissanayake, 1995). Connor (1999) points to another school of thought that suggests that the function of art is to create a useful distraction for the miseries we encounter, or to provide a cathartic mechanism for working out “issues and anxieties which... cannot be addressed directly” (Functionalist theories of the aesthetic, para. 3). Others have claimed that *art* is merely a classification of artifacts defined by social institutions as suitable for public appreciation (Dickie, 1989). In other words, this view holds that aesthetics exists only as a socially created convention, and that artists are simply skilled crafts

persons with attached celebrity, but without additional purpose. This attempts to explain the recent predilection for innovation and the emergence of radically non-traditional examples of modernist and postmodernist art. But Berleant (1991) takes a less cynical tack and posits “engagement” as the common quality that connects all the artifacts we call art, a quality that puts his theory most in line with that of Dewey, as shown below. In his view, works of art are designed to engage us in an exploration of meaning—an essential and defining human endeavor. Connor (1999) concludes that the concept of aesthetics may be of no use given its “protean and unpredictable essence,” (The fallacy of counter-aesthetics, para. 6). However, this protean essence lends further credibility to Dewey’s conception of aesthetics as a pervasive kind of experience that emerges from diverse activities.

John Dewey (1934/1989) proposed that aesthetic experience grows out of the rhythmic alternation of disruption and order, the “struggles and achievements” (p. 19), in our lives. In other words, art emerges from the rhythms of everyday experience and epitomizes our nature as beings establishing and achieving goals. As Dewey put it:

Life consists of phases in which the organism falls out of step with the march of surrounding things and then recovers unison with it—either through effort or by some happy chance. And, in a growing life, the recovery is never mere return to a prior state, for it is enriched by the state of disparity and resistance through which it has successfully passed. . . . Here in germ are balance and harmony attained through rhythm. (p. 14)

With little effort one can see that Dewey was describing the process of learning as the source of aesthetic experience. The rhythms and tensions that lead to aesthetic experience with works of art are parallel to those found in transformative learning experiences.

The rhythms of aesthetic experience give it inherent narrative qualities. Whether a work of art takes the form of painting, sculpture, architecture, drama, dance, fiction, or film, our experience of it follows a fundamental pattern in which we perceive the object or situation and over time, through engagement with it, come to sense its meaning or unity. This is the basic pattern of any narrative—a beginning that includes confrontation with an indeterminate situation or object, gradual unfolding of its nature through observation and engagement, and a final consummation that results in meaning or coherence. For this reason, aesthetic learning experiences lend themselves to narrative analysis (see McEwan & Egan, 1995), as the themes that resulted from this study demonstrate, with their attention to *beginnings, middles, endings, character, tone*, and the relationships of the “reader” and “author” to the “text.”

A necessary ingredient for the aesthetic experience of art is “the contribution we ourselves make, a contribution that is active and participatory” (Berleant, 1991, p. 4). Dewey suggests that in order to understand art,

. . . one must begin in the raw; in the events and scenes that hold the attentive eye and ear of man, arousing his interest and affording him enjoyment as he looks and listens. . . . The sources of art in human experience will be learned by him who sees how the tense grace of the ball-player infects the onlooking crowd; who notes the delight of the housewife in tending to her plants . . . ; the zest of the spectator in poking the wood burning on the hearth and in watching the darting flames and crumbling coals. (1934, p. 4-5)

In choosing these examples, Dewey posits active engagement as a necessary quality of aesthetic experience. Rather than the commonly offered aesthetics of passivity or *disinterestedness*, in which objects are enjoyed for appearance, but not for utility or understanding (Cooper, 1995), Dewey and Berleant propose an aesthetics of en-

gement. *Engagement*, in a pragmatist sense, can be defined as intellectual, emotional, or physical investment in an activity in anticipation of future consequences (the opposite of disinterest). Just as artworks can be designed to draw in readers or viewers to puzzle out a plot or to sympathize with characters, to walk through buildings or around a sculpture, or to have a vicarious somatic experience in watching a dance, learning experiences can be designed aesthetically to stimulate similar forms of engagement. For example, instructional designers might attend to the compelling stories inherent in the content they teach; to the imaginative qualities of learner activities; to the details of attractive and intuitive classrooms, texts, and computer interfaces; to the use of evocative language, examples, and illustrations; to the natural tensions and emotions that emerge during the learning process; and to the pacing of instructional activities.

Finding a connection between art and instruction is not in itself new. Authors have theorized about the artistic nature of teaching, drawing strong parallels between the activities of teaching or instructional design and those of performing or creating works of art (Davies, 1991; Eisner, 1998; Sarason, 1999). For example, teachers and IDs can sometimes be so skillful and graceful in crafting a learning experience that it can be appreciated or experienced as aesthetic. Teaching and creating instructional materials is also, like art, often a spontaneous, improvisational activity, and not dominated by prescriptive models. Indeed, the ends of instruction are never fully predetermined, but emergent. Wang (2001) more directly proposed that teachers should emphasize the aesthetic aspects of learning experiences, particularly in bringing out the unexpected, uncertain, or ambiguous aspects of their content areas to engage students. Expanding on Jackson's (1998) work, Wong, Pugh, & The Dewey Ideas Group (2001), have applied Deweyan concepts to call for creating significant anticipation in learners within inquiry science learning through the use of

compelling ideas and stories. The study described here, however, differs in its investigation of instructional practice to learn the extent to which teachers and IDs intuitively think like artists in making instructional decisions.

This study looked beyond instructional theories and models to examine how teachers and IDs in diverse settings applied strategies to enhance learning engagement and influence attitudes toward instructional content. It examined the design and implementation decisions used by participants in their work on a specific course or instructional product, such as the sensory qualities of the classroom and learning materials; the use of narrative structures in learning activities; the creation of tension, anticipation, and dramatic impact; the pacing of activities; the pattern of activities; and methods of creating closure. In addition, in order to discern relationships between their underlying values and these decisions, the study sought to understand some of their guiding values for instruction, what they considered general goals for instruction, and how they characterized learners and their relationships to them in the teaching/learning process.

PROCEDURES

Data Collection

This study applied grounded theory research methodologies (Strauss & Corbin, 1998) to discover possible aesthetic bases for decisions made by teachers and IDs. A series of interviews with five participants was used to develop the set of themes leading to this report. Applying purposive (Krathwohl, 1998) and theoretical (Creswell, 1998) sampling methods, participants were chosen based on other's judgments of their high levels of expertise. Participants were known to demonstrate great care in the quality of their instruction, care deeply about learning experience, and have the ability to articulate insights

into their practice. Participants were chosen also to represent varied arenas of practice, including both teachers and instructional designers. This range of participants was desired to ensure a broad focus on learning, rather than narrowing in on one delivery mode. The products they had created were all large components of instruction, either entire courses or self-paced modules of two or more hours of student contact time. This criterion was applied in order to capture how these practitioners perceived an evolution of learning engagement during the experience. Participants (and their projects) included

- **AF**, a member of the math faculty at an urban community college (a Calculus I course taught face-to-face)
- **BI**, an instructional designer working within a for-profit organization that creates custom and off-the-shelf training for corporate clients (a computer-based learning program on quality improvement)
- **CI and DI**, both instructional designers with a not-for-profit organization with government sponsors, specializing in weather-related education and training. The two had divergent audiences—middle-school students (hurricane science and safety) and professional weather forecasters (ocean-effect snowstorms), respectively—for their projects, both of which were online learning modules to be used individually or in small groups.
- **EF**, an adjunct faculty member (also a practicing instructional designer) for an online Master's degree program in Instructional Technology (an instructor-led online learning course on instructional strategies)

Note that AF and EF are faculty at a college or university—"F" for faculty. BI, CI, and DI are instructional designers—"I" for instructional designer. Each participant had recently taught the course or developed the instructional product

they discussed, so the decisions and experience of the teaching or development process were fresh in mind. The course materials or products were available to examine as a secondary data source.

While participants were briefed ahead of time with the general purpose of the research, with the exception of the final question the interview questions did not directly ask participants to consider the concepts of art or aesthetics (see Appendix A, Sample Interview Questions). Instead, they were designed to prompt participants to think about how learners might experience the instruction, repeatedly asking what learners might be "thinking and feeling" during the course of instruction and what they had done as designers of the experience to influence those thoughts and feelings. I considered myself an active participant in the interview process (Holstein & Gubrium, 1995), and at times the interview took on characteristics of a discussion between two practitioners. The study followed a method similar to that of phenomenological researcher Aanstoos (1985), who used think-aloud protocol to uncover actual thinking processes of chess players, rather than those predicted by cognitive theory. While think-aloud protocol is typically impractical for processes with a long time-scale, such as instructional design and teaching, focused reflection on a specific course or product (with the product at hand, when possible) achieved a similar outcome.

Data Analysis

In keeping with grounded theory research methods (Strauss & Corbin, 1998), transcriptions for each interview were initially open-coded at a high degree of detail, the unit of analysis varying from phrases to entire paragraphs, depending on the concept expressed. During open-coding and "axial coding" (Strauss & Corbin, 1998), the initial set of 50 codes were collapsed into the 11 categories reported here.

FINDINGS

Differences between participants were apparent, as anticipated given their varying professional orientations and places of practice. For example, the teachers could rely on being able to read student feelings during instruction, and could accommodate and adjust prior design decisions to changing student perceptions. They worked toward an engagement substantially built on a high degree of trust, using language that implied, “I’m here, I care about you” (Participant EF) and making students realize that “it’s not me against them . . . that I’m on their side” (AF). In contrast, the instructional designers of self-paced products realized that even with their efforts to anticipate reactions to the instruction, they might still be missing the mark with a large percentage of learners. It appeared deeply frustrating to them that they would likely never see the faces of learners to know the instruction’s impact:

My problem is that I don’t know any learners. I’m so far away from them. I wish I could watch them, I wish I could interview them, but I don’t know any of them. The only one I know is myself, and the only learning style I know is my own. (Participant BI)

Even with this substantial difference between teachers and IDs, very similar concerns for the learner experience and high degrees of empathy emerged from the interviews and similar design solutions were described. These are reported below, organized into general themes of Guiding values, Instructional goals, Opening qualities, Narrative flow, Identity, Tension, Limits, Middle qualities, Climax or turning point, Ending qualities, and Teaching as art.

Guiding Values

When asked about guiding values for their work, participants spoke of the necessity to connect with

the individual needs of learners and to keep them engaged and interested because doing so will help learners develop useful skills and knowledge to take away from the experience.

(CI) Learning is not easy. It takes work. . . . So I feel like I’ve got to get the learners to put in effort or they’re not going to get anything for their time. . . . We’re in an information overload society . . . and every moment you’re choosing. . . . If we make something, we better make it good, . . . valuable, well crafted, self-contained, and engaging and appealing.

