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ABSTRACT

This document contains the following papers on theory from the SITE (Society for Information Technology & Teacher Education) 2002 conference: (1) "The Emerging Ecological Contribution of Online Resources and Tools to K-12 Classrooms" (Therese Laferriere, Robert Bracewell, Alain Breuleux); (2) "Pedagogical Ethnotechnography: A Bifocal Lens To Understand Technology in Education" (Prince Hycy Bull); (3) "The Design of Electronic Learning Environments in Teacher Education: Understanding the Importance of Representation as a Choice in Technology Production" (Sebnem Cilesiz and Richard E. Ferdig); (4) "Educating Teachers for the Knowledge Economy" (Tony Fetherston); (5) "An Model of Self-Regulation Skills--Penetrable Process and Not-Penetrable Process" (Michiko Kayashiima); (6) "Designing a Technology, Society and Education Course" (Gulsun Kurubacak and Karin Wiburg); (7) "The Use of the Internet To Teach Critical Thinking" (Gulsun Kurubacak and Carmen Gonzales); (8) "Teaching as Design: Implications for Learning To Teach with Technology" (Punyashloke Mishra and Raven Wallace); (9) "Technology as a Developmental Influence" (Eric A. Seemann, Lamar V. Wilkinson, Anita S. Flye, Gina Gibson); and (10) "Building eLearning Communities" (Chih-Hsiung Tu and Michael Corry). A brief summary of a conference presentation on techno-humanism is also included. Most papers contain references. (MES)

Theory

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THEORY

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The integration of technology into the classroom is a dynamic process that emphasizes the theoretical constructs related to how learners learn. Primarily, the focus of change in pedagogy, curriculum, and learning experiences is the challenge of the technological classroom. The articles in this section illustrate how theory and research can provide a different conceptualization of the processes of teaching and learning using technology.

Fetherston's article, "Educating teachers for the knowledge economy" proposes the knowledge and methods needed to prepare teachers to incorporate Information and Communication Technology (ICT) into the classroom. The dominance of constructivist pedagogy when using new technologies seems to be most important in training teachers. The knowledge economy, as explained in the article, demands that teachers must be able to assist students in learning how to access and work with information. Teachers can help students learn using technology by understanding and implementing the approaches of guided participation, conceptual change strategies, metacognition, and reflection.

In Bull's article, "Pedagogical Ethnotechnography: A bifocal lens to understand technology in education," readers learn about a research method for gaining insight into how individuals use and experience technology as a pedagogical tool. The author provides definitions, procedures, and benefits regarding Ethnotechnography. This type of research should increase understanding of the changing nature of pedagogy with the advent of technology. In a related manner, Kurubacak and Wiburg's article, "Designing a technology, society and education course" moves from the individual's experience to the impact of technology on society as a whole. Relying on project-based learning and creative activities, students enrolled in the course described in this article, develop an understanding of the relationships between technology and societal and educational change. Seemann's article, "Technology as a developmental influence" also delineates the impact of technology on society. The experience of technology is developmental, requires more abstract thinking skills, and has changed learning related to individual and societal occupational, social, and educational development.

Kayashima's article, "A model of self-regulation skills: penetrable process and not-penetrable process" describes a model of cognitive processing as part of a technological instructional method. The skills of metacognition and self-regulation are developed into a model based on production systems that aid in understanding how individuals construct knowledge.

Mishra and Wallace's article, "Teaching as design: Implications for learning to teach with technology" relies on the metaphor of design in technology as a process of learning to teach with technology. By comparing the complex, creative, and dynamic processes between design and teaching, students learn about the strong parallels between the two, thus developing an understanding of teacher knowledge for teaching with technology.

Cilesiz and Ferdig's article, "The design of electronic learning environments in teacher education: Understanding the importance of representation as a choice in technology production" explains how representation affects cognition and facilitates learning. However, the key point is that representation is of paramount importance in online environments and should be given special consideration in the development of online courses.

Kurubacak and Gonzales' article, "The use of the Internet to teach critical thinking" indicates how the Internet can facilitate learning critical thinking skills. The authors feel that teaching critical thinking should be one of the most important educational goals for students and that technology, especially the Internet, can be used as an educational tool in enhancing critical thinking.

Chih-Hsiung Tu's article, "Research and online social interaction" is concerned with the online learning community. Research has not adequately differentiated computer-mediated communication from face-to-face communication; therefore, relying on sociology, social learning, and self-presentation constructs would enhance research to better understand online social interaction. Additionally, Chih-

Hsiung Tu and Michael Corry's article, "Building eLearning communities" expands on the online social process by providing a conceptual framework for developing an eLearning environment. The impact of eLearning communities on human learning is considered as well as recommendations for future research.

Laferriere, Bracewell, and Breuleux's article, "The emerging ecological contribution of online resources and tools to K-12 classrooms" explains the ecological contribution of online network technologies on student learning. Research based on observation has indicated that a distributed change across all educational activity should provide a new pedagogy in order to take full advantage of information and communication technologies.

In summary, the integration of technology and education has provided change in pedagogy, learning, and social interaction. Future research and refinement of theory should expand the understanding of the dynamic processes regarding teaching and learning using technology.

The Emerging Ecological Contribution of Online Resources and Tools to K-12 Classrooms

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Abstract : This paper presents the emerging ecological contribution of online network technologies on student learning. Significant effects of the use of ICTs were gathered from documentary reviews. An organizing framework was developed in order to make sense of preliminary observations, in combination with raising scientific discourse on the teaching-learning process. The framework was further validated through the research team's extensive participant observation in networked classrooms. Twelve observations are formulated out of the research literature. They regard process over product. Both the organizing framework and the observations form the basis of an ecological perspective on the contribution of online resources and tools to K-12 classrooms.

Introduction

Learning with online tools and resources is emerging in the brick-and-mortar primary and secondary school of North America. Meanwhile, an increasing number of researchers, including cognitive scientists and teacher educators, recognize that the teaching-learning process must evolve. It is advocated that teacher-talk and rote knowledge (addition and retention of facts, principles, and procedures) on the part of the learner must give way to higher-thinking skills acquisition for all (Resnick, 1998), and teaching for understanding (Bereiter, in press).

The contribution of new technologies to K-12 classroom learning and teaching will not obviously be well known for many years to come. As its title suggests, this paper focuses on the physical classroom, not the virtual one. The network capacity of classrooms and schools is emphasized, and not only the simple fact that resources and tools are online. A theoretical approach to the ecology of the networked classroom is presented, one grounded in three documentary reviews on the contribution of new technologies to teaching and learning (1996, 1998, 2001), and in our ongoing participant observation of networked classroom processes and products (1995-2002). A comprehensive framework emphasizing extreme circumstances of use is brought forward, followed by propositions that organize results found in scholarly works and other highly relevant studies, pointing to emerging observations in the process.

The method

The online search dealt with the contribution of new information technologies to learning and teaching in elementary and secondary schools for the 1998-2000 period. The search was exhaustive and emphasized articles, reports, papers and book chapters meeting the criteria for scholarly publications. Proceedings were judged to be of an exploratory nature which usually do not present final conclusions and findings, but some papers presented at conferences were included to support specific trends. Finally, a search using Internet search engines such as Alta Vista or Excite was also excluded since the volume of information retrieved would have been too large, many of the articles would not meet scholarly criteria and it would have be difficult to evaluate and authenticate the studies. However, online articles, reports, and papers meeting scholarly criteria were included.

The organization framework

The past five years have seen a radical change in what researchers sees as being important when considering the contribution of online resources and tools to teaching and learning in the classroom. Prior to this period, much of the research in this area can be described as implementing a rather simplistic horse-race model, in that the studies were designed to compare whether or by what amount the use of a particular technology was more successful in promoting learning than another technology or a traditional instructional practice (Zhao, Byers, Pugh & Sheldon, 2001). In contrast, more recent perspectives are grappling with the complexities of integrating online resources and tools with learners, teachers, administrators, and instruction. In a heartfelt and accessible call for a more encompassing treatment of online technologies in education, Nardi and O'Day (1999) apply the metaphor of *ecology* to the use of these technologies in the classroom, thereby highlighting the systematic relationships among participants and resources, the diversity found in educational settings, and the potential for evolution of instructional practices.

This ecological (as opposed to horse-race perspective) can be seen in the theoretical tools now being deployed in studies and analyses. Researchers are developing and applying both existing and new theoretical constructs to understand conditions for the effective use of online technologies. These include learner characteristics such as *metacognitive abilities* and *epistemological belief* (Hartley & Bedixen, 2001) and contextual variables such as the *distance* of new practices using online technologies from existing instructional practices and the degree of *dependence* of teachers using online technologies on non-traditional resources and personnel (Zhao et al, 2001). Researchers are also turning to and applying more comprehensive theoretical frameworks in investigating online technologies and resources in the classroom. These frameworks *include communities of practice* (Barab & Duffy, 2000), *problem solving* (Jonassen, 2000b), *cultural psychology* (Brown & Cole, 2000), and *activity systems theory* (Jonassen, 2000a) Application of these frameworks both provides a more adequate description of what is required for effective integration of online resources (and ICTs generally) and also brings this research and its application into the mainstream of educational research and professional practice.

Our ecological perspective relies on a number of constructs to organize the findings of the documentary reviews. The first of these has to do with the nature of change in educational practices involving online technology. Change can be characterized as being either incremental or transformative: *Incremental change* refers to the use of technology to carry out already existing instructional tasks in more effective and efficient ways; *transformative change* refers to the use of technology to instruct in new ways (Maddux, Johnson, & Willis, 1997). In addition, the implementation of change can be characterized as either isolated or distributed—it is clear from the research findings that effective use of online technologies in education requires *distributed change* involving all the constituents of educational activity. The second set of constructs has to do with the educational constituents, which are characterized in terms of Schwab's (1973), four commonplaces (or dimensions) of the educational situation: The *teacher*, the *content*, the *learner*, and the *context* (see Figure 1). With respect to the use and effect of online resources, the four constructs vary in the following ways:

- The *teacher*, who, at one extreme, may be primarily concerned with delivering content information to the learner using online technology while, at the other extreme, may be concerned primarily with facilitating network activities of the learner that result in learning;
- The *content*, which, at one extreme, may be a fact or already existing body of knowledge and, at the other extreme, may be a theme or project that is being built up by the learner(s);
- The *learner*, who at one extreme, may have only limited access to online technology and network capabilities through a school-based lab and, at the other extreme, may have full access via laptop and modem;
- The *context*, which, at one extreme, would provide minimal support with respect to leadership and knowledge for the use of online resources and, at the other extreme, would involve participation and support from all stakeholders (teachers, administration, and parents).

Figure 1: The four constituents of the educational situation in networked classrooms and their variations.

Most current classrooms would lie toward the left end of each continuum: 1) the teacher is a transmitter of knowledge rather than a facilitator of learning, 2) the content is pre-organized by the teacher or 'canned' on a CD-ROM or a web site, rather than constructed by the learner; 3) the learners have low rather than high access to online resources and tools; and 4) the context offers the teacher and his or her classroom a limited rather than a high level of support for new initiatives and resources. This model of use, called (TCLC -), which stands for each of the first letters of the four basic constituents, is being given here the notation minus (-) in order to point to low levels of interaction between the teacher and the learners, pre-organized content if any, low access to online resources and tools, and limited support from the external context.

The TCLC - model of use or any of the three other variations in which one of the four constituents is at a low level is still by far the most frequent situation at this point in time. However, we believe that the educational situation is evolving in that learners' access is less limited, and that the context has offered some technical support and opportunities for professional development to teachers. In contrast, the overwhelming thrust of research initiatives within the socio-cognitive psychological perspective would seem to be directed towards the opposite ends of each continuum: teacher/facilitator, content/constructed, learners/high access, context/extensive support (TCLC + Model of use). Here, the teacher primarily facilitates student learning, the curriculum content is largely constructed by the learners, the learners have free access to online resources, and the context supports the use and expansion of the resources.

Emerging observations in the networked classroom

First, with respect to the learner:

Observation 1: *Higher levels of control by learners are called for as classrooms are getting more online.* The student is found to play a more active role in the networked classroom.

Observation 2: *Online resources boost student interest and motivation in the classroom through a greater diversity of learning goals, projects, and outcomes.* Student motivation is increased, and this is consistently found across diverse groups of learners.

