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Fostering Pedagogical Soundness of Multimedia Learning Materials (1)

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The design and development of multimedia learning materials remains an emerging field. In terms of fostering sound pedagogy, beliefs about how these materials should be presented and what they can and should be able to do continue to evolve. This paper presents a set of 10 principles that reflect current beliefs about the processes and contexts of optimal learning in general and within multimedia environments more specifically. They are intended to serve as guidelines for generalists who are responsible for overseeing the creation and implementation of pedagogically sound multimedia products. The first two principles focus on general challenges that developers face in creating these materials; the next six, highlight specific qualities that characterize effective products; the last two principles examine issues tha arise when a product makes its way into a classroom setting.

L'élaboration de matériel didactique multimédia demeure un domaine relativement nouveau. Dans la perspective d'une saine pédagogie, la réflexion se poursuit quant à ce que de tels documents devraient comporter et quant à ce qu'ils devraient pouvoir faire. Ce document expose un ensemble de 10 principes reflétant les idées actuelles quant aux processus d'apprentissage optimal dans un cadre général et dans le cadre plus précis des environnements multimédias. Ces principes pourraient servir de cadre d'orientation aux généralistes responsables de la création et de la réalisation de produits pédagogiques multimédias. Les deux premiers principes portent sur les grands défis que doivent relever les créateurs de tels documents. Les six principes suivants soulignent les qualités propres aux produits efficaces. Enfin, les deux derniers principes portent sur les questions qui se posent lorsque de tels produits arrivent en classe.

(1) Financial support for this study was provided by the Canadian Studies Program, Department of Canadian Heritage. An earlier draft of this paper was presented to the Canadian Heritage Learning Materials Working Group, whose mandate is to coordinate learning materias within the Department of Canadian Heritage.

(2) We use the terms "multimedia learning materials", "learning materials", or "product(s)" inter-changeably to refer to interactive CD-ROMS, CD-ROMs with internet links, and fully online computer-mediated environments.

Today's technology provides exciting possibilities for creating rich computer-mediated learning environments. At the same time, beliefs about how multimedia learning materials should be designed and about what they can and should be able to do in an educational context continue to evolve as new knowledge in the form of research findings, learning theory, technological innovations and applications, actual product development, and user feedback combine in unforeseen ways to inform those beliefs.

In this paper, we present 10 principles that reflect current beliefs about the processes and contexts of optimal learning in general and optimal learning within multimedia environments more specifically. These principles are intended to serve as reflective guideposts for those generalists who have been entrusted with overseeing, participating in, and consulting on the creation of pedagogically-sound multimedia learning materials*.

Before presenting the principles it is helpful to keep in mind a few caveats. First, it became evident during our review of current educational literature that much of what is known about best practices for creating multimedia learning environments has been derived from professionals' written reflections and special "pilot projects" or "laboratory-type" studies using multimedia, rather than from research focusing on a broad range of more typical learner contexts. Also, inconsistent findings, the complexity of the issues, and the rapid technological changes within the field, highlight the overall challenge facing developers. Finally, developers and educators need to keep in mind that attentive development of multimedia learning materials is only one of many factors that shape learning experiences and outcomes. The learning impact of a given product can only begin to be understood and appreciated in terms of the local context in which it is used. Hardware and software accessibility; teacher and learner attitudes, knowledge, and experience; classroom, school, and home subcultures; and the specific ways that users "work with" the product are just some of the many contextual factors that influence learning, but that are beyond the reach of the multimedia development team.

The ten principles discussed in this paper were derived from a review and synthesis of the current (primarily 1994-1998) scholarly and professional educational literature relating to multimedia as a learning tool. Multiple searches of the ERIC database, electronic journals, currenr issues of selected journals, and our university's online catalogue were completed. A preliminary list of search terms evolved from several broadly defined early searches in the area of educational technology. These initial terms were regularly revised in subsequent searches as we read and reviewed articles and books generated from the searches. At its

most comprehensive and inclusive phase, we used the following terms to guide our searching: Computers, Computer Assisted Instruction, Computer Oriented Programs, Computer Software, Computer Software Reviews, Computer uses in Education, Curriculum Design, Education, Educational Media, Educational Technology, Hypermedia, Instructional Materials, Internet, Multimedia Instruction, Technology, and Technology Education. (Computer Mediated Communication was later added to this list following advice from an anonymous reviewer.) These descriptors were combined with Instructional Effectiveness or Evaluation Criteria. Searches were also done of key authors who were identified from our preliminary analysis of initial search results. The web sites of the Council of Ministers, all Canadian Ministries of Education, Canadian Teachers Federation, Canadian Heritage and its agencies, as well as special web sites (e.g., SchoolNet, TACT, MarcoPolo, MaMaMedia, Inspiration software) were also examined.