(AF) Everybody learns differently. . . . My job is to present the material in all sorts of different ways so those thirty people sitting there aren’t going to change their style to match me.

(BI) I think the instructional designer is sort of the advocate for the learner. . . . We’re kind of the conduit or intermediary between the knowledge and the learner.

Instructional Goals

Several participants made clear statements that their instructional goals are more than information transfer and skill development. They included affective, transformative goals, such as developing a deeper respect of the content area, an appreciation for its importance and value, and even its “elegance.” This additional appreciation requires modeling the behaviors of those who value the content and apply it with success.

(BI) The other thing we try to do is . . . create a back story, a dramatic back story . . . about a group of people working through the process. . . . It needed to be a real story. Something that made sense. . . . It’s all about modeling.

(AF) That’s one of the things I try to portray to students, that I do enjoy teaching it, and love the

math and it's exciting, and I'm trying to get them to feel that excitement with me. We'll talk about something that's happening and I'll say, "Isn't that cool? Isn't that neat the way it works? . . . It doesn't always work, but I try to pull them in."

(AF) And I want them to have gotten the best education they can so they are ready to move on. But it's almost just as important to me for them to finish the semester and not be quite as afraid of mathematics as they were at the beginning.

(DI) Meaningfulness. And then there's this aesthetic integrity that you can sense in something. Balance. And something about timing, pace, that it's . . . the right kind of pacing you know when you find it. . . . They will go through it and at the end of it they'll say that was worth my time, that meant something to me, that's something that I can use, that's something I can carry forward with and apply in my life.

These instructional goals, combined with the fact that learners are frequently multi-tasking adults with competing demands in their lives, necessitate engagement strategies. Education (or professional development) is only one of these demands on students' time. Students may come to the instruction with few experiences of academic success, and they may see instruction as intimidating rather than inviting. They may come with a limited desire for what the course has to offer, perhaps because it is required rather than chosen.

(DI) The other stuff I can't have any influence over. So as engaging and attractive as that [computer] interface is—it's what's going to key them in initially and create that relationship. . . . A lot of the thinking behind this is based on visits I had to the office [of representative learners], watching people at work, and [seeing] how tight their schedules are and how much multi-tasking there is.

(BI) You know, we see all the stats about how people don't make it [through self-paced instruction]. When I'm thinking about the person, I'm just trying to capture their interest for whatever moment I have them.

Opening Qualities (Hooks, Novelty, Comfort)

The opening of an instructional event is considered critical by each of the participants. It is the opportunity to create a lasting impression and set the tone of the relationship with the learner. It needs to have some kind of hook that draws learners in and encourages them to stay engaged.

(BI) We're always looking for a hook, [an] emotional, intellectual, dramatic hook to get the learner into what's going on.

(EF) It's real important to me that there's a conversational tone that says I'm here, I care about you. I want us to learn from each other. I think about that heavily. Students new to online learning are nervous about it. I'm trying to make it more comfortable.

(AF) I'm hoping that they're sitting there and thinking, "This isn't as scary as I thought." And interested enough to think, "I better come back tomorrow because who knows what she's going to do next."

Narrative Flow

All the participants discussed using narrative elements to create a flow to the instruction and to keep learners engaged through the end. This took many forms, from simply referring to the course as an "adventure" (AF) or facilitating a series of activities that comprise a process of "building things," (EF) to actually centering the instruction on a case, scenario, or "back story" (BI, CI, DI) that learners work through.

(AF) I always try to talk about it with the excitement of, “It’s a journey and this is where we’re going to be going, and we’re going to be discovering these things.”

(DI) By the time they get to question six [in the case study], they’re really caught up. The event is taking place now, there’s [an] ocean-effect [snowstorm]. There are some quirks about how the atmosphere is setting up, there’s some banding that’s not really explained well. So hopefully they’re engaged enough to want to continue . . . that the idiosyncrasies of the case itself will continue to hold their attention throughout all nine questions.

Identity

Participants recognized that learning includes a process of transforming identity and asked learners to assume a new identity within the instruction. In some cases, this was a request to suspend disbelief and take part in a narrative, to have learners identify with a fictional person with an immediate need of the knowledge they themselves are attempting to develop. In others, it was a more direct request to envision their own potential new identity. In both cases, the request can be seen as an attempt to make learners’ identities more malleable, preparing them for the transformation that is one goal of the instruction.

For example, in EF’s online course about instructional strategies, not only do students apply what they’re learning in designing a product of their choosing (often they are practicing professionals or interns, and the class project is for a real audience), but they are told that the course instructors have followed the same process in designing the course the students are currently taking. In this way, the students identify at several levels: as professionals given the opportunity to enhance their craft by following a new model, as IDs in a community of practice sharing reflections on their

profession, and as learners experiencing designed learning activities with a critical perspective.

For DI, transforming identity meant drawing the learner into the scenario using second-person voice—“You are sitting down to your shift,” as if the learner *was* the forecaster in the case study. As the scenario proceeds, the learner has to make decisions and use data identical to those the actual forecaster would have used at the time, furthering the identification.

In the products created by BI and CI, as well, learners are asked to participate directly in a situation in which the instructional content has to be applied, but the narration is more explicit. In CI’s case, the learner is the house guest of a fictional family in Florida, welcomed at the front door of their home, and asked by the family to help prepare for the potential of the coming hurricane. For CI, one of the primary goals of the module is to “connect with people’s lives,” and to show that “people in this place . . . know about hurricanes.” In this way, learners identify with the family in ways that help them “connect that science means something in people’s lives.”

For BI, the identification is not quite as direct, but the story is more complex. Many dramatic situations are presented in the “backstory” in which characters work through problems of practice that require the skills the learners are being taught. Frequently, learners are asked to help the characters analyze their situation or make decisions. BI spoke of the difficulty in creating a narrative that learners would relate to. “If it’s not real or compelling, then it has a tendency to hurt the content, even if the content is true.”

In AF’s case, like that of EF in part, learners are encouraged to identify with the instructor rather than a fictional character. One goal of AF’s teaching is to have students develop a positive attitude toward math, and this is achieved by demonstrating that attitude.

Tension (Withholding)

In some cases, the opening engagement of the instruction is maintained through careful use of tension. Some participants even speak of withholding information in order to create expectation and curiosity. For CI, this is inherent in the narrative structure associated with the approaching hurricane: “Maybe there’s interest and anticipation on when the hurricane’s going to hit . . . That was sort of our goal, to have a little suspense.” Tension was also introduced through game-like elements—forcing learners to explore the fictional location to find the available resources. For DI, tension is also inherent in the case study approach, but there is a small element of misdirection included as well. As the case unfolds, learners would “be confronted with the nuances and why they blew the forecast” (why the weather event misled them, which is likely for this case). Similarly, the “backstory” in the instructional product designed by BI contains a mystery that is solved only by following the story closely, and is revealed only near the end. “There are all kinds of red herrings that are laid out throughout. . . . [The characters] model the content itself in that you don’t want to jump to conclusions. You want to measure, analyze, re-measure. You want the learner to experience that. You draw them into the misdirection.”

The teachers in the study (AF and EF), in contrast to the designers, were more reluctant to introduce tension. As AF puts it, “I think there’s probably more than enough there already.” However, even AF creates a gentle tension with the frequent unexpected activities, like mathematical “sing-alongs.” EF’s original course design began with activities that were likely quite new to the learners, and for which limited guidance is provided. “We are clear in what we want them to build [a design document], but we are not obvious in describing it to them.” EF recalled a comment she had heard from a colleague that justified this treatment: “When you have someone teaching you, you have to suspend your own judgment and

just go where [the teacher] is going”. However, in a follow-on interview, EF spoke of how the course had been redesigned “to make it more coherent, to have it make more sense to people.” In the redesigned course, EF and the co-instructor provided a “roadmap” that better explained where students were headed and why. As a result, no one had dropped the online course at the midpoint, where several students had dropped out in previous incarnations of the course. Perhaps with the nature of online instruction, with its frequently larger transactional distance, and perhaps with the complex nature of mathematical content (for AF), added tension simply places excessive demand on learners.

Limits (Student Acceptance, Practical Constraints)

While all the participants strove to develop engagement, they also realized that some situational factors were beyond their control. For example, students have limited capacity or willingness to suspend disbelief during instruction. In addition, practical constraints mean that efforts can only go so far before budget, development team consensus, and the necessity to cover sufficient content limit them. Artists face similar constraints in working with their materials or developing projects for specific locations.

(DI) Initially I was hoping I could set more of a roll, use a tone that you are on shift, playing the whole game of a case scenario. That’s the first sentence, “You are sitting down to your shift.” I was hoping to sustain that tone, but working with subject matter experts, that tone went away.

(CI) Right off the bat there’s maybe pretty high engagement. Then . . . maybe when they get to this [computer] screen they may be disappointed. Then there’s this worksheet thing, and this inherently means work, so the average student is thinking, “Oh, we’re going to have to do a worksheet?”

Middle Qualities (Growing Comfort, Boredom, Pattern, Routine)

Participants noted varying qualities about the middle instruction events. Some noted that the middle marked a potential growing comfort with the instruction and a willingness to see it through. If the teacher has been successful, he or she will also have gained the trust of learners by this point, and will have created an environment where reaching the end appears achievable. However, some noted that the limitations of engagement strategies rise prominently in the middle, and that it can be a challenge to sustain engagement—the “second act” challenge also faced by authors of novels, plays, and films (Tierno, 2002). If engagement is difficult to sustain, the use of pattern and routine can help learners keep on task, or the instruction might move more quickly into the climax or turning point (discussed in the next theme), or increase anticipation for that climax through careful “plot” revelations or hints.

(BI) If they've been through it all, they know the team [in the back story] and they know the problem. Maybe they're interested. Then hopefully they're starting to get interested in some of the tools. How you can actually measure quality in a service environment. They're starting to get intrigued about what they could do [in their own workplace].

(AF) I think they're feeling pretty comfortable [by the middle]. I think they've figured out by now that it's not me against them. . . . They're much more trusting, and they're believing a lot more of what I do. . . . I think they look back at the beginning of the course and think, “I don't know why I was so scared.”

(DI) [By the middle] I think they'll be thinking that these guys really tried to make it look as if we're really in the midst of a true [weather] forecast. . . . The engagement might be a little less than I

was hoping. . . . [but] I think once they get used to the amount of data at their fingertips, they'll be engaged with the analytical aspects of this.

(CI) By the time they get [to the middle] they know there's a story, they know there's a hurricane coming, they know the routine—they know the drill of the dog thing, then you do the computer thing. They sort of know what to expect.