Observation 3: *Learners' thinking becomes more visible.* Computer applications facilitate the construction of knowledge representations that can be seen by the teacher and classmates.

Second, with respect to the content:

Observation 4: *Internet and learning projects are broadening the curriculum.* An increasing number of educational services are being offered online, and these include drill-and-practice learning activities as well as more open-ended activities such as telecommunication exchange.

Observation 5: *There is a greater range of construction of content by school learners.* In the networked classroom where the teacher has a powerful repertoire of pedagogical strategies, the content is more diverse and there is more student input. More advanced topics are studied.

Third, with respect to the teacher:

Observation 6: *Learning situations become more realistic and authentic as classrooms are getting* online. Both access to online resources and learners' increasing engagement in the construction of content is conducive to better and more authentic learning situations in the classroom.

Observation 7: The successful online classroom combines information technology with appropriate pedagogy. The more engaged teachers have students do more collaboration and communication, carry out more and longer work on projects and have students tackle more open-ended problems.

Observation 8: New online practices by educators are adopted through adaptation. The dissemination and implementation of effective uses of online technologies in classrooms take account of local contexts of instruction.

Fourth, with respect to the context:

Observation 9: *Cooperative and collaborative classroom processes are increased online.* Small group learning with computer technology has positive effects on group task performance, individual achievement, and attitudes toward collaborative learning.

Observation 10: *The education of educators is broadened to include just-in-time or collaborative learning.* Teachers have had the opportunity to join virtual interest goups and learning communities for nearly a decade, but teachers are far from taking full advantage of such opportunities.

Observation 11: *The online classroom challenges the locally-established curriculum.* Transmission of the curriculum by the teacher gives way to more approaches where the learner interacts more directly with online content.

Observation 12: *Educators use online learning as a key enabler of educational reform.* Evidence has been building on the mutual dependency between the use of online tools for learning and school renewal efforts.

Discussion

Information and communication technologies (ICTs) present us with a unique opportunity and challenge, to reach for a more human approach to teaching and learning with the purpose of preparing knowledgeable, democratic and socially responsible citizens. Therefore, to downplay the role of the teacher in the education of the knowledge worker of tomorrow – the formation and cultivation of understanding (*episteme,* knowing-that) and practical judgment (*phronesis,* knowing-why) – and to overplay that of the skillful production of artifacts as well as that of the expert mastery of objectified tasks (*techne,* knowing-how), would be here ill-advised. The new pedagogy put forward by the above observations constitutes not only a model of improved human relations but of sociocognitive processes in the classroom.

Teachers' creative integration of ICTs in the curriculum is likely to bring significant changes in the way schools carry out their educational mission. The school culture is bound to open up and to become more collaborative for the teachers and learners to face the inherent changes called for by the wide acceptance of the networked computer. On-line discussions conducted on a small group, on a school basis or on a broader scale, may greatly contribute to the development of such an expectation.

Network-enabled learning communities appear to provide most benefits: on-time access to resources, including best available practice on various subjects being studied, joint exploration of topics and issues, reflective analysis of educational situations, etc. Teacher learning communities that contribute to the intellectual life of the teacher outside the classroom (face-to-face and on-line discussions), and support his or her professional practice are key.

Conclusion

It is important to remember that the classroom is a place where order prevails. The infusion of information and communication technologies (ICTs) creates a zone of uncertainty for both teachers and learners, one that will engage them in a process of risk and exploration for some time to come. This uncertainty may be reduced by a better understanding of the sociotechnical framework needed to take full advantage of available ICTs. Research on one or the other of the four basic constituents (learner, content, teacher, context), while neglecting the others, is bound to lead to partial and confusing results that tend to raise superficial questions and unproductive debates. The interdependence of the four constituents that this review takes into account (and highly recommends for consideration in all further inquiry) should be progressively documented with respect to the impact of online technologies on teaching and learning in the classroom. More recent conceptual developments occurring in other fields such as the learning organization framework and the new domain of knowledge management, seem to point in the same direction.

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Pedagogical Ethnotechnography: A bifocal lens to understand technology in Education.

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Pedagogical Ethnotechnography

In an attempt to understand curriculum as a technological text, I developed the concept of pedagogical ethnotechnography as a research method. Ethnotechnography has its root words in Greek origins; *ethnos* from the nouns nation, tribe or people, "*techne*" is translated as art, craft or skill and "*graphy*" from the verb to write. Aristotle defines "techne" as the systematic knowledge for intelligent human action. Ely (1983) defines technology as " any systematized practical knowledge, based on experimentation and/or scientific theory, which enhances the capacity of society to produce goods and services, and which is embodied in productive skills, organization, or machinery." The term ethnotechnography simply means writing about technology as experience by people within a defined boundary.

Understanding Curriculum as an Ethnotechnography Text

Ethnotechnography as envisaged has several branches from which lived technological experiences can be study. Ethnotechnography can be viewed as "cultural ethnotechnography", "business ethnotechnography," "medical ethnotechnography," and "Pedagogical ethnotechnography."

Cultural ethnotechnography can be viewed on how members of a given group or community use or perceive technology within their culture. One major area that this may cover is the study of the "digital divide" from a cultural diversity perspective. One can also study cultural ethnotechnography from an ethnic perspective within society. Business ethnotechnography would focus on how technology is used in the business world. Medical ethnotechnography would focus on the use of technology in the medical field. Pedagogical ethnotechnography is a study of technology as a pedagogical tool as experienced by stakeholders - students, teachers, or school administrators - within an educational realm with an empirical analytic paradigm within a defined boundary set by the empirical analytic paradigm. The educational realm of pedagogical ethnotechnography spans the spectrum of educational delivery from preschool to higher education to educational policy makers. The emphasis in pedagogical ethnotechnography is the rich description of the lived experience as experienced by the participants- teachers, students, parents, administrators and policy makers.

Boundaries within pedagogical Ethnotechnography

The boundary that is set in pedagogical ethnotechnography is not a physical or geographical one, rather it is a scientific boundary to determine entry points in terms of skill level, perception or attitude, or usage before the lived experience and the exit point in terms of skill level, attitudes and usage after the lived experience.

Procedures to conduct a pedagogical ethnotechnography

1. Identify a pedagogical ethnotechnographical issue as it is lived by participants.
2. Prior to investigation, design an empirical- analytic paradigm to determine the boundary of the lived experience. By boundary I mean, entry and exit points or pre and posttests of the experiences as lived within defined parameters.
3. Investigate the pedagogical ethnotechnographical issue as it is lived by participants
4. Reflect upon the issues, essential themes or structures that occurred within the defined boundary physically or virtually.
5. Describe the lived pedagogical ethnotechnographical issue using the art of writing supported by empirical analytic paradigm.

Pedagogical Ethnotechnography and Collaborative Autobiography

Ethnotechnography can be studied using collaborative autobiography of participants lived experiences with technology. Richard Butt and Danielle Raymond advocate the use of shared autobiographical works to help teachers understand their 'lived experiences'. The concept of "collective biography" is formulated to point to the appropriateness of reporting and analyzing teachers shared or common experiences. Butt and Richard gives credence to the ethnotechnographical research methodology when they state that in the process of interpreting individual and collective biographies, one might blend qualitative and quantitative aspects of educational experiences.

Pedagogical Ethnotechnography and Phenomenology

Phenomenology is that form of inquiry, which focuses on human perception and experience. As one can see from the definitions, phenomenology and pedagogical ethnotechnography share similarities but there are stark differences between the two.

- Both theories study the world as it is lived. Phenomenology seeks to produce knowledge of what it means to be human. Ethnotechnography seeks to understand what it means to be human in using technology as a pedagogical tool. Also, with ethnotechnography, lived experience means both physical and virtual. Virtual in the sense of what is observed via e-mail, listserv, forums, teleconferencing and e-chat databases.
- Phenomenology theory seeks to ask the "what" instead of "how" questions. Pedagogical ethnotechnography asks both the "what" and the "how" questions.
- Van Manen states that phenomenology is a conscious practice of thoughtfulness and always embodies a poetic quality. I also envisage ethnotechnography as a conscious practice of thoughtfulness but not limited to poetic quality. I envisage a blissful harmony between empirical- analytic paradigm and poetic quality. One in which poetic articulation becomes the lead singer and empirical-analysis the backup singer.
- Phenomenology theory begins with a single case, moves to the universal, and returns to the single instance. Once ethnotechnographical theory takes off with a single case, it simultaneously develops universal and single tentacles to support both single and universal instances.

Some Benefits of Pedagogical Ethnotechnography

1. The qualitative and quantitative aspects compliment and validate each other in terms of the data collected and analyzed.
2. The disparities between qualitative and quantitative issues, if apparent are easily identified within the same study rather than in future studies.
3. The findings of pedagogical ethnotechnography are easily generalized to the target population.

The Design of Electronic Learning Environments in Teacher Education: Understanding the Importance of Representation as a Choice in Technology Production

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Abstract: We use representations and abstractions in every aspect of our lives. Designing and choosing the right representation is very important as Norman (1993) states "because [representations] allow us to work with events and things absent in space and time, or for that matter, events and things that never existed – imaginary objects and concepts" (p.49). In distance education environments, teachers and learners face representations rather than real entities. Thus, correct representation becomes essential in designing electronic learning environments. The authors draw on the importance of representation in cognition in, specifically when designing electronic learning environments. The authors also reflect on related topics and suggest that further studies be done.

Don Norman (1993), in his famous book "Things That Make Us Smart", makes the argument that representations are important "because they allow us to work with events and things absent in space and time, or for that matter, events and things that never existed – imaginary objects and concepts" (p.49). He also says that the "trick is to get the abstractions right, to represent the important aspect and not the unimportant" (p.49). In other words, the user of the representation is expected to understand the idea or concept—without the existence of the original—by looking at and making inferences about the representation.

His statements about representation are *important* because of the ubiquity of representations in our life. The Oxford English Dictionary (2001) defines representation as:

1. A material image or figure; a reproduction in some material or tangible form
2. The fact of expressing or denoting by means of a figure or symbol; symbolic action or exhibition
3. The action of presenting to the mind or imagination; an image thus presented; a clearly conceived idea or concept.

These definitions point to the fact that representations are things we use in our everyday lives. They include such things as numbers, alphabet, attire, graphs, imagery, tables, and even language. Norman (1993) even argues that the powers of cognition *come from* abstraction and representation: "the ability to represent perceptions, experiences, and thoughts in some medium other than in which they have occurred, abstracted away from irrelevant details" (p.47).

His statements about representation are also *timely*, though, as we begin to work with and through technology. As we begin to teach and learn with technology, we create cognitive artifacts that are, in and of themselves, representations. (for that matter, Donald (1991) would argue that human cognitive evolution itself has been greatly affected by our representational abilities.) Norman (1993) had foreshadowed this aspect in his writing, arguing that the future of human evolution would be through technology. Shaffer & Kaput (1999) follow Norman and state that "computational media make it possible to externalize not only information, but also the *processing* of information" (p.102, italics in the original). Thus, one of the most important affordances of computational media is their ability to allow for conversion of multiple representations, which eases many cognitive tasks. In some sense, we now continue to create representations as we have always done. However, we are also beginning to create meta-representations to better serve our cognitive needs because of the tools we have available.

Since representation affects cognition, it has a vital role in education and learning technologies. Distance education in specific requires focused attention on representations, because these environments lack many supplementary features of human communication, namely interaction. In other words, these electronic environs use representations as major substitutes for missing elements in non-face-to-face interactions (Muirhead, 2000). In traditional learning environments we can back up false or missing representations by additional features to convey the intended message, however we do not have the same luxury in online environments.

Representation is further important in education because it affects not only the way teachers perceive the designer's intentions but also the way they design their teaching, thus affecting their students' perception. Norman (1993) implies that teaching is a *skill* of understanding "how a topic has to be presented" so that the learner can "acquire it most readily and successfully" (p.121). For example, Suzanne Nyrop (2001) utilizes representation very well in the online environment TappedIn. (TappedIn is an online teacher professional development environment enabling teachers to discuss and share ideas. It is available at http://www.tappedin.org/) She says that she likes to combine play and work in her virtual office "Susanne's Virtual Playground". She continues "Here, I keep my notes and records for later retrieval. I also enjoy my virtual pets. Virtual food and beverages are available to offer to my virtual guests" (http://www.tappedin.org/info/perspectives/sn.html). As all other users and designers, Nyrop has made a decision to represent herself. Embedded in all representation is decisions and assumptions – decisions on how we want others to perceive us and assumptions on how they see us. [This reflects the theory of Symbolic Interactionism]. Nyrop chose to represent her office as a playground. This increases the likelihood that people interested in combining work and play will visit her office and meet her. Thus, in some sense, her representation has succeeded.