Overall, approximately 150 major articles, manuscripts, and books were consulted (a full bibliography is available from the authors). A preliminary draft of the principles was vetted with a panel of 10 experts that included classroom teachers, Canadian government and non-governmental representatives, and academic researchers. The current text incorporates comments from the panel of experts.

Prior to presenting the principles, we provide a brief overview of the philosophical context within which the principles rest. Our intent in making this context explicit is to share with the reader our own assumptions and central beliefs about the philosophical underpinnings of the principles.

Philosophical Context for Understanding the Principles

At its most essential level, an eclectic combination of behaviourism, systems theory, information-processing, constructivism, and critical pedagogy provide the main philosophical backdrop for thinking about how best to foster pedagogical soundness within multimedia learning materials,

Historically, since the 1960's, behaviourism, or behavioural learning theory, has provided the philosophical underpinnings of the vast majority of educational software. Drill-and-practice products, as well as true-and-false, matching, and sentence completion assessment strategies are typically associated with this orientation.

Like behaviourism, systems theory or the systems approach to instructional design has also had a significant impact on educational software. To the extent that multimedia designers rely on a systems

approach, they focus on taking all possible contingencies into account, and planning for them. Software products that include effective interaction between the user and the program, various feedback mechanisms, and performance-based objectives are congruent with a systems design model (Simonson & Thompson, 1994).

Although many learning materials still rely on behaviourism or systems theory in whole or in part, more recent conceptualizations of how learning occurs are introducing alternative ways to think about teaching and learning, and about educational multimedia development in particular. Information processing, with its roots in cognitive science, focuses on how the mind processes information during learning. The relationship of short-term memory to long-term memory, metacognition (thinking about one's thinking processes, self-monitoring, self-evaluation), and problem solving strategies are some examples of concepts related to this perspective (Rieber, 1994). One concrete implementation of the information processing perspective would be multimedia learning materials that incorporate helpful ways for learners to organize isolated bits of presented information and turn them into personally meaningful knowledge, for example, through access to a computerized journal or concept-mapping tool.

Constructivism adds another important dimension to our current beliefs about how individuals learn. A constructivist orientation treats learning as an interactive process whereby learners are actively involved in constructing meaning (Jonassen, 1991). Constructivists approach learning as a social, cultural and interpersonal process that is influenced as much by social and situational factors as it is by cognitive ones (Shuell, 1996). Developers of learning materials who treat learners as active participants who bring their own history, perspectives, and social context to the learning experience, and who believe that individuals learn best when they feel a sense of ownership, control, and authenticity when using multimedia learning materials, are incorporating a constructivist perspective, Today's technologies make it much easier to operationalize this learning philosophy. Although microworld environments are particularly known for this orientation, many new applications incorporate some aspects of constructivism within their design.

Critical pedagogy (Nichols & Allen-Brown, 1996) also plays a role in the development of pedagogically-sound multimedia learning materials, by highlighting several important issues. First, this perspective emphasizes that information is never value neutral; and it encourages socially responsible critical thinking by encouraging learners to reflect on the processes and implications of knowledge production. Second, this perspective reveals that the development and use of new technologies

carry with them consequences that may result in unintended and undesirable outcomes. It asks us to consider possible negative implications of the proliferation of multimedia learning materials --for example, the persistent and high cost to schools and families that comes with multimedia access as well as the widening gap between the technological haves and have-trots. Third, the perspective reminds us of common pitfalls such as cultural biases, marginalization of less powerful groups, stereotypical portrayals of people, gender, places, activities, and so on, It highlights the importance of fostering inclusive learning environments that are accessible, equitable, and responsive to all learners.

The Principles

The following 10 principles fall into three main types. The first two principles deal with more global issues; they consider the "general challenges" facing developers today who hope to create pedagogically sound multimedia materials. Principles 3 through 8 highlight specific qualities that characterize effective products. The final two principles focus specifically on important issues that arise when a product hopes to make its way into the formal school setting.