Climax, Turning Point

None of the participants had difficulty in pointing to a climax or turning point within the instruction. This point may have been either a surprise or puzzle that added an interesting twist, an “Aha” moment, or a low point that was overcome, making the rest of the experience seem easy in comparison. In narrative terms, this is the denouement, the “untying” of the story complication(s). In learning experiences, the aha moment may occur at different times for different learners, but it may be associated with the same sort of content revelation. Some designers specifically attend to this and attempt to build opportunities for such revelations into their designs.

(AF) In a math class, that point in the semester you would call a climax . . . I think is more related to a [difficult] concept. . . . You see this again and again, this struggle point. . . . And that's kind of a low point of the semester. . . . But I do see a lot of students at this point go, “It's not as hard as I thought.” It's a kind of Aha moment.

(BI) [The climax] is when they actually measure and find out what the problem is [in the backstory].

(CI) [In the scenario] we had the electricity go off [when the hurricane strikes]. It breaks up the whole structure and the pacing. And it's timed with how hurricanes [actually] disrupt things.

(DI) There's the juggernaut in there of the [precipitation] banding taking place [in the snow event]. . . . I still think there's no way that you'd ever be able to forecast banding at that level. . . . But I don't see that as a bad thing . . . if it sparks somebody's interest to go research something else. . . . In retrospect, these cases are great to look at, because they are intriguing.

(EF) I'd say [the climax] is when they have to use all the work we've done in the beginning to design a blueprint for their own course. They actually have to pull in everything. And the ones who are able to do that have major Aha's.

Ending Qualities (Closure vs. Open-Endedness)

Participants spoke of mixed goals in providing closure for the instruction. First, there is the goal of providing a solid conclusion to the “story of the course” (EI) by reaching a logical ending. There is also the goal of drawing the entire experience into a unified whole, showing how all the parts of the course were necessary for reaching its intended conclusion. At the same time, there is a desire to keep the end somewhat open, to indicate that the end is another beginning, or that the course is just the starting point for deeper, more important learning to take place.

For AF, while the last Calculus I class session is a time for celebration, with an awards ceremony for those who have gotten “As” on all their tests, there is also the fact that the final few days of the course were spent on Calculus II content, giving students a preview of where they may be heading next. CI felt strongly that the instructional design was faulty in that it didn't provide enough linkage back to the classroom, where the teacher and students could carry forward with other related activities. For EF, the course ends with a reflection and becomes a rite of passage, where learners are told, “Welcome to the group of instructional designers who think through learning.” For BI

and DI, the end of the back story and the end of the severe weather case provide natural closure to the instructional experience.

Teaching as Art

When asked for their opinions about the artistic aspects of teaching and instructional design, each of the participants had well formed thoughts on the matter, indicating that they had considered this question before.

(AF) Watching someone do the teaching process well is like watching a Broadway show. . . . I think the feeling that you get is emotionally similar to looking at great art or hearing great music.

(BI) I think great art changes perception. And . . . great instruction should change perception as well. I don't know that it's been done, but I think that it's possible that great instructional design could be an art form.

(CI) I feel that teaching is a spontaneous, creative art. Teachers think they have a plan, and they have strategies, and the content, but they're in the moment too. There's an aesthetic value in and of itself. I think it's important. It makes learning real.

(DI) You know you've got all these theories . . . but it's a very creative process to actually take your content and put it into a structure. . . . And that's a very creative thing, where you're blending theory with aesthetics and common sense and some usability ideas.

(EF) It's artistic because I can impact people's lives and their emotions. It's artistic because there is no one solution.

Note that different notions of art are reflected in these comments. Some participants express the view of art as based in creativity, spontaneity, and individual judgment—in contrast to traditional

approaches to instructional design as perhaps overly scientific and formulaic. But either in the comments above or as noted in other findings, most also connect the artistic nature of instruction to its transformative potential, its ability to change ways of thinking, emotions, and in the end, the lives of learners.

The Story of a Learning Experience

One of the more significant conclusions to be drawn from the findings is that teachers and instructional designers can and do think about the learner's experience in aesthetic terms, even if they might not be naturally inclined to use those terms explicitly. Taken together, the findings provide a rich description of the aesthetic qualities to be found in learning experiences. Based on the themes that emerged from this study, one can imagine the story of an aesthetic learning experience as it unfolds. The composite picture below is based on beliefs expressed by participants and describes the impacts of the many aesthetic decisions they might make in any instructional situation. It is not intended as a model of learning, but as a story derived from practitioner experience that suggests guidelines for instructional decision making.

As learners enter a formal instructional situation, they may do so with a wide variety of anticipatory feelings. They may be fearful, skeptical that the experience will be worthwhile, ambivalent but willing to trust the instructor (at least for a time), or ideally, optimistic and highly motivated. Each of these initial feelings is either justified or modified by their experience at the start of the course or first engagement with a self-paced product, coloring their attitude as they proceed. Because negative feelings can interfere with learning by reducing either engagement or expectations, the instructor or designer typically has included a strategy to minimize negative impressions. If so, learners may lose their negative feelings (or improve upon their neutral ones) and become engaged with the instruction, either through enjoyable and familiar

activity, unique or pleasant sensory experiences, or the creation of a sense of drama, mystery, or anticipation.

By the middle of the experience, if things have gone well, learners may have forgotten their fears and skepticism. They may experience an increased feeling of belonging and trust, but the reality that learning is hard work has also set in. The beginning phase may have gone by quickly, but the end is still far away and a substantial amount of work remains to be accomplished. The role of the instructor or ID in the middle phase is often simply to make the experience as bearable as possible by providing a routine pattern to the activities and clarity in the instructional communications. Inevitably, some of the luster and newness of the experience is lost, and only if learners maintain sufficient trust in the experience and are sufficiently willing to "suspend disbelief" to continue the temporarily crafted relationship of student and instructor will their engagement stay intact.

Finally, the ending approaches, typically in a fluster of activity. The sheer exhaustion that accompanies the conclusion of this final activity, if kept in balance, adds emotional intensity to a feeling of consummation and restored order. The instructor or ID can provide further closure by creating opportunities for learners to reflect on what they've learned, helping to tie the preceding learning activities into a unified whole by showing how they were each necessary to get to this endpoint. Perhaps there is also a ritual of closure that points out how far learners have come, and there may be reference to the fact that life goes on beyond the experience, but that the future will forever be touched by it, adding significance to the parting.

Trust comes up frequently in the above account because it was stated or strongly implied by participants as a necessary condition for effective learning. Similarly, others have pointed to trust as an intrinsic aspect of artistic endeavors. Cavell's (1976) advice to artists could also be advice for teachers and instructional designers who respect

the individual intentions of their students. He tells artists that they must necessarily take chances, but also to remember that

... you are inviting others to take them with you. And since they are, nevertheless, your own, and your invitation is based not on power or authority, but on attraction and promise, your invitation incurs the most exacting of obligations: that every risk must be shown worthwhile, and every infliction of tension lead to a resolution, and every demand on attention and passion be satisfied—that risks those who trust you can't have known they would take, will be found to yield value they can't have known existed (p. 199).

CONCLUSION

Two essential qualities of aesthetic experience are its *immediacy* and an *anticipation of consummation* (Dewey, 1934/1989). *Consummation* is an experience of unity or coherence in which it becomes apparent that “all the varied parts are linked to one another, and do not merely succeed one another” (p. 55), it. In cognitive terms, consummation is achieved by the integration of knowledge. Dewey also claims that “what is not immediate is not esthetic” (p. 119), suggesting that aesthetic experience is not achieved in reflection only, it arises from a situation in which the immediate details stand out as compelling in themselves. The participants in this study demonstrated that they were concerned with both of these essential qualities in designing learning experiences for their students.

One prominent aesthetic decision made by these practitioners was to use tension to enhance engagement and increase anticipation. Learners may naturally experience tension by confronting complex content in their attempt to fulfill a desire to complete the course successfully, and instructional providers can use and manage this tension to achieve successful results. Instructors and IDs

can impose tension by finding dramatic conflict within the content or by purposefully withholding and releasing information at a controlled pace (see the above comments on tension in the Findings section). The participants also worked to achieve a coherent experience for learners, using narrative or other techniques to reveal how the contents of the course fit together. The dramatic structure of several of the instructional designs inherently created anticipation of a consummation. Finally, a concern for the immediacy of their learners was demonstrated by their abilities to empathize with learners and imagine their thoughts and feelings at each stage of the course or module. They demonstrated clear concern for many details of the learning environment that would help create a rich, immediate (*un-mediated*) experience for learners.

Instructional designers have recently increased their contemplation of the artistic nature of their work (Visscher-Voerman & Gustafson, 2004; Hokanson, Hooper, & Miller, 2008; Hokanson & Miller, 2009). However, their explorations sometimes begin with rather limited stereotypes about the nature of art. One of these stereotypes is that an artist is focused on attractive and pleasurable qualities. Yet any careful survey of the art that surrounds us in books, films, theater, and even the visual arts will demonstrate that artists seek something more substantive than to bring pleasure. They challenge us. Another stereotype is that artists use their own judgment as final arbiter of quality, with little care for their audiences. To the contrary, artistic merit relies more on empathy than insular inspiration. Art is a social phenomenon; meeting needs in all cultures and in all historic periods by helping people understand the dimensions and demands of experience. A final stereotype, arising primarily within the modernist and postmodernist historic periods of rapid change, is that art necessarily includes innovation and experimentation, with little concern for productive outcomes—concerns that are best left to those in other roles of society. However, every artist is con-

cerned with one critical productive outcome—the aesthetic experience of those who appreciate his or her work. Innovation (in technique, material, or subject matter) is but one potential starting point for achieving this. While bringing aesthetics into the discussion of instructional design practice is intended to broaden the concerns of practitioners, the result of using limited notions is to ignore the deeper connections between art and instruction.

This study sought to demonstrate that aesthetics plays a significant role in instructional practice, beyond these superficial views of art and artists. A true instructional artist is less concerned with innovation or attractive products as she is with designing compelling experiences that lead to transformative learning.

FUTURE DIRECTIONS FOR RESEARCH

This study focused on the design of whole courses or large modules that likely take more than one session to complete. It would also be useful to look at smaller and larger scales of learning experiences for ways in which aesthetic principles come into play. What is the pattern of aesthetic experience for individual lessons or class sessions? In what ways do even smaller scale activities play out? What is the role of feedback in adjusting the “qualitative immediacy” during instruction? At the other extreme, one might ask how larger scale experiences, such as degree programs, display aesthetic qualities. These questions are only touched upon in this study and deserve further investigation.