As representations are important, they should be considered as such for designing electronic learning environments for teacher education. The discussions have many implications for designing online teacher education environments. We suggest that further studies that (i) provides a more complete history of representation and cognition drawing on the works of Donald and Shaffer & Kaput, (ii) describes how to become cognizant of representations (iii) using Mead's Theory of Symbolic Interactionism, presents information about the self and ways to design representations. (iv) concludes with implications for design and future study needs be conducted.

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Techno-Humanism: Teaching and learning for an Information Age

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Several decades ago there was a movement in curriculum for a humanistic education. In part it represented a reaction of educators against the behavioral theories that of learning that were then dominating curriculum and educational policy making. This paper explores the apparent failure of the humanistic education movement and the part that contemporary information technologies play in its revitalization.

EDUCATING TEACHERS FOR THE KNOWLEDGE ECONOMY

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Abstract: Driven by common international trends and the acceptance of such constructs as the knowledge economy, p re service teacher education institutions are forced to conceptualise how to integrate ICT into their curriculum. In this paper the author proposes that Habermas's three domains of human interest are an excellent beginning in organizing the curriculum to include ICT. Using these domains he proposes possible curriculum content under headings of What should they be able to do, What should they actually do (in the classroom) and What knowledge empowers them.

Education systems in Australia at all levels increasingly have to respond to the challenge of incorporating Information and Communications Technology (ICT) into curricula. Like many other countries, Government policies mostly drive this movement. Recent Australian National reports such as: Teachers for the 21st Century: Making the Difference (DETYA 2000a); Learning for the Knowledge Society (EdNA 2000); and Models of Teacher Professional Development for the Integration of ICT into Classroom Practice (DETYA 2000b) all highlight the importance of teachers being able to integrate ICT into normal classroom practice. As pre service teacher educators, need to revisit what and how we teach this group of students.

Another factor, which forces us to examine practice at all levels in regard to ICT in Australia, is that Australian State governments are rapidly equipping schools with computers and Internet access. This access is occuring concurrently with a national initiative designed to develop a wide array of on - line learning resources.

All these elements focus attention on the preparation of our pre service teacher education students for the rapidly changing context in which they will eventually work. We, as pre service teacher educators, need to revisit what and how we teach these students.

Deciding on what we should teach our pre service teachers is essentially a curriculum design task. This is a task as Grundy (1987) describes, of "constructing" or "designing" a curriculum (p27). Approaches that are dynamic and interactive appear to hold the most promise. These approaches usually start from the premises that planning involves making decisions about the learning experiences of students (content and process), that it will involve many groups, that it will take place at many levels and that it is a continuous proces s (Beane, Toepfer & Alessi 1991).

It appears that a useful beginning point might be to accept that planning curriculum involves making decisions about the learning experiences of students (content and process). So what follows then is just one personal conceptualisation of what we should be teaching our preservice teachers. It is accepted that other processes would need to follow this beginning. What is proposed below would have to be subjected to some kind of systematic process before it was adopted and these processes

In my thinking about learning experiences of pre service students, it occurred to me that Habermas's views about the three domains of human interest in learning might be useful. These areas define cognitive interests and are grounded in different aspects of social existence that include work, interaction and power. In regard to pre service teachers, this grouping can be put very simply. At the end of their course What should they be able to do, What should they actually do (in the classroom) and What knowledge empowers them? In the remainder of this paper I would like to use this scheme to propose some answers to the main question of what we should teach.

What should they be able to do?

It is difficult to define exactly what teacher's technical skills should be, as we all know that the history of the ICT industry shows us that technical advances are inexorable and rapid. Nonetheless it is possible to define some generic areas in which they should have enabling skills. Enabling skills are those that I define as those that enable a graduating teacher to use ICT for learning purposes. In other words they are generic skills that become transferable and ubiquitous but allow the user to accomplish much more in learning terms than if they didn't have the skill.

A good example of an enabling skill is word processing. Teachers should be able to use a word processor to enter text, format text, check spelling and print and this skill should be at mastery level. These skills should be transferable to word processing programs other than the program on which they were learnt. These skills would also be able to be used to advantage in other programs. Teachers should have similar kinds of basic skills in the use of a spreadsheet, database and presentation software. They should be able to use a web browser and search engine to locate information efficiently on the Internet. Every teacher should be able to receive and send an email, know how to subscribe to a list server and conduct an on-line chat session

I think it is also reasonable to expect teachers to be adept at transferring digital information to, from and around a computer. Teachers need to be skilled in these transfer procedures in regard to still pictures and in regard to video and sound files. I believe also that all teachers should be able to construct a simple Web page and mount it on a server.

Should all teachers be required to know how to configure a computer so that it can act as a server or know how to maintain a network? Should they all have a passing familiarity with IP addresses? I don't think so but they should have a conceptual overview of what a network is. Such an overview would enable teachers to make good judgments about the use of emerging technologies like Wireless Application Protocol (WAP) devices.

Should they have knowledge of programming? Programming I would regard as a specialist curriculum subject not applicable to all preservice teachers but with a place in a preservice course for some specialist teachers. Similarly I believe that not all teachers need to know how to upgrade a computer or install a card or memory even though these skills are reasonably straightforward. Anyone aspiring towards a coordinating position in a school should be able to perform these tasks and so courses like this should be available as part of teacher training for those aspiring to specialist coordination positions.

What should they actually do?

How teachers should act in a classroom is essentially a pedagogical question. The answer depends on the individual teacher who takes into account many, often conflicting factors such as the learners' characteristics, their own curriculum knowledge, management issues, outcomes desired and the general social setting in which the learning occurs. The additional factor, which now has to be taken into account in many settings, is ICT. The key pedagogical question facing the teacher is how to best use these technologies to assist the learning process.

The dominant learning theory today is constructivism. Constructivist pedagogy acknowledges that students construct meanings that are individual, that students interpret classroom events in individual ways and that social processes are important in learning. This means that for example, when using new technologies like the Internet in the classroom, teachers should regard the Internet as not just a delivery medium but a potentially rich teaching and learning tool (Fetherston 2000). They would then use the Web to address student's own ideas, to allow students to become active participants in their learning and to attend to conceptual change.

Authentic approaches like situated cognition (Brown, Collins & Duguid 1989) are essentially constructivist approaches and the Web has enormous potential to assist with these approaches as they allow explicit links to be drawn between knowledge encountered and its conditions of use. For example, through communications technology students are well able to contact practitioners within their field of interest, to work collaboratively on real world problems and to compare their growing concepts with the expert's and other's conceptions.

Guided participation (Rogoff 1990) offers a sound theoretical framework to guide learning in this way. The Web can potentially allow a "...formal, instruction-oriented apprenticeship model in which novices are systematically coached, guided and supported by expert practitioners" (Hodson and Hodson 1998, p17) to be established. Participation in joint activities with more knowledgeable others is congruent with a social constructivist approach to learning and establishes an environment in which scaffolding can take place. Scaffolding in most settings is mostly a language-based activity that allows cognitive processes that occur first in this social plane to become shared processes and eventually to be internalised by a student. This Vygotskian (1978) process is deserving of much research in the on-line environment (and indeed in all classrooms).

Any pedagogy that embraces the use of ICT would recognise that when students use the Web they can potentially join a community. This community can be like-minded "surfers" or the community could be founded around a common topic and utilise communication technologies. By constructing and posting a web page students immediately have an audience for their work even if they do not know who and how many constitute this audience. For this to be meaningful in learning terms, students need good models to enable them to participate successfully in this environment and to be able to evaluate the quality of information available. Pre service teachers need to develop these models as part of their training. They need to also to be able to eventually implement them in their classes.

The knowledge economy has rapidly become a well-worn phrase. It refers to an economy that recognises that the generation and exploitation of knowledge play a dominant part in the creation of wealth. The rise of the knowledge economy is closely coupled to the globalisation of capital where capital continually circulates economies in search of maximum investment opportunities. Information technology has not just accelerated this process and made it more successful but is the key factor that underpins the existence of the knowledge economy. The key attribute of knowledge workers in the knowledge economy is that they are symbol handlers and that they know how to access and work with information, using ICT.

Romer sees knowledge as the third factor of production in leading economies (Romer 1990). Romer views knowledge as the basic form of capital, and economic growth as being driven by the accumulation of knowledge. Innovation, intelligence, concepts, symbol manipulators, information massagers would seem the essential "right stuff" for a successful knowledge worker. In the same way as machines were the stuff of the industrial revolution and people became wealthy by inventing new machines or new applications for existing machines, concepts are the stuff of the knowledge economy. People will become wealthy by coming up with new ideas or by applying new ideas in creative ways

This means that in terms of pedagogy our graduating teachers must have ways of assisting students so that they can turn information available on the world's biggest library into meaningful concepts. Of course before this can occur students need to know how to locate such information in the Internet environment and this ability is now I believe a critical literacy. Once having found the information, it is not the information itself but the effect of that information on students' own ideas that is important and teachers must know how to develop each student's individual understandings. Much research accords with the view of Becker (2000):

> "that teachers were three times more likely to have their students use the Internet if they held more constructivist beliefs about teaching in general—that is, they believed in devoting attention to student interest rather than curriculum coverage, focusing on critical thinking and real-world applications, and using complex problem solving in small groups to help students learn, compared with teachers with more traditional beliefs and practices" (p54).

For students entering the competitive knowledge economy it is their own ideas that they bring that are important as well as their ability to apply these concepts in new and interesting ways.

Metacognition and reflection are regarded almost universally as important elements that affect learning. As part of a pedagogy that embraces the use of ICT in schools, these elements need to be encouraged and developed. In addition students in schools increasingly need access to tools which enable them to track the progress of their own knowledge: not just by using tools like concept maps nor by working with data bases, but by using personal tools that track their own ideas and the influences upon them. They need tools which answer the metacognitive question "what was I thinking", tools that enable them to reify their ideas, to link these ideas to other ideas, to link them to what they know already, and allow them to also present these ideas in various forms to others. Allowing students to draw upon existing textual material, graphic images, video or web pages in order to present their ideas should facilitate this and accords with a constructivist framework. Unfortunately such cognitive tools that can do all this do not exist at present. However even presentation software like PowerPoint can assist with the process and pre service teachers need to know how to use these tools to accomplish as muchof the above as possible.

So what does the existence of the knowledge economy mean for pre-service teachers? Firstly it means that these teachers must know how to develop conceptual understanding in students. Teachers need understanding of broad based, conceptual change strategies generic through a range of units of study and across many learning areas. Teachers would probably need at least to become familiar with Posner, Strike, Hewson and Hewson's (1981) four conditions for conceptual change or Hewson, Beeth, & Thorley's later views that conceptual change can be seen through a change of status attributed to a particular conception (1998).

If we wished preservice teachers to adopt particular approaches to teaching in their classrooms, then teacher training organisations should model these approaches These organisations also need to re-examine some of the

assumptions about what constitutes core content and what it means to be a teacher.
Deakin University (Victoria, Aust.) and Microsoft have entered into an agreement to implement a degree built around the philosophy of "learn while you work". Students complete 12 months study in traditional manner at university they will then complete the rest of their qualification while working and learning within the IT industry with a guaranteed job. They emerge with a bachelors degree, an industry qualification and two years of work experience.
We must construct similar innovative training for our pre service teachers as the people who teach the future knowledge workers need direct experience in the knowledge economy and this should be a national priority. Benefits would flow onto the students they teach. Perhaps it could be argued that pre service teachers are the group more than any other that need good knowledge of this industry.

What knowledge empowers?

What are students' values and perceptions of technology and how are they affected through interaction with ICT? Our pre service teachers need heightened awareness of the possible effects the use of these technologies have on the acceptance or not of individualistic values. Our teachers need to be able to critique the use of ICT in schools and to assist students to develop values that enable them to use these technologies in socially useful ways that enhance the human condition. They need an understanding of the social impacts of such technologies.