I) Effective learning materials strive to incorporate technological potential in pedagogically meaningful ways.

As noted earlier, today's technology provides exciting possibilities for creating rich learning environments. Audio, static graphics, text, video, and animation, along with authoring tools, can be combined in imaginative ways to yield innovative and inspiring products that provide meaningful and interdisciplinary learning environments, For example, some products allow learners to investigate ideas, theories, and concepts in the context of real-life problems. What's more, the nonlinear, nonsequential hypertext environments provide the potential to link personal "findings" within and across domains. Other products allow learners to manipulate real data; examine copies of original manuscripts; listen to, create, and revise a range of visual images and sound effects or recordings; or take on the roles of imaginary or real characters who are involved in complex problem solving.

At the same time many multimedia learning materials fall far short in terms of pedagogical value. For example, in a review of 750 software programs marketed for young children, Haugland and Wright (1997)

report that only about 20 percent met children's developmental needs. There are, of course, many reasons why any given product may prove to be pedagogically weak. One major reason is the "technocentric" trap, wherein the primary motivation for including a functionality in a product is simply because the technology makes it possible to do so. Another major reason is the misguided belief that these materials are simply re-purposed books, what critics of this approach have described as "coffee table books 10,000 pages long" (Druin & Solomon, 1996, p. 81). That said, there are some success stories--the edutainment CD-ROM of David Macaulay's *The way things work* is considered one such case (Druin & Solomon, 1996).

Another important reason why multimedia learning materials may not realize their full potential as learning tools is that the developer may not be aware that current instructional practice relies much less on drill-and-practice, rote memorization, and factual recall approaches than in the past. These types of methodological approaches may be helpful as introductions to simple, well-structured knowledge domains (for example, learning the multiplication tables). At the same time, they are much less effective in helping learners authentically apply that knowledge or in helping them solve real-life problems that typically involve using more ill-structured and complex knowledge domains (Jacobson & Spiro, 1994).

The overall challenge, then, is to build multimedia learning environments that complement other valued and more entrenched learning environments by discovering and drawing on their unique pedagogical strengths. The remaining principles are intended to assist in that challenge.

2) Effective learning materials strive to be intrinsically motivating to learners.

An important distinctron to be made here is the difference between extrinsic and intrinsic motivation during learning experiences. The former provides "rewards" for good responses (e.g., a smiley face, ribbon, hand clap, drum roll), whereas the latter taps into the excitement of learning; for example, it builds on a learner's willingness and desire to learn (Jacques, Preece, Carey, 1995). Extrinsic motivation, for example, could be a game that is fun to play but the "learning" that takes place is seen as something to be endured or tolerated. The incorporation of graphics and sound are often seen as opportunities to enhance motivation; but when their primary purpose is to amuse and entertain, they can quickly become ineffective extrinsic motivators. Once the novelty of glossy and glittery

presentations fades, the experience can quickly become flat and tiresome, and even disruptive, if little is offered in the way of purposeful and meaningful learning encounters.

Most writers agree that fostering intrinsic motivation should be the aim of multimedia developers. Current American Psychological Association (APA) guidelines (1997) highlight the essential role of intrinsic motivation for learning. It is enhanced in those situations that the learner perceives as personally relevant, interesting, meaningful, and challenging. It is also enhanced when learners have opportunities for choice and control in how and what they learn, and when the reasons for learning are rooted in the learning situation itself. It incorporates challenge, curiosity, and fantasy (Rieber, 1994). It gains and keeps learner attention and interest. It blurs fun and learning and helps develop a "research spirit" (Gregoire, Bracewell, & Laferriere, 1996).