In addition to the descriptive results reported here, further research on aesthetic practice in teaching and instructional design could lead to sets of guidelines for instructional practice. Identifying aesthetic strategies in current practices and finding those that appear to create the desired outcomes can lead to a catalog of aesthetic strategies for instruction. Educators may be able to expand upon and more clearly describe these strategies

by finding comparisons to the strategies applied by artists. For example, Parrish (2009) explores the potential contributions of literary theory to describing learning experiences and deriving aesthetic principles for designing them.

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APPENDIX A

Sample Interview Questions

1. How did you come to be a teacher/instructional designer? What drew you into the profession?
2. How long have you been in the profession? In what capacities have you worked?
3. Tell me about any guiding values or philosophies you hold about your practice. In particular, how do you view your relationship with and responsibility to your learners?
4. How did you come up with the concept for this design? Are there any models or sources that influenced you? Are there any specific products or experiences that led you to this design? Were you influenced by any models or metaphors NOT from instructional sources?
5. Tell me how you view the content of your module/course. For example, is it a set of well defined rules, or is it more complex and open to interpretation? How do you want the learner to engage with and to think about this subject matter?
6. Tell me a story about an imaginary student who might use this module or be enrolled in this course. Make it a typical student, not an ideal one.
 - a. How does the student enter into the module/course? What catches their attention first? What are they thinking and feeling as they begin?
 - b. As they are near the middle of the module/course, what is their experience? What do they remember about the beginning? What do they anticipate about the end? What are they thinking and feeling now?
 - c. Is there a turning point or climax that the student reaches during the course? Describe it(them).
 - d. As they conclude, what are they thinking and feeling? What impression are they left with? What is most memorable about the module/course?
7. Use a metaphor to describe how learners experience the course. For example, you may think about the module/course as either as a physical space the learners are exploring, such as a building, a city, or a park. What catches their eye as they first enter? How do they move through it? How do they exit?
8. Think about the level of tension or engagement of learners as they work through the module/course. How does it change over time? Where does it change? What is that level at the very end?
9. Now think about what it is about your course/module design that creates an initial impression or mindset in the learner. How do you use language to influence the impression or mindset of learners? Visuals? Color? Interactivity? Are there any surprises, conflicts, or disruptions that you purposefully want the learner to experience? How do you want learners to deal with or resolve these? What have you done in the final parts of the course/module to create a lasting impression? How do you “wrap up” the experience for the learner so they can feel a sense of accomplishment?
10. People experience time differently depending on the situation and how they are engaged with it. How do you think learners experience “course/module time” when taking this course/module? How does that experience of time change over the duration of the course/module?
11. In general, in what ways do you think that instructional design/teaching could be described as an artistic process?

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Chapter 8.7

The Pervasiveness of Design Drawing in ID¹

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ABSTRACT

This chapter is a survey of the literature of ID to look at the breadth and usage of design drawings in this discipline to better understand the emerging use of VIDLs to improve designs. To conduct this research, we sampled several ID textbooks, ID journals, software, and case studies looking for examples of design drawing. Design drawings found were then categorized using Gibbons' (2003) seven ID layers as a taxonomy to understand the drawings' purposes. We did not find the same pervasiveness or level of self-awareness as found in other design fields. Examples of design drawings were found, but were somewhat rare. Furthermore, we discovered that those examples we found tended to document only two of Gibbons' seven layers, indicating narrow applica-

tion. We believe this gap represents a serious shortcoming in ID, indicating a lack of tradition, skill, and standards for visual representations of design except in limited ways. At present, design drawing is a rare but growing phenomenon in ID, which, when fully understood and implemented, can only benefit the practice of ID.

INTRODUCTION

This chapter applies a layered concept of instructional design (ID) architecture described by Gibbons and Rogers (in press) to a taxonomy of design drawings described by Stubbs (2006) to produce a refined category system for describing the use of drawing and sketching in ID. The value of doing so is dramatized by Stubbs, who compares the use of design drawing in ID to its use in other design fields, detecting a large disparity. If

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Stubbs' analysis is correct, then designers in other fields have a much richer tradition of the use of drawing in design and a literature that shows a much higher level of self-awareness in the use of drawings during design than most instructional designers would expect.

Design drawing might be considered the primitive of visual instructional design languages (VIDLs). In this chapter we hope to understand where we are with this basic form of VIDL to better understand where we are going.

Though instructional designers excel in the use of drawings of many kinds in their *produced* designs, it would appear that they lag behind other design fields in exploiting the value of drawings and sketches while *designing*.

This deficit has important consequences for the economics, quality, and quantity of instructional designs. Whereas other design fields have begun to capitalize on the power of computers as a design tool, instructional designers seem to be more at the mercy of the tools and design interfaces created for use by others who have more vibrant economies, such as Web and software design. Early attempts to create tools to express designs in the instructional designer's vernaculars appear to have been swallowed up in the success of other design fields, notably the Web and Web development tools (Fairweather & Gibbons, 2000). Only recently has interest in the authoring of learning objects revitalized interest in design interfaces that emphasize ID structures, a trend that we hope will persist and broaden.

The value of the computer to design lies in its ability to take part in routine and mundane decision-making. Successes in computer-aided design have come largely from the ability to describe a design problem (or some portion of a design problem) in terms that can be translated into computer languages. For instance, the design of an architectural column can be translated into sub-problems for the design of the capital, the shaft, and the column base (Mitchell, 1990). If only the shaft sub-problem could be expressed in

computer terms, then that portion of the design could be given computer support, and the remaining sub-problems would depend entirely on human decision-making. By the same reasoning, if only portions (sub-problems of sub-problems) of the design of each of the capital, shaft, and column base could be expressed in such terms, then the design of each of these would require human effort and decision-making, supplemented by some degree of computer assistance. This is the principle today of popular development systems for Web and software design. The involvement of the computer—which is capable of making numerous routine decisions very rapidly and dealing with representation issues at the same time—creates an economic lever. More quantity at higher quality can be produced more rapidly—cheaper, better, faster. And as languages for problem description and solution improve and become more nuanced, the quality and sophistication of the designs improves. This is exactly what has happened to the design of computer chips over the past thirty-five years. Chips designs today are created to human specifications with human decision-making concentrating mainly on high-level design issues. As a result the economics of computer chip design have changed so that a return to hand-drawn circuit design would be an expensive luxury.

This chapter addresses how ID problems can be described in terms of design languages (some portion of which may be translatable into computer languages). It begins by describing research by Stubbs (2006) on the use of design drawing by instructional designers. Stubbs conducted a review of ID literature, and categorized the drawings he found there according to the layers described by Gibbons and Rogers. Stubbs discovered the disparity we have already mentioned between the level of interest in design drawing in ID and other fields of design (see chapter III). He found that, though in the field of design studies there is strong interest in design drawing, there is not a corresponding interest and self-awareness of the use of drawing in the literature of ID.

According to Stubbs:

The general design studies literature has both theoretical and empirical studies on the subject of design drawing. In this literature, design drawing is considered an important, even vital part of design thinking. It is thought of as a design language, which comes in a variety of distinguishable forms, and accompanies and contributes to the design process as it progresses through various stages of development. Studies in this literature show how the intentional ambiguity of design drawing provides space to the designer for creativity and innovation, invoking a kind of dialogue between the designer and the design, which is deemed essential to the design process.... By contrast, the literature of ID has nothing like this level of consideration for design drawing. Instead, the few available articles in the literature of ID touching on design drawing are about proposed notation systems. Evidence of design drawing in the practice of ID as seen in the literature finds that, when it does appear, it is most often concentrated in two aspects of ID identified with Gibbons' content and strategy layers.... To say that there were no examples of design drawing in ID would be hyperbole. However, considering how little was found and how narrowly focused it was, it prompts the question, "What might ID be missing by its lack of attention to this language, so valued in other fields of design?" (p. 85–86. See also chapter III).

Stubbs notes McKim's (1980) observation "that designers with versatility and skill in graphic languages have an advantage, which may apply to instructional designers as well" (p. 134). McKim postulates that "not only [will designers]...find more complete expression for their thinking but also [they will be able to] re-center their thinking by moving from one graphic language to another" (p. 134). On this basis, Stubbs proposes that design drawing in ID "deserves a thorough examination" and presents the typology of design drawings,

described below, that distinguishes six types of drawing that commonly appear in the literature of the field. Only one of these six types is considered design drawing.

Next, the chapter uses the layered ID architecture proposed by Gibbons and Rogers (in press) to categorize design drawings by function. This architecture draws on concepts from many design fields, showing that designs in those fields have a layered architecture that decomposes design problems in functional terms. Baldwin and Clark (2000) describe how this principle of decomposition lies at the economic center of the modern computer industry, making possible design modularity. Gibbons and Rogers demonstrate that layering applies to instructional designs as well, with the benefit that the problem thus described can be solved in terms of existing design languages, most of which are derived from instructional theory or proven design practice.

EVIDENCES OF DESIGN DRAWING IN ID

The experience of many instructional designers strongly suggests that design drawing is a part of ID. However, this chapter will show that ID does not appear to have the same tradition for design drawing, especially during the early phases of design, as is found in other design fields. For this review, evidence of design drawing in ID was sought in several sources: a sampling of ID textbooks, journals, software, and case studies were examined. The ID literature for research about design drawing in ID was also searched. With some notable exceptions, very little was found.

To facilitate the study of design graphics, a typology was created to identify the types of graphics found in ID literature. This section describes this typology as a means to categorize graphics of interest to this study. Gibbons' instructional design layers are then used to provide further

sub-categorization of one of the types of graphics found in the literature.

A Typology of Images

A variety of types of illustrations can be found in the literature of ID. Some are design graphics, but many are not. This typology of images has been devised to aid in distinguishing those that are from those that are not. A sampling of the literature of ID was scanned for graphics, and then those graphics found were categorized into one of five types based on their apparent intent:

1. **Design graphics:** Design graphics illustrate some aspect of the design of a specific piece of instruction for the purpose of planning or building that instruction.
2. **Content graphics:** Content graphics are part of the instruction delivered to learners that aid or support learning.
3. **Reporting graphics:** These graphics are used to illustrate or report the outcomes of research.