ICT technologies have the potential to alter our understanding of what is important, "which is another way of saying that embedded in every tool is an ideological bias, a predisposition to construct the world as one thing rather than another" (Postman 1990). Does the use of ICT in schools help construct a Technopoly where "the primary, if not the only, goal of human labor and thought is efficiency, that technical calculation is in all respects superior to human judgment ... and that the affairs of citizens are best guided and conducted by experts" (Postman 1993). Implicit in this statement is the realisation of such a society is based on the assumption that science is supreme and that ICT technologies support and make possible such a society. The knowledge society seems already disturbingly like this.

Conclusion

This paper started with the recognition of the importance of newly graduating teachers being able to develop learning environments that utilise ICT and which contribute to the realisation of a wide variety of learning outcomes. We need to examine what we teach our pre service teachers in regard to ICT and such an examination I regard as essentially a curriculum design task. After examining traditional approaches to design, I decided that a Habermasian view of knowledge centered on what this group should be able to do, what should they actually and what empowers was useful. I then suggested content that could be addressed under these headings in a pre service course. In conclusion I recognize that all the above attends mostly to scope and content: what has to follow are more systematic curriculum design processes in volving sequence, articulation and continuity.

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An Model of Self-Regulation Skills
-penetrable process and not-penetrable process -

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Abstract: ITS (Intelligent Tutoring Systems) researchers consider how ITS assists a user in the construction of knowledge. The formulation of an answer to this question examines a new instructional methodology. Additionally, it is observed that metacognition is involved with a new instructional methodology. In further exploration of these relationships, a metacognitive architecture, based on a production system as a cognitive architecture, is proposed.

Introduction

While learning theory maintains that learning is the successful transmission of knowledge, the central issue for traditional ITS (Intelligent Tutoring Systems) is finding efficient ways of transferring this knowledge. However learning theory has shifted to social constructivism or situated cognition. This has further shifted the view of learning from instruction to construction [Koschmann, 1996]. The new learning theory forces ITS researchers to explore new ways to help learners in their acquisition of knowledge such as coaching self-explanation [Conati and Vanlehn, 2000].

We deem the successful acquisition of self-regulation skills as a new and helpful way to help learners to acquire knowledge. Self-regulation skills, that are parts of metacognition, allow one to monitor and control one's cognition by oneself [Brown, 1987]. Supporting to acquire self-regulation skills allows learners to apply their knowledge to wider variety problems.

The new learning theory takes a nonabsolutist, fallibilist view of knowledge as constructed, and views this construction to be essentially a social process [Ernest, 1995]. According to this theory, knowledge is closely connected with a social situation on which knowledge is constructed. Despite of this view of knowledge, human experts can use their knowledge in multiple ways according to context. Their flexibility depends on not their general knowledge but their strategy to use cognitive resource efficiently. We believe that a learner's self-regulation skills could cause the learner to apply their knowledge to the problem solving in different situations. The purpose of this study is to help learners acquire self-regulation skills.

The acquisition of self-regulation skills helps learners to make their knowledge plastic. Discovery learning requires learners to reflect upon procedures used in solving tasks and to explore which procedures must be improved [Collins and Brown, 1988]. However, solely utilizing a discovery learning system such as LOGO does not require the learner to directly monitor and control cognitive activities by himself. Adding them to a function to help learners to monitor and control their cognitive activities by themselves augments the weak point of these systems. In this study, we utilize production systems to represent a model of self-regulation skills. Production systems are adequate for this study, because they represent human cognitive architecture, and they are constructed by a set of condition-act pairs called productions. The separation between acts and conditions have the possibility to apply actions to different conditions.

In this paper, we propose a model for self-regulation skills, which are based on production systems. We will first describe production systems. Next, we will categorize cognitive process into "penetrable processes" and "not-penetrable processes". This distinction can be viewed as the difference of inferential mechanism at production systems. Continuing, we will propose a model of self-regulation skill.

Production systems

Here we wish to describe production systems, which are known as cognitive computational architectures.

There are a number of candidates for general computational architectures for achieving a mental system, including general problem solvers [Newell and Simon, 1972], general schema systems [Minsky, 1975, Shank and Abelson, 1977], ACT* (Adaptive Control of Thought Star) [Anderson, 1982], SOAR(State Operator and Result). ACT* and SOAR have been predicated on the hypothesis that production systems provide the right kind of general computational architecture.

A production system consists of two memories: working memory, and long-term memory. Working memory contains the information that system can currently access, consisting of facts retrieved from long-term memory as well as temporary structures deposited by encoding processes and the action of productions. Long-term memory contains facts and productions. The basic claim of production systems is that underlying human cognition is a set of condition-action pairs called productions. The condition specifies some data patterns, and if elements matching these patterns are in working memory, then the production can apply. The basic action is to add new data elements to working memory.

According to ACT*, all knowledge initially acquired declaratively through instruction must be interpreted and reorganized into general procedures through experience. However, by performing a task, proceduralization gradually replaces interpretive application with productions that perform the behavior directly. This mechanism is a learning mechanism. It is referred to as knowledge compilation on ACT* and called chunking by SOAR, creating task-specific productions through practice. Knowledge compilation is the means by which new productions enter the system.

The knowledge compilation processes in ACT* can be divided into two sub processes. One, which is called composition, takes a sequence of productions that follow each other in solving a particular problem and collapses them into a single production that has the effect of the sequence. A composed production still requires that the information be retrieved from long-term memory, held in working memory, and matched to second and subsequent clauses. The second process, proceduralization, builds new productions. These productions no longer require the domain-specific information to be retrieved into working memory. Rather, the essential products of these retrieval operations are built into the new productions [Anderson, 1982].

Penetrable processes and not penetrable processes

Here, we will categorize productions into penetrable processes and not penetrable processes. This distinction implies the difference of inferential mechanism within production systems.

Penetrable processes and not penetrable processes

According to one of cognitive psychology's recurrent hypotheses, there are two modes of cognitive processing. One is automatic, less capacity-limited, possibly parallel, invoked directly by stimulus input. The second requires conscious control, has severe capacity limitations, is possibly serial, and is invoked in response to internal goals [Anderson, 1996]. Also, a process can be considered as semantically penetrable or not. A penetrable process is a process that can be affected by specific instructions or by giving some explicit information [Pylyshym, 1998].

Here, we wish to distinguish the above-mentioned productions between penetrable processes and not penetrable processes. Proceduralized productions and composed productions are not-penetrable, a sequence of general productions is penetrable.

First, we consider that the process of a sequence of general productions is penetrable. The process of combining one general production with other general productions can be affected by data in working memory retrieved from long term memory, data encoded from the outside world, data deposited by executing production, or conflict resolution. Here, we describe the process to decide a general production which should be executed. These data in working memory and conflict resolution decide the production to be combined as a sequence of productions to solve a problem as in the following. In the match process, data in working memory are put into

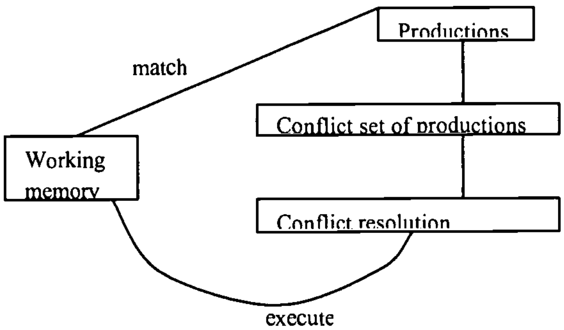

Figure 1

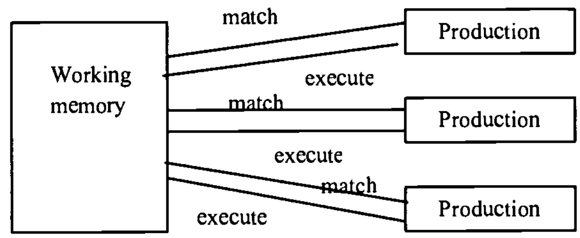

Figure 2 A sequence of general productions

correspondence with the conditions of productions, and then a conflict set of productions is selected. Then only one production that will be executed is chosen by a conflict resolution principle (Fig. 1). Therefore, the execution of a sequence of general productions is penetrable. From this process, a sequence of general productions for solving a problem can be shown in Fig. 2.

However, although the execution of composed production involves the match process, data in working memory are put into correspondence with the conditions of productions, the match process cannot affect the choice of a production. The process of composed production is a non-penetrable process(Fig.3). Also, the process of proceduralized productions no longer invokes the match process and then is a non-penetrable process (Fig.4). Therefore, both processes of composed productions and proceduralized productions are not-penetrable processes.

The distinction between penetrable process and not-penetrable process indicates the difference of inferential rule in production systems. Although penetrable process is affected by data in the working memory that production appended immediately, not-penetrable process is not. Furthermore, the distinction between composed productions and proceduralized productions can be viewed as the difference of the extent of knowledge compilation.

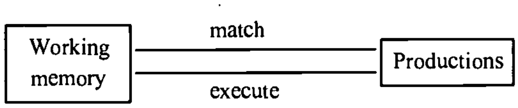

Figure3 Composed Productions

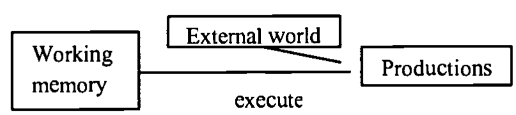

Figure 4 Procedualized Productions

A model of self-regulation skills

Here, we propose a model of self-regulation skills.

The architecture for both cognitive and metacognitive process is same

The same architecture must be responsible for both cognitive and metacognitive processes simultaneously [Lories, Darsenne and Yzerbyt, 1998]. This idea leads to the following cognitive process and metacognitive process. Cognitive process is the processing of the information, which is retrieved from long-term memory or the outside world and held in working memory by standard cognitive architecture. Metacognitive process is considered as processing the information that is held in working memory as a product of cognitive process by the same cognitive architecture.

A model of self-regulation skills

As self-regulation skills rely on cognitive process, self-regulation skills on penetrable processes may be different from those of not-penetrable processes. Self-regulation skills which rely on penetrable process result in the monitoring and control of the inferential process. But self-regulation skills which rely on not-penetrable process result in monitoring and control of the composed process. Although the process of self-regulation skills is different, both of them process information in working memory. The contents of working memory included actions of production that were executed immediately.

Penetrable process

As Self-regulation skills are employed to monitor and control inferential processes which were executed for achieving a goal, they can be viewed as exploring a set of productions that have been executed. The trace chaining is shown in the following .

step1. A production in which actions correspond with data that is set as a goal, is chosen.

step2. If conditions of the productions correspond with data in working memory, go to step 3.

step3. A production in which actions correspond with conditions of the chosen production is selected. If there are no productions to which actions correspond with conditions of the chosen production, the process will stop. If a suitable option may be chosen, go to the step 2.

The trace chaining will separate composed production into a sequence of productions. Next, this separation must be evaluated as to whether it is justified.

The relationship between the actions of the productions that were chosen at the last and the conditions of the productions that were chosen next to last in the sequence is evaluated as to whether it is cause and effect. If it is cause and effect, the sequence is justifiable. If not, the sequence must be improved. This process indicates self-regulation skills.

Not-penetrable process

Here, we propose to divide composed productions and proceduralized productions into a sequence of general productions as self-regulation skills. As not-penetrable process doesn't involve the choice of appropriate production, we must evaluate and regulate the process of knowledge compilation as self-regulation skills. This idea is seen in NEOMYCINE's decompilation. Decompilation is the separation of strategic knowledge from domain facts and rules. This was an attempt to recognize the performance of human experts who can access their knowledge in multiple attempts according to context [Wenger, 1987].

To divide composed productions and proceduralized productions into a sequence of general productions make the composition and proceduralization explicit, providing them warrants. The process of unpacking the complexity of these productions is to articulate knowledge, including justifications in both causal and teleological terms. From this, we propose to isolate composed productions and proceduralized productions by a sequence of original productions as self-regulation skills.

Additionally, proceduralized productions can be viewed as a part of composed productions. In other words, proceduralized productions are a specific form of composed productions. Thus, we describe a model of self-regulation skills of only composed productions.

The process of separating into a sequence of general productions is trace chaining without memory access. Consider the following productions which were demonstrated by Siegler [Siegler and Klahr, 1982].