Because intrinsic motivation is believed to be essential for sustained learning, choices around what content gets included and about how and what prose, graphics, authoring tools, games, simulations, microworlds, and the like are presented need to be carefully considered. It has often been said, for example, that quality storytelling need not rely heavily on fancy visuals for engaging learners. In another vein, when developers forget that the main purpose of charts and graphs is to provide the learner with helpful data, and add too much decoration (sometimes referred to as "chartjunk") (Rieber, 1994), confusion--and hence reduced motivation, can follow. This in part is one main reason why developers are always encouraged to carefully consider, and include, various media as *the product develops* rather than to add them at later stages of development,

Engagement or effort is also considered to be an important dimension of motivation to learn (e.g., APA, 1997; Gregoire et al., 1996; Jacques et al., 1995). Acquiring complex knowledge requires considerable energy, effort and persistence on the part of the learner. Products that are learner-

that place high value on the quality of the ideas, that encourage thoughtful and challenging interactions, that allow the learner to choose the types of media they like for their learning activity, and that include opportunities for regular evaluation would appear to offer the most potential for promoting the active and sustained involvement of learners, Active and sustained involvement is also likely fostered when a product presents material in a functional way which allows for easy yet sophisticated navigation; when a product incorporates aesthetic choices and/or learner options which take into account currently valued age, gender, class, race, and cultural preferences; and when its authoring tools help learners transform information gleaned from the product into personally meaningful knowledge.

3) Effective learning materials link to prior knowledge

Learning is believed to be enhanced when the learner is able to meaningfully link new information to prior knowledge and experience (APA, 1997; McFarland, 1995; Shuell, 1996). Shuell, for example, highlights the central role of prior knowledge in determining what and how much is learned.

There are various ways that multimedia learning materials can foster links to prior knowledge. Well thought out linking capabilities such as pop-up and jump links or notetaking, outlining, and concept-mapping tools (Schroeder & Kenny, 1995), can facilitate personalized knowledge-building by helping learners transform data and information through rehearsing, extending, revising, and integrating their existing and emerging understandings. One online example of this type of learner support can be found in the MaMaMedia online environment, where learners are invited to build "sandwiches" (hierarchical grouping of information) and create "villages" (clustered grouping of information) (Tapscott, 1998).

Often, too, learners use multimedia learning materials for carrying out a quick, strategic search for information related to a particular issue or sub-issue, rather than for browsing, exploring, or immersing themselves in the content. Electronic reference materials such as electronic encyclopedias are often used for this purpose, although many other products containing a content-rich infobase can serve similar needs. It is essential, however, that multimedia learning materials rely on "smart" and user-friendly search engines that incorporate Boolean (and, or, not) and proximity operators, if learner expectations are to be met. Search engines that yield meaningful results and allow for adjustment of search strategies as new knowledge arises can also help learners build on past and evolving understandings. A review of the 1996 edition of *Compton's interactive encyclopedia,* for example, illustrates the frustration that arises when a product relies on a poor search engine (Jacso, 1996).

Given that hypermedia allows for personal exploration along a range of "paths", learners can also build knowledge through more unanticipated, incidental, learning (Rieber, 1994). Jump links that allow learners to pursue an unanticipated line of interest as well as tidbits of knowledge tucked behind "minor" icons are ways of fostering this discovery aspect of knowledge-building. For example, the Canadian Heritage Terra Nova product *Making history: Louis Riel the North-West Rebellion of 1885* provides a good example of effective use of the latter strategy. Also, a well constructed multimedia environment allows learners to construct their

own personal linkages between and among different kinds of information that they encounter (Wiburg, 1995).

4) Effective learning materials support developmentally appropriate learning experiences.

Learning is also believed to be most effective when educators take into account the cognitive, social, and emotional development of a learner (APA, 1997). Shade (1996) uses the term "low entry, high ceiling" to describe multimedia learning materials that allow for more or less complexity and that can be used by learners at various developmental levels. In a similar vein, current Manitoba guidelines (Manitoba Education and Training, 1998) highlight the value of multimedia learning materials that allow accessibility by a range of learners and provide "room to grow." Other writers also highlight the value of multimedia learning materials that allow varied points of entry and option paths for learners with more or less sophisticated levels of experience and knowledge (e.g., Gregoire, et al., 1996).

Consideration of this principle might suggest a range of interfaces (from simple to more complex), reduced or expanded menu items, less or more complex parameters (coupled with optional progressive help), opportunities to change a presentation sequence, editable instructions, and program alterations that take effect based on learner response. At the same time, the use of non-hierarchical terms to present these options helps to avoid undermining learner self-esteem.

When striving to create a developmentally appropriate product, it is also helpful to keep in mind that human intelligence is now conceived of as a range of multiple intelligences, for example, spatial, verbal-linguistic, logical-mathematical, bodily kinesthetic, musical, interpersonal, and intrapersonal intelligence (Gardner, 1993). Therefore, a learner's capabilities will often vary from one type of context to another. A product that is responsive to these differences builds in customizing flexibility, thereby encouraging learners to take fuller advantage of their specific intellectual strengths and yet providing them with electronic coaching and support when strengthening their weaknesses.