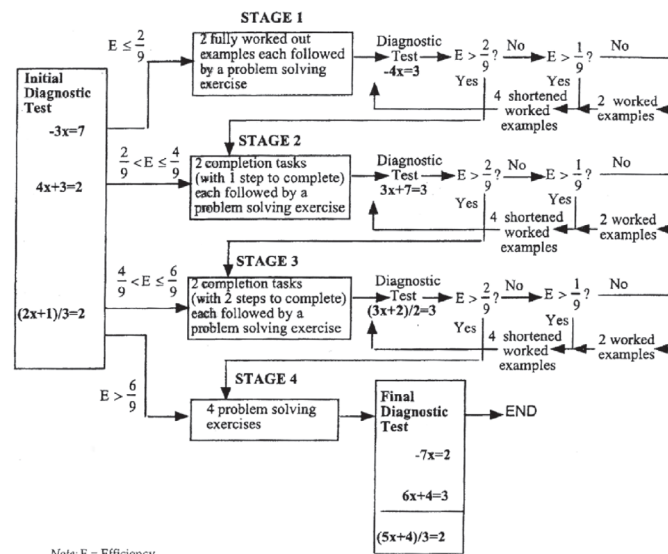
4. **Illustrations of ID models:** Graphics of this sort are illustrations that represent processes of design or construction of instruction. Diagrams of the popular ADDIE or ISD processes fall into this category.
5. **Instructional models & learning models:** These graphics include illustrations of the components of instructional theories or learning theories and the relationships among them. They are sometimes not differentiated from ID models (type 4).

The principal difference among these types is intent; the surface form may not be the discriminator. For example, it is possible to imagine a graphic, whose intent is unclear without the accompanying explanation. The mere existence of a diagram with circles and boxes connected with lines would not be enough to determine a graphic's purpose.

Let's examine each of these different types of graphics found in the research literature.

Figure 1 is an example of a type 1 graphic. It is clearly related to some specific piece of

Figure 1. An example of a type 1 graphic from ETR&D (Kalyuga & Sweller, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT]. Used with permission.)



instruction, charting the flow of procedures for training a specific piece of content. It may have been created to help a programmer or developer understand what was supposed to happen in this instruction.

Notice the specific content in the graphic in Figure 1. Type 1 graphics have information, either in the diagram or in the accompanying context, that ties them directly and clearly to the design of a specific piece of instruction. They may refer to specific content, as does Figure 1. They illustrate the structural elements, flow, process, information chunking, or some other aspect of the specific instructional design. To determine if a graphic is of type 1, ask, “Was this graphic representation created to assist in the creation of specific instruction?”

Type 2 illustrations are distinguished from type 1 by being part of the content of the instruction, rather than part of the design. That is, they are presented to the learner. Figure 2 was part of the content of experimental instruction trying to determine the difference in value between using mimetic icons versus standard square icons in a content graphic.

Computer screen shots of finished computer assisted instruction (CAI) are common illustrations in the sources reviewed. These screen shots

should be considered type 2. To decide if something is type 2, ask, “Was this graphic representation part of what was presented to learners during instruction?”

Type 3 graphics are used to illustrate the outcomes of research. They are often employed to help make statistical results more transparent to the reader. Bar graphs, pie charts, line graphs, etc., are common, though they are not limited to these. They are distinguished from type 1 because they illustrate the results of evaluation or research rather than the proposed design of a piece of instruction. Figure 3 is a typical example of type 3 graphic which supports a report on outcomes of research.

To determine whether a graphic representation belongs to type 3, ask, “Does this graphic help report the results data or other outcome of the evaluation or research?”

Type 4 diagrams are used to illustrate models of design processes, what Reigeluth (1993) calls an “instructional-design process” (p. 13). Figure 4 shows Dick and Carey’s model for the systematic design of instruction—a classic example of an illustration for a design process. The purpose of type 4 graphics is to help the reader understand a design process model, i.e., how to design or create instruction.

Figure 2. An example of two type 2 graphics from ETR&D (Griffin & Robinson, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT]. Used with permission.)

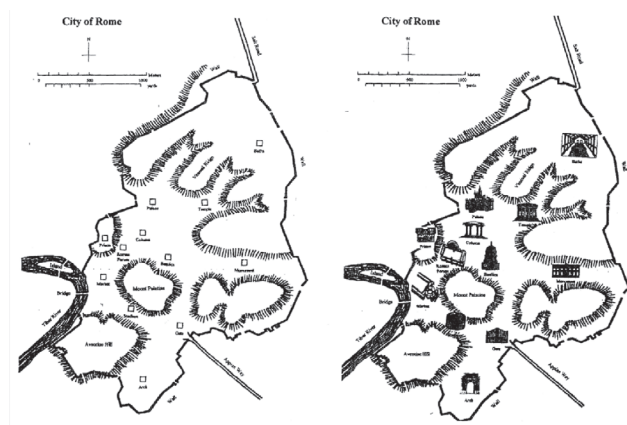
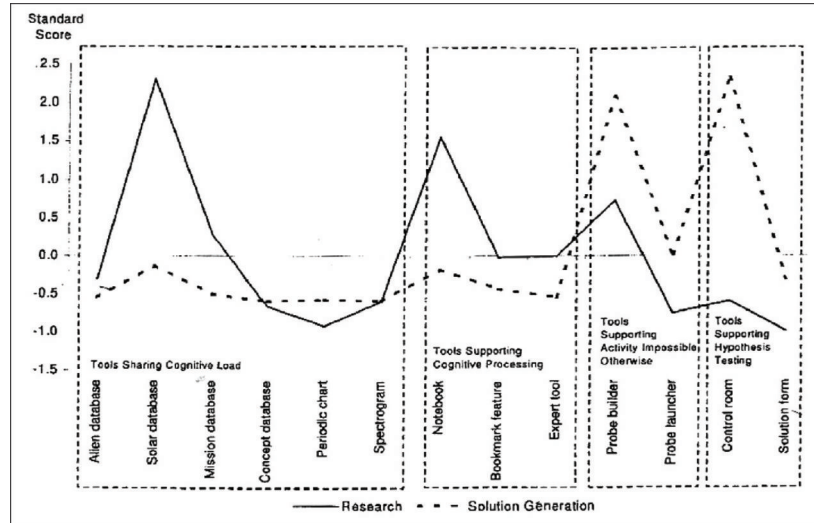


Figure 3. An example of a type 3 graphic from ETR&D (Liu & Bera, 2005) (Copyright © 2005, The Association for Educational Communications and Technology [AECT] Used with permission.)



To clarify whether a diagram belongs to type 4, ask, “Does this graphic illustrate a design process or theory about how instruction ought to be designed?”

Finally, type 5 diagrams illustrate instructional models and learning models. Figure 5 is an example of a type 5 diagram. Note that it describes or illustrates a general principle of teaching or learning and is not specific to a particular piece of instruction nor does it describe a process by which instruction is created. This type of diagram would normally be illustrating an instructional theory or learning theory.

Design theories and models (type 4) are often confused or conflated with learning and instructional theories and models (type 5). May (2006) distinguishes between design theories and learning or instructional theories by noting that design theories pertain to how someone designs an instructional product to achieve certain objectives, whereas learning theories pertain to how someone receives, processes, and remembers information. Though similar in some respects to type 4, design process model diagrams, type 5 diagrams can be distinguished from the others by asking, “Does

Figure 4. From Dick, Carey, and Carey, *The systematic design of education*, 5th ed. (Published by Allyn and Bacon, Boston, MA. Copyright 1985 by Pearson Education. Reprinted by permission of the publisher.)

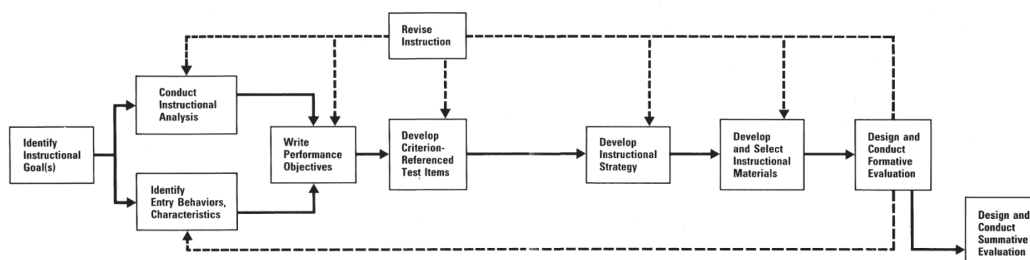
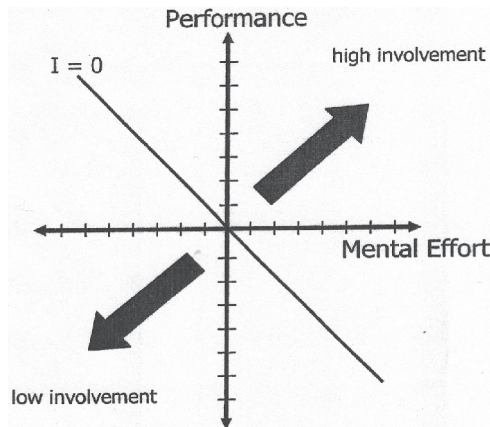


Figure 5. An example of a type 5 graphic from ETR&D (Copyright © 2005, The Association for Educational Communications and Technology [AECT] Used with permission.)



this graphic illustrate a theory of learning or a theory of instruction?”

While this typology covers the majority of illustrations one might expect in research about instructional design, other kinds of images occasionally occur. For example, a photograph of the principal of a school where an intervention took place, is probably not easily placed into any of the types proposed.

Extending the Typology of Type 1 Design Graphics with ID Layers

Once graphics have been established as type 1, design graphics, is possible to extend the typology to identify and distinguish them from each other. This sub-level of categorization provides the ability to see how widely design drawings are used throughout the design process.

This sub-categorization is accomplished by adapting a concept put forth by Gibbons (2003) called instructional design layers. Gibbons has observed that instructional design often takes place as the design of several interrelated layers. Design of each layer can be considered separately from the other layers, providing an important

modularization to the design effort. The design of each layer is expressed in design languages, and these languages define the scope of designers’ thinking. Gibbons’ instructional design layers are:

- Content
- Strategy
- Control
- Message
- Representation
- Media-logic
- Data management

At the content layer, the designer defines the units of content segmentation, determines the method of content capture, and defines the kind of content elements that will be gathered. The design problem in the strategy layer consists of several interrelated sub-problems concerned with structures of time, goals, sequence, activity, physical setting, and social relationships are decided. The design problem within the control layer is the means of communication of messages from the learner to the source of the learning. The message layer determines the types of instructional messages, how they are composed, and how they are generated. The representation layer is the selection of media types, the selection of media, its generation, and the rules governing its structure and display. The design problem within the media-logic layer involves the description of execution structures that enact the representation and interactions. The design problem at the data management layer is to plan the capture, storage, analysis, aggregation, interpretation, and reporting of data produced during instruction.

To determine the pervasiveness of design drawing in ID, this typology and its extension of type 1 graphics by ID layers has been applied to a number of sources to discover and analyze examples of design drawing in ID. These sources are discussed below.