P1: IF weight is the same THEN say "balance".

P2 : IF side X has more weight THEN say "X down".

P3 : IF weight is the same AND side X has more distance THEN say "X down".

P4 : IF side X has more weight AND side X has less distance THEN compute torques: t1=w1xd1; t2=w2xd2.

P5 : IF side X has more weight AND side X has more distance THEN say "X down".

P6: IF the torques are equal THEN say "balance".

P7: IF side X has more torques THEN say "balance".

Applied to the sequence of production P4 above followed by P6, composition create P4&P6.

P4&P6: IF side X has more weight AND side X has less distance AND compute torques: t1=w1xd1; t2=w2xd2. AND the torques are equal THEN say "balance".

After composed production P4&P6 is executed, data "balance" might be appended into working memory. Self-regulation skills on P4&P6 are described as the following.

The candidates of general production; P1, P6, and P7; the actions of which correspond with data "balance", are chosen. From these candidates, a sequence of general productions will be combined. We describe two cases; the candidates of general production P1 and P6.

The case of P1:

There are no productions, the actions of which correspond with conditions of production P1, "weight is the same". Then, a candidate sequence of general productions is P1.

The case of P6:

There is no production, the actions of which correspond with conditions of production P6 "the torques are equal". But the relation between the actions of the production P4 "compute torques" and the conditions of the productions P6 "the torques are equal" is of cause and effect, and consequently this connection may be evaluated as being justifiable. Next, the production, the actions of which correspond with conditions of production P4 "side X has more weight" and "side X has less distance" was chosen. But, there are no productions, the actions of which correspond with conditions of production P4; "side X has more weight". Then, a candidate sequence of general productions is P4 and P6.

There are two candidates of separation as a conflict set. As the condition of P1 "weight is the same" doesn't satisfy the criteria, a sequence of P4 and P6 is a candidate of separation.

Summary

We propose a model of self-regulation skills based on penetrable processes and one on not-penetrable processes.

Reflecting on the not-penetrable process, compiled knowledge has become so specialized toward a specific use as to have lost transparency and generality. The state of being compiled is independent from the process by which the state was reached [Wenger, 1987]. Therefore it is necessary to warrant compiled knowledge through the process by which the state was reached. Kitcher (1983) defines intellectual knowledge as warranted belief, where the "warrant" for a belief is a set of specific experimental episodes that have given rise to the belief and that justify it to a particular person. In other words, the actual warrant is a process.

The process of separating compiled knowledge into a sequence of general productions is also to justify it to oneself. Therefore the process of separating compiled knowledge into a sequence of general productions is one of self-regulation skills.

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Designing a Technology, Society and Education Course

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Abstract: A distance education professor from Turkey and a professor of Learning Technologies in the United States have collaborated on the design of a graduate course for studying the dynamics of change in an era of electronic technologies. They will describe the perspectives used to examine the impact of technology on society and thus on the pedagogical tools developed to enhance eventual online delivery. The course provides an opportunity for students of learning technologies to look at the field from broader perspectives through historical, sociological, political/economic, cultural and personal perspective on how technology has changed human activity. Through short writings, reaction papers to the books and research syntheses in an area of interest, students develop a personal change model and revisit that model. Students, also, wrote a science-fiction story that shows what they think education might be like in the future. Readings are from fields other than education.

Introduction

This graduate course titled "Society, Education & Technology" in the College of Education at New Mexico State University covered a lot of different aspects of how technology affects society and education. It began with the larger historical perspective offered by Toffler of how technology has changed world history during three distinct phases or waves of technological change moving from the agricultural to the industrial to the current information/communication age. We looked briefly at how technology and specifically computers have changed in the last 50 years and what that means for education. Our model of the changing functions of computers involved moving from computers as number crunchers to data processing machines to communication devices and finally to seeing computers and the networks they are connected to as a knowledge creation environment. Then we considered briefly how technological innovations have influenced education or not influenced it and finally we looked at some of the stages of technology use in education.

To explore the dynamic relationship between changes in technology, society, and education and their influence on human interactions and learning, students in this class collected information from a variety of perspectives, historical and philosophical, sociological and cultural, political and economic, and psychological and personal, and create their own knowledge environments related to technology, society, and education. They tried to find a answer to how technology affects society and thus education and technology and its relationship to societal change. They found these answers not only through reading widely in books outside of education but also by interviewing young students who were involved in using the web.

During the second week students received an invitation from the instructors to participate in a research symposium to be held toward the end of the class on the subject of technology, society and change. The students refined their questions and formed question research groups. The intention was for the class to formulate a number of powerful essential questions that can drive the investigations into the relationships between technology, society and education. An essential question must be meaningful and deep enough to lead to fruitful research and consideration of big ideas. The research groups developed questions about technology, society, and education, which are answered through interactive multimedia presentations, which will be presented at the (Society for Information Technology and Teacher Education (SITE) conference 2002.

The main objectives for the students were:

- To discover technology and its relationships tosocietal and educational change.
- To work in a project-based team to investigate a technology, society and education question deeply.
- To make assumptions based on their coursework and write a narrative on the future.

Background of the Class

In the words of Buffalo Springfield, *Something's happening here... what it is ain't exactly clear...* or as Dylan suggested *The times they are a-changing.* The world is not the same place in which we grew up or in which our parents and grandparents lived. We live in what Margaret Mead called *a post-figurative culture*, in other words a culture in which our children experience a whole different reality from what was experienced by older generations. The effect is that much of the knowledge we gained growing up may not be especially relevant or useful in today's world.

Yet, there are historical parallels to this period and common to these parallels are how society often reacts to fundamentally new technology. The course begins with a story from Socrates about the fears educators had about student learning when the alphabet was introduced. When the printing press was first invented no one envisioned the profound effect it would have on human activity. Books were still seen as something only for the elite. Language and literacy are crucial technologies influencing human events. History has many examples of how writing and reading was forbidden in different cultures including the slaves in early U.S. History. From 1066 to the late 1300's in England all official transactions were done in Latin or French. At one time English was only an oral language spoken by the peasants. By 1400 the people's English began to blend with French and Latin into Chaucer's Middle English and eventually modern English.

Now we have the personal computer. Where once only computer gurus in data processing departments could control the information to which people had access, an elementary student today can quickly access the Web and soon know more than his or her teacher about a specific subject. Scary. And then there is the more recent history of technological innovations in schools, so well articulated by Larry Cuban in *Teachers and Machines* (1986). In each era from films to radio to instructional television great claims have been made by researchers and technologists about how this new innovation will change education. In fact, very little has changed. Is there something fundamentally different this time? Is the web more like the printing press than just a faster engine? This class is about all of these issues. It asks the essential question: "How is technology changing the world and what does that mean for education?"

The historical perspective in this class was investigated by studying Toffler's three distinct waves of technological change from the agricultural to the industrial to the current information/communication age. Students also read *The Victorian Internet* (Standage, 1999) and compared this innovation to current web development. They were amazed at the similarities between the development of the telegraph and the web today. We looked at the long view of history using writers like Alvin Toffler and his book *The Third Wave*. We also began scanning current media to detect the hottest issues in society today in relationship to technology following the lead of Naisbitt's *Megatrends* (1991) a book he wrote based on column inches dedicated to current news. As part of the historical perspective students developed their own interactive timeline in relationship to the Question/Research group they join.

A sociological perspective included reading *Growing Up Digital* (Tapscott, 1999) and doing student interviews with *Netgeneration* students. Technology has always had a profound effect on human activity. Small communities were formed when the technology of firming was invented. The invention of the wheel made it possible to move goods and people easily from place to place and contributed to the creation of commerce. The class investigated models of the change process, examined speculations related to the directions and dynamics of change in an era of electronic technologies, explored shifts in the cultural and personal activities and relations of humans, and speculated on concomitant educational implications. Each student developed a personal model of change and shared it in class.

We also discussed the importance of tools. Technology is not neutral, but affords different kinds of activities (Norman, 1994). As computer capacity has grown and network resources increased exponentially the power of computers have changed from what were at first glorified typing and teaching machines to systems in which it is now possible to create as well as distribute education. High levels of access allow teachers and students to participate with others in the community and to generate new community knowledge environments. One of the important potentials for today's interactive multimedia technology is to help students who are English Language Learners. Technology can also afford community building or individualistic types of learning.

In the year in which the Berlin Wall fell (November 9, 1989), Francis Fukuyama (1993) believed that the end of the cold war signaled the end of a long ideological evolution from feudal times through republics, communistic approaches, to the final form of government - a universalization of liberal democracy. In contrast, Samuel Huntington (2001) highlighted that the world was entering a new period in which there would be a Clash of Civilizations. He issued a much more ominous forecast and suggested that the passing of the cold war had brought an end to competition among nation-states, but it had also launched an era of growing competition among the world's major civilizations. These questions were pressing after the September 11th terrorist activity and the class turned to books like Jihad vs. McWorld (Barber & Schulz, 1996) to help understand the current crisis and its relationship to society and technology. Political and economic explorations were also grounded in the economic history of Hegel and Marx and expanded to include cultural perspectives through reading C.A. Bower's *Let them Eat Data* (2000). We abandoned the regular syllabus after September 11 and spent three weeks on questions related to this event including time spent exploring alternative world media. Especially interesting was how different countries used media to explain their point of view on this event. We returned frequently to a very professional web site developed underground by professional women in Afghanistan (http://rawa.fancymarketing.net).

Project-Based Learning

If teachers are going to change the way they teach they need to be in classes that model constructivist, project-based learning. This class was designed to involve students in researching, organizing, evaluating, and presenting information that they felt illustrated relationships between technology, society and education. *We are to thinking as the Victorians were to sex,* writes Papert (1980), *everyone does it, but no one knows how to talk about it.* As we create new electronic learning milieus, we have the potential to create environments that scaffold and enhance higher-level thinking. Anchored Instruction is one way to think about a constructivist design for learning. The term was introduced by the Cognition and Technology Group at Vanderbilt (1990) to describe situated learning. Norton and Wiburg (1998) describe this type of instruction, *Anchored instruction creates environments that permit sustained exploration by students and teachers and enables them to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools. (p.103)* It is this type of constructivist learning that we aimed to model in our course on Technology, Society and Education.

Students built their research presentations around problems and questions that were both meaningful for them and rich in opportunities to understand how technology affects society. The culmination of the course was the research symposium presentations. During the class, findings from the readings were explicitly tied by the students to their larger research questions. The topics were extremely diverse and quite interesting. The groups in this class choose the following topics:

- Environmental Racism - What impact have computers had on the quality of life from an economic, health, and consumer perspective?
- Virtual Learning & Real Benefits - As the need for education increases and time for pursing and education decreases, can the combination of high-quality instruction and current technology assist specialized groups of learners to obtain their objectives and does gender play a significant part in this learning progress?
- Influence of Technology on Human Health - How has the growth of technology has an effect on individual's quality of life and health across socioeconomic boundaries?
- Technology & Multicultural Diversity - How does an individual's socioeconomic, gender and racial background affect their learning with technology?
- The Influence of Technology on Educational Delivery - How have new technological media influenced distance education opportunities for woman?

Each presentation took almost an hour in spite of the assignment, which was to do a 30-minute presentation. However, students had created extensive time lines, web connections, and interactive multimedia components to their presentations and we did not want to limit their time. The student presentations will be available via the web on the New Mexico State University Learning Technologies web site (http://mathstar.nmsu.edu/EDL610.htm).

Creative Activities

Piaget once wrote, *To understand is to create*. To provide students with a truly constructivist environment we asked them to build creative products as part of this class. The first product was their personal theory of change in which they developed both a visual metaphor and a narrative related to their theory of how things changed. We did not limit their product to education but allowed them to think about change in the world. This reflected the class in general, for which we had decided that graduate students need to think outside of the paradigm of education. Metaphors included different types of swimmers in a race, a peeling onion, a train going downhill, types of eaters, and spirals without beginning or end.