ID LITERATURE SAMPLING

A sampling of common texts in the field of ID was searched for images. Images found were then filtered through the typology above to identify examples of design drawings, type 1, in the texts. The texts included in this review are common, well-known textbooks about instructional design. Included in this review are the following textbooks: *The Systematic Design of Instruction* (Dick & Carey, 1990), *Principles of Instructional Design* (Gagné, Briggs, & Wager, 1992), and the two volumes of *Classic Writings on Instructional Technology* (Ely & Plomp, 1996). An argument could be made to bring in other texts not included here, but these are an adequate representative sample for our purposes.

The original edition of Dick and Carey's book from the late 1970s is the source of the first "Dick and Carey model" of instructional design known to nearly every instructional design student of the last thirty years. This model is particularly helpful to inexperienced or beginning instructional designers because it provides a complete systematic approach to the process of instructional design. (This review uses the 1990 edition of the text.)

The familiar blue and violet book by Gagné, Briggs, and Wager (1992) can be found on the bookshelf of nearly every instructional designer trained in the 1990s. Its presence on the bookshelves of colleagues often means that it was purchased as a class textbook, but it was kept for its ongoing value as a reference. This textbook provides a rational basis for much of the practice in instructional design, based in cognitive psychology and information processing theory.

The two-volume set from Ely and Plomp (1996) is a collection of classic literature in the field of ID. As such, it has value for both its historical reach, and the breadth of coverage. These volumes of classic articles reveal some of the roots of the field of instructional technology in audio/visual production and distribution, about which many of the papers are concerned.

For the purpose of this review, three respected ID journals were also scanned for graphics. Graphics found were categorized by the types above to discover any type 1, design graphics. The journals surveyed included: *Educational Technology Research and Development* (ETR&D), *Interactive Learning Environments* (ILE) and the *Journal of Educational Technology Systems* (JETS). It was felt that this combination of journals gave a sufficiently broad cross section of the field to effectively represent graphic communication in ID research literature.

ETR&D is a bi-monthly research publication of the Association for Educational Communications and Technology (AECT). It contains sections on both research and development, as well as book reviews, international reviews, and research abstracts. AECT has a historical connection to schools and libraries (especially audio/visual departments) and has good relationships with the faculty and students from universities that have degrees in instructional technology. AECT is an international organization, but its roots are American, and the majority of its members are from the United States. Articles in ETR&D tend to reflect this orientation. For this study we looked at all the graphics in volume 52 (2004), one full year.

ILE is an international journal published in Europe about the impact of technologies (the Internet, groupware, multimedia, etc.) on education, training, and life-long learning. The journal includes articles that cover both tools and organizational support required for authoring and implementing courseware. ILE is published three times a year; one publication contains two volumes. We reviewed volume 12, numbers 1 and 2 (a single publication), volume 13, numbers 1 and 2 (also a single publication), and volume 13, number 3. This covers roughly a year and one third.

JETS is published by Society for Applied Learning Technology (SALT). This quarterly journal deals with systems in which technology and education interface with special emphasis given to the use of computers as a component

of education systems. Members of SALT tend to come from the ranks of government and military, industry, and education, in that order. JETS reflects this priority in the types of articles it contains. For purposes of this study volume 33 (2004-5), covering one year, was reviewed.

Instructional design software was also considered. Since the early days of multiple slide projectors driven by cues on a sound track, multimedia has been explored as an instructional medium. Since the computerization of these tools, there have been graphic user interfaces among instructional multimedia authoring tools. PCV3 from Control Data and forms of visual PILOT (a computer-assisted instruction language; the acronym stands for programmed instruction, learning, or teaching) are examples of these. Of all these systems, Authorware enjoyed a unique position by being popular as a general-purpose multimedia authoring system as well as an instructional design solution, in spite of the fact that it was expressly developed to serve the needs of ID. Though they are very popular with instructional designers, Macromedia Director and Flash, are not reviewed for this study because they are general-purpose multimedia authoring tools, though they are used extensively in the production of instructional materials.

Authorware was selected for discussion in this section because it is by far the most popular ID-specific tool and it uses a graphic user interface that mimics traditional flowcharting familiar to instructional designers and others.

It may be argued that ID textbooks and journals would not be a fruitful source of ID graphics because they are mostly concerned with general theory and broad explanations. If that were true, then one particular kind of study would be more apt to provide evidence of design drawing in instructional design: case studies.

Indications that cases may be a fruitful source of examples of design drawing in ID can be found in a popular set of competencies for instructional designers called "Competencies and Skills for Instructional Designers" (Analysis & Technol-

ogy, 1995) of this list of competencies suggests that instructional designers be competent in the ability to:

- Develop flowcharts to identify learning events at the frame specific level using standardized symbology
- Develop storyboards using a template appropriate to the needs of the project

Case studies may be found in journal articles, dissertations, and books. For purposes of this study, one book of ID case studies, plus five additional case studies were reviewed.

The book of ID case studies reviewed is *The ID Casebook: Case Studies in Instructional Design* (Ertmer & Quinn, 2003) which is a compilation of 36 instructional design cases for use as practice by beginning instructional designers. Five additional case studies, four dissertations and one research article, were also reviewed. Most of the additional case studies were found by searching Doctoral research in educational technology (2005) as well as Digital Dissertations (University Microfilms) and ISI Web of Science (Institute for Scientific Information), searching for the term "case study" in the title of instructional design articles and dissertations. Case studies were considered that seemed to cover the instructional design of materials, rather than other cases (such as those about educational programs or processes), as it was thought that these would be the most productive sources of design drawing. The article is by Gastfriend, Gowan, and Lane (2001) and the dissertations include Ludwig-Hardman (2003), Hall (2004), and Twitchell (2001). Another dissertation, May (2006), was recommended by a colleague.

Although drawing as a method of design has been discussed in general literature of design studies since the 1960s and before (Jones, 1970), it has only recently become the object of study in ID. Initially, the search for ID literature about design drawing was frustrating—particularly with automated search tools. Any attempt to combine

terms like “drawing,” “graphic,” or “representation” with “instructional design” or “instructional technology” invariably resulted in research titles that had to do with the use of visual media in designed materials (type 2), not for their design and development (type 1). However, by careful screening, a few studies were identified that seemed relevant. These are: some articles authored by Gilbert Paquette and others (Paquette, 1996; Paquette, Aubin, & Crevier, 1994; Paquette, de la Teja, Lundgren-Cayrol, Léonard, & Ruelland, 2002; Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006; that design language is presented here in Chapter 2.3) about proposed graphic notation systems for ID; and, an article by Figl and Derntl (2006) which discuss visual instructional design languages (VIDL). One of the VIDLs discussed in Figl and Derntl is Botturi’s E²ML. we will also discuss Botturi’s (2003) dissertation on E²ML in detail.

Results of ID Literature Review

Textbooks

For this literature review, three textbooks, Dick and Carey (1990), Gagné, Briggs, and Wager (1992), and Ely and Plomp (1996) were reviewed. All the graphics and illustrations in these textbooks were classified according to the typology discussed earlier into one of five types (or miscellaneous if they did not seem to fit any of the categories). This classification is presented in Table 1.

In two of the books, design drawings predominate, taking 42% in Dick and Carey (1990)

and 62% in Gagné, Briggs, and Wager (1992). In Ely and Plomp (1996), design process model diagrams—type 4—lead, but with only 33% of the total. The difference in dominance of type 1 in the first two books versus type 4 in the last book can be explained by the differences in the purposes for which the books were written. The textbooks by Dick and Carey, and by Gagné, Briggs, and Wager are both intended as textbooks for the beginning designer. As such, they provide basic instructional design process information for guiding the novice instructional designer in her beginning work. This explains the prevalence of instructional design examples represented by these design drawings. Ely and Plomp, on the other hand, is a collection of miscellaneous papers from various sources brought together because of their seminal value to the field of ID. Because many of these papers propose instructional design models, the prevalence of type 4 model graphics should not surprise us.

The beginning of each chapter of Dick and Carey starts with a duplicate of the diagram of their model, with that chapter’s step highlighted. Because the same diagram is repeated each time to aid in navigating the book, these model graphics were only counted once. Also, Dick and Carey contains a relatively large number of graphics categorized as “miscellaneous.” Most of these miscellaneous graphics are depictions of proposed elements of their notation system for skills analysis. As such, they do not fit neatly into any of the categories.

The preponderance of design drawings or graphics in both Gagné, Briggs, and Wager, and in

Table 1. Types of graphics found in three ID textbooks

	Type 1 Design	Type 2 Content	Type 3 Report	Type 4 Process	Type 5 Instr'l	Misc
Dick & Carey	28	2	6	6	9	15
Gagné, Briggs & Wager	16	4	1	4	1	0
Ely & Plomp	2	7	4	12	4	7

Dick and Carey was unexpected. Closer inspection of these graphics reveals that nearly all of these type 1 design graphics occur in the first third of both books, and all of them are examples of skills analyses. Each book sets forth a slightly different notation system for illustrating the results of skills analysis.

Viewing the skills analysis drawings through Gibbons' (2003) instructional design layers, discussed earlier we found that all the type 1, design graphics, in Dick and Carey, and in Gagné, Briggs, and Wager, fall within the content layer. As such, they are an important use of design drawing in their own right, but represent only a small fraction of the potential uses of design drawing in ID.

In summary, examples of design graphics in these textbooks are common, but limited to only one of Gibbons' seven layers of instructional design: content. If design drawing itself were considered an important aspect of instructional design work by these authors, we would have expected to examples illustrating other of Gibbons' design layers represented in this sample literature. Interestingly, content or skills analysis is often used as the starting point for instructional design, so the use of graphic as an aid to the start of instruction is noted.

Journals

For this literature review, three ID journals were reviewed. They are *Interactive Learning Environments (ILE)*, *Educational Technology Research and Development (ETR&D)*, and the *Journal of Educational Technology Systems (JETS)*. All the

graphics and illustrations in selected issues were classified according to the typology discussed earlier into one of five types. This classification is presented in Table 2.

The three journal titles that were sampled for this study show some variation from the results of the textbooks.

In these journals, many articles demonstrated or discussed specific instructional design projects. As a result, type 2 graphics (screen shots from instructional computer programs and other illustrations of content) predominated: in *ILE* 56%, in *ETR&D*, 31%, and in *JETS*, 48%.

In *ETR&D*, the balance between research and development articles is reflected in the balance between type 2, content graphics (31%), and type 3, report graphics (29%). *JETS* is similarly balanced between type 2 and type 3.

Type 1 graphics, while not the least common, are always in the minority. In *ETR&D* they were the smallest category, 2%; they are the third smallest category in both *ILE* at 14% and, in *JETS*, at 9%.

In summary, even more dramatically than in the textbooks analyzed, these numbers indicate the relatively light value placed on type 1, design graphics, in the journal literature of ID. Instead, we find a preponderance of type 2, content graphics, often, captured computer screens or graphics, used to illustrate reports about specific products.

Software

Authorware is the ID multimedia authoring software reviewed in this study. The original Authorware, called Course of Action, was created by

Table 2. Types of graphics found in three ID journals

	Type 1 Design	Type 2 Content	Type 3 Report	Type 4 Process	Type 5 Instr'l	Misc
ILE	11	46	7	14	3	0
ETR&D	1	13	12	8	4	4
JETS	5	30	26	2	0	0

programmer and instructional designer Michael Allen who had been working on Control Data's PLATO courseware. It was his intent to build a system that would require little or no programming to produce instructional courseware. (Wikipedia: Authorware)

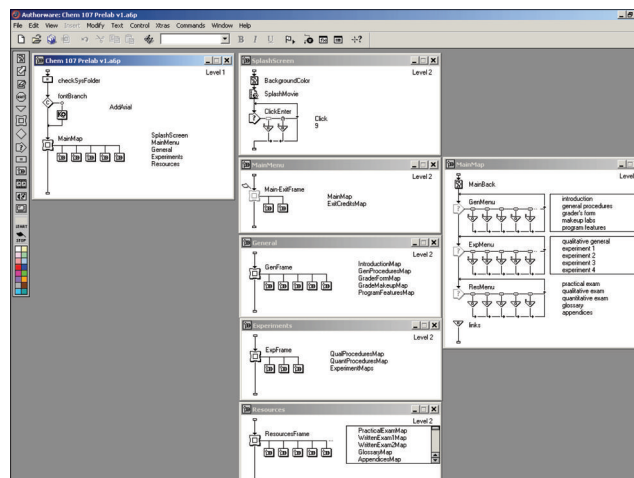
To build a presentation in Authorware, the designer drags pre-defined behavior icons from a palette of behaviors onto a design window. Once in the design window, a behavior's specific attributes can be set. The behavior icons in the design window are connected into a visual flowchart called a flowline, which determines the sequence in which the behaviors are executed. Figure 6 shows several design windows with flowlines in them. Also note the palette of behaviors on the left side of the figure. Behaviors include display, motion, erase, navigation, interaction, calculation, movie, and others. The available behaviors have changed over the life of the product. When an Authorware presentation is executed, the behaviors play out their actions on the presentation window (not shown).

It is surprising that Authorware is one of the few ID products that uses a visual approach to design. The dragging of behaviors to the design window and connecting them into a *flowline* is a

good example of a visual metaphor. Authorware's iconic, visual interface allows designers and authors to work more efficiently. The visual metaphor excels at providing the author the ability to see the flow of media-logic and to catch logical errors in thinking.

However, much of Authorware's functionality is not accessed visually, but by means of dialog boxes for specifying the attributes of behaviors and in other non-graphic ways, including a complete scripting language inside the application. Viewed through Gibbons' layers of ID we find that the flowline—the most graphic aspect of Authorware—is limited to Gibbons' strategy layer and media logic layer because it allows the designer to define the sequence of instructional events, and it directly affects the logic of execution. Visual means are also provided for composing the screen presented to users (the representation layer) but each screen must be composed separately—there is no way to compose families of screens through the visual interface (though it might be scripted in the scripting language). There are also ways to add control elements to the screen (addressing the control layer), but, except for their placement on the screen, the manipulation of these screen controls is not performed through the visual

Figure 6. Authorware presentation's behavior palette (far left) and several flowlines



interface. Authorware does have some built-in student tracking capability (supporting the data management layer), but more than basic functions of this capability require scripting. Authorware has no provision for the content layer, or for the message layer to be addressed by the designer.

Case Studies

Of the six sources for case studies reviewed, only two illustrated significant examples of design drawing. In the other four, there was little or no evidence of type 1 design graphics (though several of them did have examples of types 4 and 5—graphics supporting instructional design process models and instructional or learning models).

The first source of ID case studies examined was Ertmer and Quinn's *The ID Casebook: Case Studies in Instructional Design* (2003). Ertmer and Quinn contains only one illustration of type 1, shown in Figure 7. It is the results of a skills inventory for flight attendants. Like the design graphics found in the textbooks, it addresses Gibbons' content layer.

Of the five additional case studies chosen, the research article (Gastfriend, Gowen, & Layne, 2001) and two of the dissertations (Hall, 2004; Ludwig-Hardman, 2003) contained no examples of design drawing at all.

The dissertation-case study by Twitchell (2001) contains in an appendix a copy of the design document for the courseware about which the case is written. Included in this design document are several instances of design drawings and representations. Here is a sampling:

1. A structural perspective: component parts (a venn-diagram-like illustration, with a circle and squares representing instructional components), p. 199.
2. A data-flow diagram, p. 200.
3. A logic & data-flow diagram, p. 202.
4. Several tables containing important data.

5. A rough screen shot of the initial screen, p. 214.
6. Several other rough (wire-frame?) screen shots, pp. 10, 11.
7. A flowchart of instructional logic for a drill, p. 234.
8. The instructional flow of the program, p. 237. (see Figure 8)
9. A screen shot (more refined than previous screen shots, but still not final) + pull-down menu items, p. 240.
10. Additional screen shots, pp. 242, 244, 245, 247, and 249.

These figures comprise a fairly broad representation Gibbons' ID layers. For example, the rough screen shots (items *e*, *f*, *i*, and *j*) are intended to guide the developer in the production of user-interface screens. As such they are clearly illustrative of the representation layer in the abstract, but probably also contain elements of the content and message layers as well. Item *a* is a broad view of the strategy layer as it applies to the entire piece of courseware; *g* is an example of a narrow view of one component of the courseware at the strategy layer. Item *h*, shown in Figure 8,

Figure 7. Simplified job map for level 1 flight attendants (Ertmer & Quinn, 2003, p. 68). Reprinted by permission of Pearson Education, Inc., Upper Saddle River, NJ)

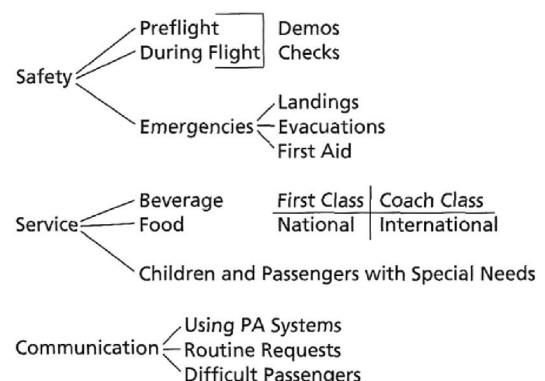
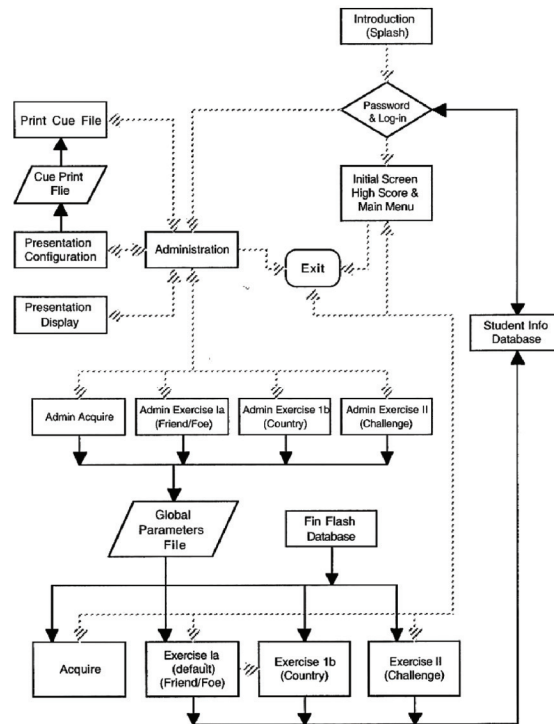


Figure 8. Program instructional flow from Twitchell (2001)



illustrates aspects of both the strategy layer as well as the media-logic layer.

Another example of a case study is a dissertation by May (2006) which analyzed the use of Gibbons' (2003) model-centered instructional design theory by a team of instructional designers tasked to design an instructional simulation. May carefully transcribed design sessions, and analyzed photographs of the rough design sketches drawn on the white board during design sessions. One of these photographs is shown in Figure 9. Many of the features of design drawing, are apparent in May's study.

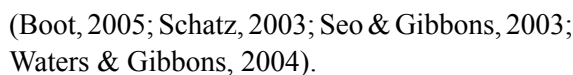
May's study was unique among the case studies that we encountered in the depth to which he analyzed the design process. Parallels between the general field of design and ID became clear in May because of his careful and thorough reconstruction of events and words. May's study is a wonderful window on the ID process in gen-

eral and model-centered instructional design in detail.

To summarize, only two of the case studies reviewed gave insight in the role of design drawing in ID. The fact that we found so few speaks to the point that design drawing is not commonly discussed in ID as it is in the general design literature.

ID Literature about Design Graphics: VIDLs

Our search uncovered three important sources of research on the topic of design drawing in ID. They are an article by Figl and Derntl (2006), a dissertation by Botturi (2003), and the research of Paquette, et al. (Paquette, 1996; Paquette, Aubin, & Crevier, 1994; Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006). These three sources are reviewed below. They are part of an increased interest in visual ID Languages (VIDLs)



One example of this increased interest is the report of Figl and Derntl (2006), comparing the value of three VIDLs for the design of blended learning courses. What all these VIDLs have in common is their connection to the concept of learning objects and the SCORM (sharable courseware object reference model) standard. The three VIDLs compared are E²ML (educational environment modeling language), PCeL (Person-centered e-learning), and EduWeaver.

E²ML, a VIDL by Botturi (2003) is a semi-formal modeling notation for creating and documenting instructional designs. Its notation is similar to the unified modeling language (UML) used in object-oriented computer programming, substituting learning objects for computer-code objects. PCeL is founded on the person-centered philosophy of Carl Rogers (1983) but related to Alexander's (1979) concept of architectural pattern languages. PCeL includes a library of instructional patterns, modeled in UML activity diagrams, which serve as templates for the creation of instructional instantiations. EduWeaver is a Web-based courseware design tool that uses a

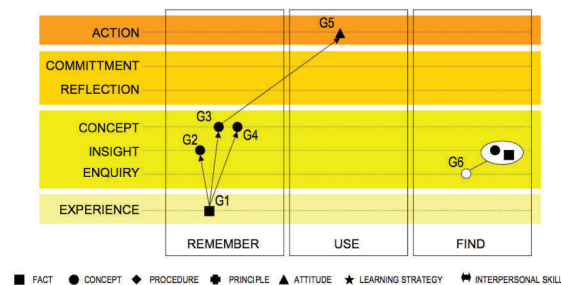
modeling framework for grouping and sequencing learning objects into cohesive lessons, modules, and courses into its own visual format.