The final project in the class and the one the instructors felt best evaluated the ability of students to think about the future was an assignment to create a science fiction story about education and life in the future. Graduate students who were now well trained in writing research papers protested loudly against having to write fiction. However, the instructions understood the value of transforming information from one form to another (expository to narrative) as well as the value of showing via narrative what things mean (Brunner, 1966). The resulting stories were uniformly very, very good and showed, often in a very moving way, the potential relationships between technology and society. The stories reflected the two-sided sword of technology. Some were very scary and portrayed an Orwellian future in which technology controlled all human interactions to make them efficient and non-messy. All babies had to perfect in order to enter society and all jobs were designed for each individual's skills and interests. A character who was curious about the what other people did or the possibility of changing jobs had to be eliminated. Other stories reflected the liberatory potential of technology to serve rather than destroy diversity. In one educational system a student and his grandmother used the web as well as electronic time travel to study an area of historical interest.

Conclusion

This course covered many different aspects of how technology affects society and education. It began with the historical perspective offered by Toffler of how technology has changed world history and then explored parallels between an earlier revolution caused by the telegraph and the impact of the web today on society and education.

As with any new technology computers were first used to do more efficiently things that teachers have always done. During the 1960's and the 1970's the computer was used for "drill-and-practice" or "tutorial" programs with students. This was known as computer-assisted instruction (CAI) or computer assisted learning (CAL). Students would type in answers and the machine would indicate whether the answer was right or wrong. If it were wrong then the computer would indicate that the answer was wrong and then present a new question at the same level of difficulty. If the answer were correct then the computer would present a progressively more difficult question. It was believed that students could learn more in a shorter period of time using this type of technology. In many cases CAI has been useful in improving student achievement. However, Cuban notes a study by Levin, Glass and Meister (1984) that noted that peer tutoring was actually more cost effective in terms of learning gains that the use of computers. Hativa, N. (1988) did an extensive meta-analysis of the use of computer-based drill and practice in arithmetic and suggested it was widening the gap between high-achieving and low-achieving students. CAI is often least effective with English Language Learners since their problem may not come from not understanding language rather than content (Wetzel, K & Chisholm, I., 1998; Butler-Pascoe & Wiburg, in press). In a 2000 study, A recent large-scale study by Wenlingsky (2001) found that those children whose teachers used computers in constructivist ways to teach mathematics (simulations, spreadsheets) scored significantly higher in mathematics achievement than those who used the computers as tutorial and drill and practice machines

Most current leaders in the field of learning and technology suggest that it is only by tying the use of computers to new forms of instruction such as constructivism and socioconstructivism that the power of the computer for learning can be tapped (Bereiter, 1994; Dede, 1998; Norton and Wiburg, 1998; Rodriguez & Berryman, 2000). There is emerging a powerful synthesis between new theories of how students learn by constructing and sharing knowledge and the capacity of new computer-based technologies to support these types of learning strategies. However, access to these best uses will not occur until teacher educators embrace and model these deeper uses of technology.

It was important in this class to think critically about the notion of change. Each new innovation is introduced with strong words from the developers as to how this new device will fundamentally change education.

In reality, many of these innovations have had very little impact on teacher practice. The final book we read in the class, Leadership and the New Sciences, reinforced for the students the nature of systems and the potential impact of the larger system on efforts to make change. As a result of studying changes in society and education in relationship to technology, students became more reflective and critical about what kind of change is possible in the world of education today. Is the computer such a fundamentally different machine that its integration into school practice is likely to alter practice in fundamental ways as suggested by Norman (1994) or Dede (1998)? Or is the institution and culture of K-12 education fundamentally in conflict with the potential of computers to create changes in educational practice? What are the limitations of the current educational structure in the United States and how does this limit what is possible in terms technology and learning? Taking a variety of perspectives and a global view of change helped students to think about how to answer these questions and to become the leaders we need in the field of information, communication, and learning technology.

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The Use of the Internet to Teach Critical Thinking

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Abstract: The world is rapidly becoming more technologically complex. As a result, students need to be taught differently than they have been in the past. Schools must prepare students to become active members of this changing society, and to adapt to these transformations as they occur. The Internet can be a strong partner in enhancing a student's ability to think and solve problems critically. However, without teachers who understand how to integrate technology meaningfully into their teaching, the desired student outcomes may not occur. This paper discusses ways that the Internet can be used to teach critical thinking in a classroom.

Introduction

Critical thinking and problem solving have become increasingly important in the educational development of students. Critical thinking helps students to better read, listen to, understand, and remember information (Smith, Knudsvig, & Walter, 1998). Moreover, engaging in critical thinking requires students to be active participants in the construction of knowledge, rather than passive receptacles for information delivered by a teacher or instructional medium (Jonassen, 2000).

Critical thinking can be easily incorporated into a constructivist classroom that supports students in being producers of their own knowledge. In a constructivist environment, students work on complex projects, synthesize information to build their own understandings, learn skills and concepts, and use them to solve real-world problems. These projects, often done in groups, follow from a theory of learning that suggests subject matter becomes meaningful, and therefore understandable, when it is used in context-rich activities (Fosnot, 1996; Norton & Wiburg, 1998).

The availability of technology and access to the Internet has allowed educators to bring real-world problems into the classroom for students to explore and solve. In addition, students are often more engaged in problem solving when using such external vehicles as the Internet, because they encourage comparing ones ideas with others, an important component of the critical thinking process. Students in today's world have other possibilities than learning face-to-face from a teacher. They can also learn by discussing problems, ideas, and beliefs with peers and experts throughout the world by using the Internet. According to Bransford, Brown, and Cocking (1999), "Technology can help to create an active environment in which students not only solve problems, but also find their own problems" (p. 195).

The Internet as an Enhanced Critical Thinking Tool

The Internet is the world's largest computer-based communication network. It contains many resources that educators can access to create enriched learning environments, and it has the potential to offer up-to-date information for teachers, and learning activities for students. It also can expand the boundaries of a school far outside its walls, and change the roles of teachers and students in the educational process.

Learning on the Internet can help make education more meaningful for some students than learning by traditional methods, because they can acquire knowledge using a variety of modalities, including visual, audio, and text. They can also gain a great deal of information about any topic in a very short period of time, and have access to original sources and experts throughout the world. Numerous databases found on the Internet can help teachers guide students to access, analyze, and evaluate information. With appropriate instructional strategies that teach critical thinking, students can then learn to construct their own meanings from this information.

According to Harris (1994), the use of the Internet as an enhanced critical thinking tool in the classroom can include independent learning, one-on-one coaching, and large group projects, with both independent and assisted practice. For example, retrieving research information can be done alone or as a member of a group. Email is a useful medium for collaborative writing activities, and can also be used for communication among groups of students from various cultural and socio-economic backgrounds. Bulletin boards and Usenet newsgroups provide individuals the opportunity to read, reply and reflect on messages focusing on specific areas of interest. Web sites also allow users to store documents and multimedia resources. In addition, the Internet allows for computer conferencing and virtual classrooms. Internet Relay Chat (IRC) lets users see what is typed on other users' screens; and, video conferencing permits users to send and receive video images from people throughout the world. One of the newest learning environments is virtual reality, which gives users the impression of three-dimensional interaction.

Although there are many advantages to using the Internet in the classroom to enhance critical thinking, learners may become overloaded with information. Harris (1994) found that students are more successful when they consciously apply specific strategies to learning tasks. The learning tasks then direct their thinking, and encourage them to monitor and evaluate their progress. Thus, it is crucial for teachers to assist learners in developing strategies for best accessing and evaluating online information. In addition, educational activities should include offline resources, such as video, books, and other available resources.

If educators hope to use the Internet effectively to enhance the teaching of critical thinking, all schools and teachers must have access to technology and the Internet. However, they also need to have professional development opportunities that teach them to meaningfully integrate the Internet into their curricula. Without such staff development programs, delivering web-based courses to teach critical thinking may be a time-consuming and frustrating educational activity for both teachers and learners.

Conclusion

Teaching critical thinking should be one of the most important educational goals in today's society. When thinking critically, we become active, productive, hopeful, and psychologically healthier people. However, teaching students to become critical thinkers is often difficult. With today's emphasis on test scores, a teacher must make an extra effort to integrate problem solving and critical thinking into her daily routine. When done correctly, this may have the additional benefit of higher test performance.

We need educational environments with high levels of communication, interaction, and collaboration. The Internet can be a valuable tool in an instructional strategy, because it enhances active, cooperative learning through communication with people, both nearby and around the world (Smith, 1996). Today's educators are beginning to use technology to support students in critical thinking activities, because they provide learning environments that are more interactive and engaging. Teachers will continue to have a very important role in the development of Internet applications for their classrooms.

It has become quite clear that the Internet is breaking down the walls of the traditional classroom, and allowing students to gain worldwide communication and information online. Moreover, instead of teaching and learning only in the conventional educational environment, we can now do so at a distance with our own computers. We are just beginning to understand the potential of the Internet as an educational tool that can be integrated into the classroom in a meaningful way.

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Teaching as Design: Implications for Learning to Teach With Technology

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Abstract: Teachers, particularly those working with technology, have to deal with the issue of design. However, it is often hard to describe what design means. This paper offers an analytic framework for better understanding the process of design and comparing it to the kinds of activities that are involved in teaching. We do this by looking at case studies of design as instantiated in a Master's seminar in Educational Technology. Participants in this class were expected not only to learn interactive web-based technology but also to generate abstract knowledge (about designing educational technology) through working on authentic design projects. In this paper we look closely at the design process and compare it to the process of teaching. Our analysis is guided by prior work on the analysis of design conducted by Mishra et. al. (1999). We believe that a better understanding of design can enrich our understanding of both teaching and technology taken individually, as well as offer us new ways of teaching with and about technology.

Introduction

This paper grew out of a conversation about teaching with technology, a conversation between two researchers who focus on educational technology, teaching, and teacher education—though with slightly different backgrounds and interests. The first author is a designer, researcher and educational technologist with a keen interest in the nature and process of design while the second is a former school-teacher and researcher in teacher education. Clearly we approached these topics (of designing technology, teaching with technology, and teaching about teaching with technology) from different perspectives but with fundamentally similar concerns, (a) to better understand the manner in which teachers use technology in their classrooms; and (b) to use this understanding to develop better strategies for assisting this complex process. As we continued to talk it seemed that certain themes began to emerge, themes that tied together teaching and design in interesting and insightful ways.

Underlying our conversations was a concern with teacher's attitudes towards technology or more appropriately people's perceptions of teacher's attitudes towards technology. Too often it seemed to us teachers were being represented as Luddities or people resistant to the incorporation of technology into their classrooms. Moreover teachers also report feeling ill prepared to teach with technology, and research suggests that for the most part, teachers are not making the kinds of transformative uses of technology that seem likely to have a positive impact on education (Becker, 1999). However, this is where we faced a paradox. Through our conversations we came to realize that at some level, teachers should be the ones most comfortable with technology. They are accustomed to complexity; they design complex environments and solve ill-defined problems day in and day out (Leinhardt, 1994; Lampert, 2001). On the face of it, they have some of the most important characteristics needed to be effective technology users.

This seeming contradiction between perceptions of teachers towards technology and our belief that teachers should be the most comfortable with it is the basis this paper. To understand the problem, we use the metaphors of teaching as design, and design as teaching. Through these lenses, we explore ways that teachers can understand the work of learning to teach with technology as an extension of what they already know and can do. We begin by talking about design, what it is, and what it is not. At each and every point we contrast it with teaching. What we find is that both design and teaching share many important characteristics. Specifically we shall focus on a series of themes about design and look at each theme as it plays out in the case of design and of teaching.

Why these particular metaphors?

Recent research projects on learning environments have been described as design experiments, and the metaphor of designing for teaching has been extended by some to teaching as design. Educational technology researchers work at the interface between design and teaching. We help teachers learn to design technologies, and to design their teaching to take advantage of the affordances of those technologies. We help them learn to teach with designed artifacts. The link seems natural because our work is focused on both design and teaching.

From time to time, both teaching and design have been conceived as being formulaic—a series of predetermined steps that must be accomplished in order to achieve a particular goal. Both programmed learning and standard design methodology courses suffer from this misconception. At the heart of misconception is what Donald Schon calls the "model of technical rationality" (Schon, 1983, p. 21). This model assumes that both design and teaching consist of "instrumental problem solving made rigorous by the application of scientific theory and technique" (Schon, 1983, p. 21). Just as too often technology is seen to be "merely the application of the relevant basic sciences to the making of artifacts" (Dasgupta, 1996, p. 4), teaching has been seen as the application of psychological principles to the process of student learning.