Of these three, Botturi's E²ML can notate the widest variety of instructional constructs (see also Chapter VII). Botturi (2003) describes the intent of E²ML as a kind of blueprint for instructional designs, allowing all stakeholders in an instructional design effort the ability to agree on details of design. His goals for E²ML are to provide a notation system that will visually support design and development, document a design, and support evaluation.

While Chapter VII of this handbook presents a more lightweight version of E²ML, its original presentation, in 2003, proposes a wider set of inter-related diagrams. One of the principal strengths of E²ML is indeed the many varied types of diagrams that can be used for various purposes. This flexibility comes from adapting a majority of UML's views to instructional design purposes. Botturi proposes several types of ID diagrams, shown in this list of diagrams (Botturi, 2003, p. 82) below:

1. Goal definitions
 - a. Goal statement

Figure 10. An example of an E²ML goal mapping diagram showing dependencies (Botturi, 2003, p. 94)



- b. Goal mapping
- 2. Action diagrams
- 3. Resource lists
 - a. Role and actor list
 - b. Location list
 - c. Tool list
- 4. Overview diagrams
 - a. Course breakdown statement
 - b. Dependencies diagram
 - c. Activity flow

Figures 10, 11 and 12 are examples of a few of these types of diagrams. Figure 10 is an example of a goal map (item 1b on Botturi’s list, above), showing dependencies among instructional goals. It was produced following the specifications of the QUAIL model, a sub-model of the original E²ML specification. The symbols on the diagram labeled “G1,” “G2,” etc., represent different goals, Figure 11 is an example of an action or activity diagram (item 2 from Botturi’s list). Note the goals which this instructional action is supposed to address, listed along the right side. Figure 12 is an activity flow diagram (item 4c on the list above), “A1,” “A2,” etc., are the identifiers for specific activities and the diagram shows their order of occurrence. All of the various types of representation in E²ML are related to design, and fall under type 1.

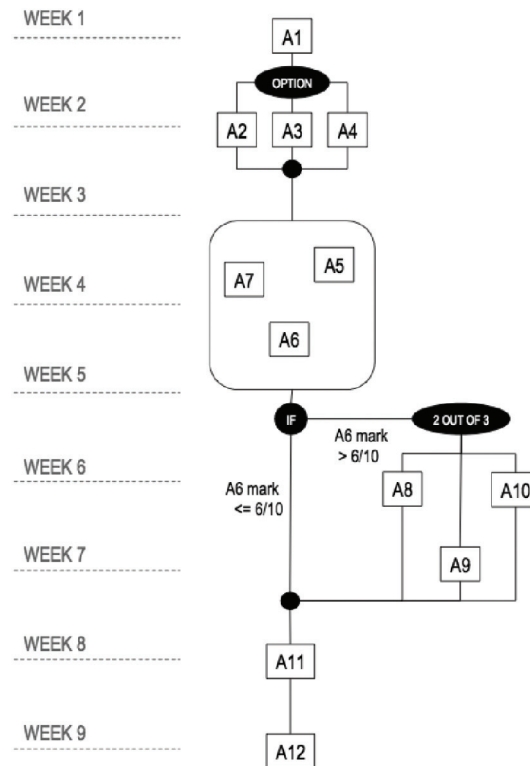
While E²ML’s many types of diagrams give it broad coverage, nearly every diagram can be related to Gibbons’ strategy layer in one way or another. However, most diagrams also contain

elements for multiple layers and integrate those layers together. For example, the goal mapping diagram (item 1b from Botturi’s list of diagrams above; see Figure 10 for an example) as well as his dependencies diagram (item 4b from Botturi’s list) address Gibbons’ content layer as well as the strategy layer. E²ML’s action diagrams (item 2 from Botturi’s list; see Figure 11 for an example), sophisticated tables of information, document some aspects of Gibbons’ control layer, as does the activity flow diagram (item 4c from Botturi’s list; Figure 12 is an example). Despite the preponderance of connections to the strategy layer, many of these diagrams integrate support for other layers as well.

Figure 11. An E²ML action diagram (Botturi, 2003, p. 98)

Website analysis		WA
Students (all, assigned groups), Tutor		LEARNING
Master the W2000 hypemedia design model	Increased mastery in W2000; critical analysis of a Web site (distinguish good design from errors)	G3
Browsing the Web; Using MS PowerPoint + MS Word	-	G4
The Web site to be analyzed	Analysis report (10 pages max., diagrams in PowerPoint)	G5
(Group) Visit the assigned Website, reconstruct its content and navigational structure. Represent it with W2000. According with the Web site requirements, identify design inconsistencies and potential usability problems. Write a report according to the guidelines		G6
(Tutor – available in defined timespans during the week) provide support and guidance at intermediate states of the analysis.		
DURATION: 8 hours in the 4 th course week		
[anywhere] PC129		
W2000 specification, course syllabus		

Figure 12. An example of an E²ML activity flow diagram, (Botturi, 2003, p. 103)



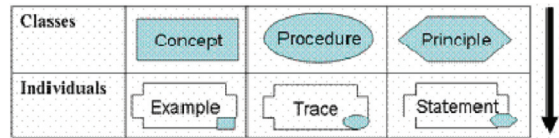
Botturi's goal for E²ML is that it serves as a means for detailing instructional designs with a high level of specificity like the finished blueprints in architecture, or the detailed orthographic projection drawings in engineering. E²ML is being used to provide unified curricula among schools in Switzerland with different languages and cultures. Its high level of specificity allows it to do this. E²ML portrays the final, detailed outcome of design thinking, not the process by which it occurred, much like the design document examples found in Twitchell's (2001) case study discussed above. E²ML diagrams provide a level of detail that supports collaboration as well as detailing, documenting, and communicating a fully developed instructional design (as a language of design).

Paquette (1996; see also Chapter 8) created a graphic notation system, with supporting software, called MOT (an acronym for the French

term *Modélisation d'Ojets Typés*). MOT includes symbols (see Figure 13) for abstract knowledge classes (concepts, procedures, and principles), as well corresponding individual facts (examples, traces, and statements). Similarly, lines (arrows) connecting the symbols also come in a number of types. MOT's abstract knowledge classes correspond to object-oriented programming *classes* and individual facts correspond to the *instantiations* of the classes.

Because MOT can be used for both abstract classes as well as specific instantiations, it is able to describe both models (types 4 or 5) and instances of instruction (type 1). Figure 14 shows an example of a generic cognitive skill model ("Simulate a process") on the left, and an activity structure based on this general skill ("Choose a multimedia production process") on the right. Figure 14 does not show a third level of specific-

Figure 13. The integrated vocabulary of the MOT representation (Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006)



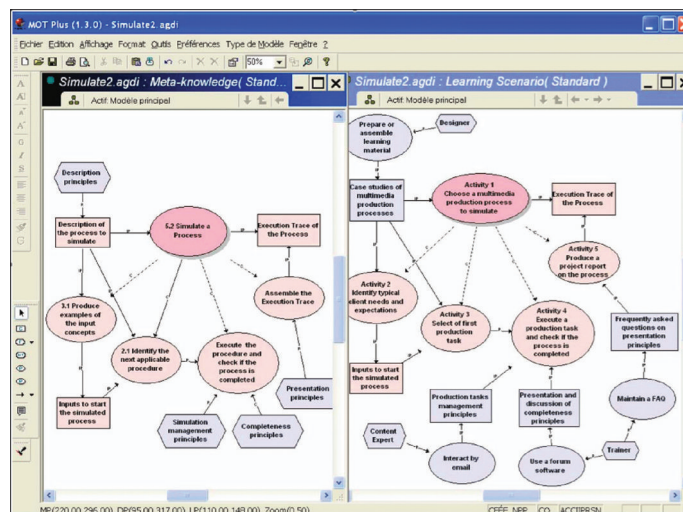
ity with specific instantiations of the classes in the general skill diagram, using the second set of symbols. The level of specificity it adds to the common hierarchical flowcharts of skills analyses, such as those found in Dick and Carey (1990), and in Gagné, Briggs, & Wager (1992) make it a good augmentation to these diagrams of content layer material.

Examples of MOT from Paquette's writing most often document Gibbons' content layer (for example, knowledge analyses), and strategy layer (for example, instructional activities). With MOT's primitives, this notation system can be applied to virtually any general notation task that uses containers and arrows, such as Laseau's (1986) bubble diagrams and networks. Because of its basic structure, MOT might be used to il-

lustrate other layers of design if those layers can be illustrated abstractly.

MOT's basic approach also makes it flexible enough to serve the various stages of design. As noted, Paquette and his colleagues have created software for creating MOT diagrams, but virtually any diagramming software that allows custom symbols (such as Visio or Omnigraffle) would be capable of implementing MOT. In addition, MOT's symbol set and concept are simple enough that they could be the basis of hand-drawn design drawings.

Figure 14. A MOT diagram showing both a meta-knowledge representation and a learning scenario (Paquette, Léonard, Lundgren-Cayrol, Mihaila, & Gareau, 2006)



SUMMARY OF DESIGN DRAWING IN ID

Our purpose in this chapter has been to understand the usage and breadth of design drawings in ID. These visual representations of instructional design are closely related to VIDLs. In other design fields, the use of graphics, sketches, or drawings in design is highly developed widely studied (see, for example, Robbins' (1998) book *Why Architects Draw*.)

We began with a review of ID literature to see if we could observe a similar tradition in ID. To conduct this review, we sampled several ID textbooks, ID journals, software, and case studies looking for examples of design drawing. We learned to distinguish design graphics from four other types of design drawings typically found in the literature (content graphics, reporting graphics, illustrations of ID models, and instructional and learning models). With design graphics identified, we categorized them using Gibbons' (2003) seven ID layers as a kind of taxonomy to understand the purposes for which these design drawings were created. These layers are: content, strategy, control, message representation, media-logic, and data management.

We did not find the same pervasiveness or level of self-awareness as found in other design fields. Examples of design drawings were found, but were somewhat rare. Furthermore, we discovered that those examples we found tended to document only two of Gibbons' seven layers: content and strategy (with some exceptions) indicating narrow application. We believe this gap represents a serious shortcoming in ID, indicating a lack of tradition, skill, and standards for visual representations of design except in limited ways.

It is widely held that a common visual language for conveying design ideas has facilitated progress in many other fields of design. The lack of such a medium in ID may be a roadblock to improving the practice of ID. This book represents a possible groundswell of interest in the subject of

visual design languages for ID. At present, design drawing is a rare but growing phenomenon in ID, which, when fully understood and implemented, can only benefit the practice of ID.

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ENDNOTE

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