For instance, looking more specifically at design, it has been argued that design is more than the application of scientific knowledge to a given real world problem (Dasgupta, 1996; Gelernter, 1999; Mishra, Zhao & Tan, 1999; Schon, 1983; Winograd, Bennett, De Young & Hartfield, 1996).

As Mishra, Zhao, & Tan (1999) say:

> Design is a creative activity that cannot be fully reduced to standard steps, and should not be thought of as mere problem solving. A designer lacks the comforting restraints of a well-organized discipline because designing is inherently a messy endeavor. It includes, but goes beyond, the ability to be creative in solving problems. A host of techniques and skills come into play during design. Many of the techniques and skills are explicit and publicly available, while others may be tacit and unspoken. According to Smith and Tabor (1996), design is as much an art as it is a science–spontaneous, unpredictable, and hard to define. (p. 221)

It is enlightening to read the above quotation once again, though this time replacing the words "design", and "designer" with the words "teaching", and "teacher". The new quote would echo a perspective that is valued by many teachers and teacher educators.

Similarly, both teaching and design require a balancing act among a variety of factors that often work against each other. It requires the application of a wide array of knowledge, from algorithms to rules of thumb. This inherent "messiness" of both these professions is further complicated when we consider the very abstract nature of their respective goals—be it learning for understanding or the design of an after-school program (Vyas & Mishra, in press) or an online course.

Both design and teaching are inherently teleological. Both are concerned with the invention of artifactual forms–an activity that aims to satisfy human goals and aspirations. Often , particularly in the case of design These goals can be quite concrete as in the case of building a bridge or or writing a poem. In the case of teaching, however, these goals can be more abstract: developing student understanding, learning content and so on.

In addition, both design and teaching are dependent on dialogue or interplay. As the individual acts on the environment, the environment also acts upon the individual. Design and learning are not simply about understanding and assembling materials. It is fundamentally about ideas and transforming oneself and the world through the process of working with those ideas. This process of "acting on" an idea happens in two ways: intellectually and physically. Intellectually, the designer or the learner engages with the ideas and concepts and attempts to learn more. Physically the designer works with the artifact, modifying, manipulating objects to fit the desired ends. This is essentially a dialogue between ideas and world, between theory and its application, a concept and its realization, tools and goals. We see this dialogue as being at the heart of true inquiry, involving as it does the construction of meaning and the evolution of understanding through a dialogic, transactional process.

We begin with a framework for thinking about design developed by the first author (Mishra, Zhao & Tan, 1999). In this paper we attempt to "unpack the black box of design" by closely studying the theoretical, technical, social and cognitive issues surrounding the design of two different computer programs. This analysis (1999) builds on previous empirical and theoretical work by other scholars (Dasgupta, 1996; Schon, 1983; Winograd and Flores 1986; Winograd *et al,* 1996), and led to the outlining of twelve general themes that underlie the design process.

We extend this discussion about the similarities and differences between design and teaching through a deeper analysis of the 12 themes of design as offered by Mishra *et al* (1999). These are:

1. Design/Teaching is purposeful, intentional, and conscious
2. Design/Teaching keeps human concerns at the center
3. Design/Teaching is knowledge intensive
4. Design/Teaching is historical and path-dependent
5. Design/Teaching is selective
6. Design/Teaching is aesthetic
7. Design/Teaching is communication
8. Design/Teaching is a social activity
9. Design/Teaching is creative
10. Design/Teaching is emotional
11. Design/Teaching is an ongoing conversation
12. Design/Teaching requires closure

Limitations of space prohibit us from delving into each of these themes in greater detail. Clearly some of these themes will not be new to teachers and educators. However there are others that may not be as obvious. The fact that design is aesthetic brings to the forefront the fact that teaching is also an intensely aesthetic activity. However, this is not an issue that is raised often during discussions on teaching. Similarly both design and teaching require immense emotional commitment, once again not something discussed often. Finally the fact that design requires closure allows us to think about the ebb and flow of teaching (be it a single class or a school year) very differently. Thus what this metaphor does is allow us to think about teaching with a new perspective.

Applying our ideas

The similarities between teaching and design can also be seen in discussions about how both are to be taught. Schon (1987) lists a range of reasons arguing that design cannot be "taught" in conventional ways. Once again it is instructive to see how appropriate these reasons for why teaching cannot be taught in conventional ways. Schon argues that: (a) Designing is a holistic skill. It must be grasped as a whole, by experiencing it in action; (b) Design depends a great deal on recognition of design qualities. This recognition is not something that can be described but rather must be learned by doing; (c) Designing is a creative process in which a designer comes to see and do things in new ways. Therefore, no prior description of it can take the place of learning by doing; (d) Descriptions of designing are likely to be perceived initially as confusing, vague, ambiguous, or incomplete; their clarification depends on a dialogue in which understandings and misunderstandings are revealed through action; and finally (e) The gap between a description of designing and the knowing-in-action that corresponds to it must be filled by reflection-in-action.

Over the years we have been applying our ideas about design and teaching in a series of master's courses taught by the first author. The emphasis in these courses has been on learning about design by "doing" design. Most participants in these courses are practicing k-12 teachers who bring their rich professional knowledge of teaching and learning to the classroom. Participants in this class were expected not only to learn interactive web-based technology but also to generate abstract knowledge (about designing educational technology) through working on authentic design projects. In the learning process, each member of the communities is engaged in activities that compel them to seriously study technology, education, the interface between the two, and the social dynamics of working with others. They participate various learning activities such as group projects, whole class discussion, group collaboration, project presentation and critique, asynchronous on-line discussion, journals and final group reflection on design process. Through learning about and through authentic design focused on genuine problems of practice, participants use technology creatively in various educational contexts.

One of the key arguments developed over the duration of the semester is that of the similarities between design and teaching. This is not something that is explicitly pointed out at the beginning of the course. Rather in the beginning they are told this course is just about learning technology through design. As the semester progresses, these similarities between teaching and design are allowed to emerge. This culminates in a formal presentation by the instructor towards the end of the semester that describes the similarities between design and teaching. Finally the students are asked to write a paper on the design and teaching process connecting them to the 12 themes of design/teaching.

Design and teaching are not things that can be taught by lectures and demonstrations. They are best learned through the active process of creating and doing. That said, both are hard to learn. Both can be extremely motivating and enjoyable though frustrating as well. The fact that there are no magic solutions, and even the solutions that emerge are compromises at best is often a difficult message to swallow. By involving teachers in these design projects we offered them an opportunity to explore and play within the relatively "consequence-free" zone of a classroom. In some sense the classroom became a laboratory for teachers to experiment and try out different concepts, to experiment with technologies and ideas.

Bringing ideas of design into the realm of teaching allows teachers to think about what they do on an everyday basis in a new light. As one of the students in the class wrote in a journal posted to the class listserv: "I buy into the strong parallels between teaching and design. We design lesson plans. We design strategies to hopefully interest children in learning, discovering, and developing an interest to learn more. Early on I tried to design lessons to get them to learn the correct information they needed. Correct information is important, but now I try so much harder to just get them interested in learning and develop learning as a lifestyle. I work at designing an environment that is appealing not only for the information, but for the aesthetics. Over the years that I have taught (~20) I agree ... that teaching is spontaneous, unpredictable, MESSY, and creative. So much more is involved than just me. How much the students know already and what the students are like just from one class to the next." He continued "The problem is design cannot be taught. It is a holistic skill - it must be experienced.... I was so unprepared for what I found in the classroom, because there was so much more going on than what my college classes covered. I needed college for the knowledge of my field, but I needed more input from teachers than I had when I started... If I had not been under contract the first 2-3 months I think I would have quit."

The course became a site where students thought about the complexities inherent in both design and teaching. As one of the students in the class said: "Ultimately, I think one of the things I've learned from this is how complex and dynamic the process of design can be. We have brainstormed, gotten ideas from and been influenced by other people, our audience, our surroundings, and by the object of our design itself. By listening to opinions, taking the advice of others, and considering our own vision we are creating something unique and exciting."

Conclusion

We believe that bringing these two worlds (that of design and that of teaching) together adds to our understanding of teacher knowledge for teaching with technology. It allows us to explore aspects of what teachers already know, albeit tacitly, and how that knowledge can be called on in support of new skills and competencies. Finally we believe that the metaphor of "teaching as design" allows us to think of both teaching and design in interesting ways. As we know, metaphors serve as filters for our perceptions, providing a kind of framework within which we interpret our experiences and assign meaning to them. Metaphor is deeply embedded in our language, culture, and the way we think, and hence affects how we experience and interact with the world and other people. We believe that bringing the metaphor of design into teaching with technology allows teachers to step out of the "paradigm of technical rationality" and to become better and more flexible users of technology.

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Technology as a Developmental Influence

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Abstract: As a prominent environmental feature, the availability of advanced technology likely has a pronounced developmental influence on those who encounter it. As technology becomes more integrated into society, and as society becomes more technology dependent, an individual without even basic technology skills may face the same challenges as one who lacked basic literacy twenty years ago. Exposure to technology likely has other benefits, such as facilitating the development of advanced cognitive and conceptual skills. A problem exists, however; not all individual have adequate exposure to technology or adequate opportunity to develop technology-related skills.

Human development is largely dependent on the environment. A compromise accepted by many in the seminal nature-nurture debate is that the environment determines how heredity expresses itself. Society has changed much in the last eighty years, and the degree of change within the last thirty years has been more rapid than in any other period of human history. Basic skills sets have always changed based on the availability of technology and the dynamics of social convention. The advent of the computer age has changed human occupational, social, and educational development significantly in a very short period of time. The computer is likely responsible for the single largest developmental shift across many areas of learning and performance; this is especially true of not only what children, adolescents, and young adults are expected to be able to do, but how they conceptualize problem solving and the degree to which abstract reasoning is important in concept formation.

The workplace has changed significantly due to the automatization of many formerly manual jobs. Education has changed on several fronts as well; not only do computers (and other sophisticated electronic devices) require special skills to use, they are also now part of standardized education in many areas and will only become further ingrained in education service delivery at all levels. Occupations formerly considered to be non- or low skill vocations now require at least some degree of technological sophistication. This level of knowledge is considered minimal compared with other, more technology dependent occupations, but for the unskilled person trying to learn a new job, these basic skills can pose a significant obstacle.

Because the changes in available technology have occurred so rapidly over the last three decades, the more glacial pace of social change is having difficulty keeping up. Standard developmental influences, such as modeling work behavior from a parent or a role model, acquiring training in a traditional vocational or elementary classroom, and hands-on exploration of one's immediate surroundings will likely not be sufficient to teach fundamental skills necessary to later acquire more advanced abstract concepts and hands-on technology skills. There is a significant impetus to put computers in elementary and college classrooms, but not all classrooms have them and many do not have a sufficient number of machines for the number of students served; many learners on all levels have insufficient exposure to technology in the learning environment and hands-on time is severely restricted. Computers are present in most learning environments, but in many cases the number of machines is simply insufficient.

Many students of all ages do not have computers at home and do not have access to them in their community. Government initiatives, such as Head Start, do not have the funding to provide significant numbers of computers in all areas along with instructors trained in how to maximize their utility as teaching tools. This lack of access sets the stage for learners, child and adult, who do not have access to computer and electronic technology outside of the classroom to be at a competitive disadvantage compared to those who contact advanced technology in a number of different settings.

The importance of learning technology skills from the job performance/occupational requirement perspective requires some examination of the evolution of most common occupations with respect to the availability, reliability, and capacity of computer and electronic technology. Computers and computer-controlled technologies are readily available to business and industry, companies, service providers, and manufacturers. Those who integrated these advances early on found themselves at an initial competitive advantage over the competition. With the widespread integration of technology into the workplace, this advantaged seemed to normalize across employers, leaving those who either failed to integrate advanced technology or failed to fully incorporate and update technology on hand at a competitive disadvantage. Advanced technology is no longer an advantage, it is requirement. Simple paper and pencil functions, such as signing for a parcel or filling out a room reservation in a hotel have been almost entirely replaced by computers and portable data units. Many organizations keep few paper copies (unless required by law) and store most of their data and documents electronically. Any business or service provider that attempts to operate without at least a minimal level of technological integration is almost certain to fall short in their respective market. The integration of technology into our lives has come both as a massive rush of change and as subtle changes to everyday life. The computer revolution suddenly reinvented mass communication, giving us an entirely new medium in the Internet. Just as revolutionary but with greater subtlety came debit and credit card purchases in supermarkets, on-line shopping, computer controlled ignitions in vehicles of all sorts, cellular phones, and so many other changes. Skill in the use of advanced technology, even in its most basic form, is now a fundamental skill set as important as literacy. Twenty years ago an illiterate adult entering the workplace found his or her options decidedly limited. Lack of literacy skills is less common of a problem than twenty years ago, but the lack of basic technology skills is fast replacing illiteracy as a fundamental skills deficit.

The social and educational environments have changed as well due to the infusion of technology into every aspect of our lives. Technology has become a developmental experience and is no longer a set of supplemental skills. Children socialize by playing games. Many of the games children play involve computer technology, and the skill to use such game stations are relatively easy to acquire, especially if there is another child to act as a model. Internet use and skill with the more advanced functions of a personal computer are more difficult. Children who lack these skills may withdraw from the settings in which they are used. Such early skills development and the development of patterns of approach/avoidance behavior to technology will influence the learner for the rest of his/her life. Technology serves not only an occupational function, but is increasingly a social medium and catalyst as well. Potentially, the lack of education and availability of developmental experiences with technology could create an "out group" of people who not only have difficulty maintaining adequate employment, but who also find themselves at a distinct social disadvantage.

Not only have the tools of the trades changed, and not only have the media of the social environment followed the evolution of technology, but basic conceptualization and cognitive mediation have changed as well. People with exposure to technology as a key feature of their environment likely develop advanced thinking skills earlier than those without such experiences. Those for whom technology has been consistently available likely think in more abstract, representational terms, as opposed to a more concrete style involving more realistic references and less abstract interpretation. Advanced concept formation and problem solving are likely the benefits of exposure to technology across many settings over a sustained period of time.

Potential solutions must include increased exposure to appropriate technology and fundamental skills acquisition. The main problem is not inability to learn these skills, but the insufficiency of learning opportunities for many learners. Within the economic structure of the United States a series of broad solutions, based on collaboration, is possible. Because of the rapid nature of technology-driven change, and the correspondingly ponderous rate at which various social engines adapt to that change, these solutions must include a higher level of collaboration between private coronations, educational institutions, and government bodies than has been present to this point. Advanced technology likely has an impact on individual development second only to heredity. The children of today who are consistently exposed to a technology-rich environment will undoubtedly develop advanced conceptual and synthesis skills when they become the adults of tomorrow. Integrated cooperation from all sectors will be necessary to ensure such development.

Building eLarning Communities

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Abstract: Effective eLearning communities play an important role in the technology-based learning environment. An eLearning community has been misrepresented as a place where learners only learn together. This thesis is discussed, reviewed, and examined by considering effective eLearning communities, the impact of eLearning communities on human learning, different frameworks for eLearning communities, and proposes a refined theoretical framework for future research and development of eLearning communities. In this thesis, eLearning community is referred to a place where learners learn together and, in addition a community that learns. A refined theoretical framework for eLearning communities is proposed that encompasses three major constructs "Instruction," "Social Interaction," and "Knowledge Construction Technology." It is recommended that eLearning communities should be implemented with looser structure but with effective systemic strategies.

Introduction

Active approaches to effective learning present learning as a social process that takes place through communication with others (Hiltz, 1998) in communities (Hiltz, Turoff, & Benbunan-Fich, 2000). The importance of online learning communities has been emphasized by recent studies (Gordin, Gomez, Pea, & Fishman, 1996; Haythornthwaite, Kazmer, & Robins, 2000). In fact, students and faculty were yearning for a deeper sense of community. From a social learning aspect, learning community is defined as a common place where people learn using group activity to define problems affecting them, to decide upon a solution, and to act to achieve the solution. As they progress, they gain new knowledge and skills (MacNeil, 1997). It is a process much more profound than merely appreciating one another. Little conceptual framework has been developed regarding this new learning environment. ELearning community is the term widely applied in electronic education. Researchers (Schlager et al., 2000) are aiming and advancing toward a community that learns/evolves in addition to being a community for learning. How learners gather information and apply appropriate information to knowledge construction is more critical than simply obtaining information, making it necessary to examine knowledge construction in an eLearning community and advance to the level of a community that learns, rather than just information sharing and learning together.

Learning Impacts

Before exploring eLearning communities, it is necessary to understand what impact an eLearning community has on learning. Studies of virtual teams have shown that issues of interdependence, leadership, social communication, and project management are critical in forming successful teams (Jarvenpaa et al., 1998).

Collaboration

Research has demonstrated that electronic collaboration as an effective instruction design for an eLearning community. Ocker and Yaverbaum (1999) found that asynchronous electronic collaboration is as effective as face-to-face (FTF) collaboration in terms of learning, quality of solution, solution content, and satisfaction with the solution quality. Additionally, Hiltz (1998) argued that eLearning with a collaborative design is more effective than working individually.

Collaboration mechanisms directly affect cognitive processes by three functions (Dillenbourg & Schneider, 1995). First, conflict/disagreement. Second, Internalization. Third, Self-explanation. The more advanced members also benefit because providing an explanation improves the knowledge of the explainer (self-explanation effect).

Equal Access

An eLearning community has the potential to equalize economic and learning opportunity. OECD (1996) has identified eLearning as an effective means by which disadvantaged communities and individuals can acquire and improve their skills and knowledge. Although this argument is strong there is little evidence to define the impact that online technology exerts on equality and a particular digital divide may be created (Gladieux & Swail, 1999). Graham basically agreed with the value of an eLearning community; however, in the construction of the ideal eLearning community network model equality should be optimized and the impact of technologies should not be the main focus.

Social Presence

Learning in an eLearning community occurs as an active social process. Online Social presence, the degree of feeling, perception and reaction of being connected by online to another intellectual entity through a text-based encounter, is required to insure the interaction necessary to sustain community activity (Hiltz, 1998). Social presence is a critical factor that affects the eLearning community. Gunawardena and Zittle (1997) found that the degree of social presence is predictive of the satisfaction of online learners with their learning. Social presence, online learners' social relationships, tasks being engaged in, communication styles and personal characteristics impact online learning (Tu & McIsaac, 2001). Therefore, it is concluded that to foster an ideal eLearning community, one should increase and idealize the level of social presence.

Technology as Learning Tools

Technology has been seen as a tool to sustain and enrich an eLeaming community. Office of Learning Technologies (1998) argued that computerized commuting technology has been viewed as a revolutionary tool to build eLeaming communities, strengthen relationships, and mobilize joint planning and community action. In the past two decades, research has shown that "The No Significant Difference Phenomenon" exists between technology-based instruction and traditional instruction (Russell, 1999). However, technology can be applied as a tool to enhance learning and as a means where learners can approach the learning experiences of their choosing at their own pace.

Resources

Resources available through technology provide the greatest advantage to its use. Current technology is capable of delivering many resources, particularly resources that can trigger and reflect on knowledge. These resources are likely to enhance learning in an eLearning community. Technology brings participants together to generate online interaction. An ideal eLearning community should be able to provide its members with multiple perspectives in their learning experiences (Tu, 2000). These rich perspectives will be able to enhance the online interaction and to stimulate a higher level of thinking and learning. A cumulative sharing of learning, knowledge, and experience can result in the development of a community.

Blurred Boundaries

Electronic communication democratizes the eLearning environment (Rheingold, 1993). Computer-mediated communication (CMC) has been described as a venue where participants can contribute equally in communications (Rheingold, 1993). Democratic openness, the absence of nonverbal status cues, teacher-student role reversal, and learner-to-learner interaction within a CMC environment provide an opportunity for a more equal platform for communication and more stimulus for action than does a traditional classroom and more peer interactions were concluded. This phenomenon obscures the boundary between learners and teachers.

Learner Driven

Because of the blurred roles of students and teachers more weight is placed on the learning process/experience than upon roles and "teaching" processes. In other words, both students and teachers are learners and share their responsibilities in an eLearning community. Morrison (1995) argued that the learning process is unbounded by *time* (when one learns), *space* (where one learns), *mode* (how one learns), *pace* (the rate at which one learns), *level* (the depth of learning) and *role* (with whom one learns). Therefore, it is not merely learner-centered; in fact, an eLearning community is a learner-driven process.

Lifelong Learning

Since the learning paradigm is shifting to community-centered learning, lifelong learning is gaining in importance. Lifelong learning is what individuals learn over the course of their lifetimes and in a multitude of contexts. Galbraith (1995) defined it more precisely as: "those changes in consciousness that take place throughout the life span which result in an active and progressive process to comprehend the intellectual, societal, and personal changes that confront each individual human being." Clearly, this definition has given weight to community-centered learning.

Theoretical Framework

A new theoretical framework for eLearning communities is proposed in this thesis. It is a preliminary model that provides an appropriate direction for future research in eLearning community.
In this framework, "Instruction," "Social Interaction," and "Knowledge Construction Technology" are major three dimensions of eLearning communities. To develop an ideal eLearning community, these three dimensions should be consistently maximized. Somewhat lopsided development may result in different learning experiences in the process. However, the balanced development is not a static force. This framework represents a theoretical framework for eLearning communities that are dynamic, not static, flexible, not fixed, and negotiable, not pre-set.

Instruction

One should engage their community members in an authentic and an interactive design of activities. Community members that are more experienced, or experts, should function as mentors to stimulate members in processing knowledge internationalization. Material and information should be presented in a fashion that stimulates and indicates to members what is to be understood. Coaching processes allow novice members to receive appropriate feedback and to be aware of how they deviate from mastery and how can they modify their processes to be closer to the model.

Community learning is not only active but is also interactive. Community of Practice (CoP) serves as an appropriate concept for an eLearning community. Several factors identified in a recent study (Tu & McIsaac, 2001) should serve as a model for building a CoP for education reform: determine knowledge; build important topics/issues; gain members' background context; and design pull technology.

Collaboration enhances the active exchange of ideas within small groups and increases interest among the participants but also promotes critical thinking (Garrison, 1999). The community of collaborative learning, the grouping and pairing of learners for the purpose of achieving an academic goal, has been widely examined and is advocated throughout the professional literature.

Recent publications (Berge & Collins, 2000) have emphasized the importance of moderation in an eLearning community, a necessity that has often been ignored in online instruction. Knowledgeable use of strategic moderation can enrich and deepen the dialogue and foster learning in this emerging venue.

Social Interaction

Social context is constructed from the community members' characteristics and their perception of the eLearning environment. Less attention is being paid to other components, affective and social, as well as cognitive.

Bauman (1997) argues that social factors can be as powerfully motivating (Lowell & Persichitte, 2000) as intellectual ones in keeping learners on task. Research should focus on the relationships of community members and their perception of the eLearning community.

Ideal eLearning engages community members in deep thinking, provides multiple viewpoints, supports reflection, and offers frequent feedback and guidance toward higher standards. Kearsley (1998) contends that but the most important overall impact of the eLearning environment is the emphasis they place on critical thinking and discourse. The one thing that happens in eLearning, is that community members communicate a lot more with each other (novice and experts).

Knowledge Construction Technology

Knowledge construction technology contains attributes of electronic technology and technology that assist learners conduct knowledge construction. The latter is more important than the first.

Electronic computing and telecommunications technologies are converging into knowledge construction tools. Technology not only delivers content (information) and it has the capability to trigger and stimulate chances for knowledge construction. In fact, contents, bits, learning, and cognitive science are converging to "knowledge Media (Eisenstadt, 1995)."

Unlike a traditional FTF communication, knowledge construction technologies have the capability to deliver single or multiple channels either asynchronously or synchronously. When a new communication medium becomes available, one often applies a FTF communication style to this new communication environment, which often generates misunderstanding between the two communicators. Appropriate selection and use of communication media is very critical.

Conclusion

ELearning community is an important concept in technology-based learning. An effective eLearning community reaches beyond the point that community members learn together and should be perceived as a community that learns. The concept of an eLearning community implements the generation of social interaction and learning processes to generate dynamic and effective knowledge rather than "fixed" information. An eLearning community never dies after it is born. Instead, it grows and learns; and it may mature into a different character as a community. Therefore, community learning is endless and translates to knowledge construction and gaining information that is infinite.

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