Performance assessment functions help learners *create* learning experiences that are appropriate to their own developmental level. Pedagogically sound practice or self-assessment exercises encourage reflection on and reconsideration of errors, misconceptions, or stereotypic reasoning through clear feedback that links to related content, optional

assistance, alternative problem representations, easier and similar follow up problems, and/or personal record-keeping.

5) Effective learning materials support learner control and choice.

Supporting learner control and choice is believed to be important for a range of reasons. For example, it allows individuals to work at their own comfort level, it fosters ownership of the activities, it recognizes individual needs and preferences, it encourages independent use of a product, and it fosters self-monitoring and self-evaluation. Learner control and choice within a product can take many different shapes. Products that provide intuitive interfaces enhance learner control by limiting the need for extensive outside help. Navigational flexibility permits learners to easily follow different paths through the content, to access different forms of knowledge, and to limit or expand the level of environmental complexity they wish to experience. In a similar vein, optional electronic coaching (for example, by activating a *helpful* help button or pop-up links), optional bimodal discourse (for example, by activating simultaneous written and oral discourse), optional cueing (for example, by activating a process highlighter to clarify a particular aspect of an explanatory animation), and an optional index with a user-friendly and helpful search engine for easy and strategic access to the overall infobase, help learners tailor their environment to suit their own needs and preferences. Problem-solving simulations that include the necessary content for developing solutions within or with the product enhance a learner's sense of control by acknowledging the "do-ability" of a task. At the same time, products that permit learners to input their own personal or local resources (e.g.. photographs, drawings, original local documents), tap into the "real" lives of learners.

Products incorporating user-friendly tools that allow individuals to easily plan, organize, create, keep track of, represent, erase, interrupt-and-later-resume, copy, save, and print their "work', support learner control by assisting with specific sub-tasks that foster personal knowledge-building. Tools that allow learners to refine and revise their work by means of friendly editing features recognize the importance of allowing that knowledge to be re-presented.

Finally, learner control and choice can be enhanced by providing an easily-accessible learner guide. This guide could present and explain a range of interesting on-computer and off-computer learning activities. In addition to fostering independent and creative use of the product itself, suggestions for off-computer activities can extend the value of the product

by encouraging other ways of interacting with the world (for example, activities that rely on kinesthetics, on non-virtual experimentation, or on face-to-face relationships with other members of the community),

6) Effective learning materials support inter-dependent learning.

Learning communities, where learners and teachers can interact and collaborate with others within and beyond the classroom to generate, revise, and evaluate knowledge, are also believed to be powerful vehicles for fostering individual learning (e.g., APA, 1997; Shuell, 1996).

Multimedia learning materials can offer opportunities for learners to form learning communities through various project-based initiatives. For example, Scardamalia and Bereiter (1996) have developed a multimedia collaborative learning environment that brings together diverse groups of participants. A key feature of this learning environment is a community database constructed by learners. As much as possible, this database is open to all participants, although sections can be designated as private. Learners can visit the database, comment on its contents, create links to other media, develop visuals that synthesize their emerging conceptual understandings, initiate special purpose discussions, as well as search content or comments within or across databases. Through these activities, learners are encouraged to develop working relationships; to critique each others' work; to create, use, and revise knowledge; and to consider ideas from multiple perspectives.

Multimedia learning materials can also offer collaborative learning opportunities by connecting participants to authentic activities outside the classroom (Dyrli & Kinnaman, 1995) through links with official educational partners and recognized web sites. These links to high quality sources can provide learners with access to helpful archived or up-to-date information, to "recognized experts" with specialized knowledge in particular fields, and to other "emerging experts" (or co-learners) who are examining similar issues. For example, a product might include links to primary databases of a national agency or consortium for use in personal projects and/or provide access to the working worlds of scientists, historians, mathematicians, curators and the like. Canada's SchoolNet consortium is one example that supports this type of inter-dependent learning.

Multimedia learning materials can also encourage collaborative learning in learner dyads, small groups, or larger class groups. For example, the CD-ROM *Le Maitre des* produced by Club Pomme in

France, has been successfully used by teams of learners as well as by individual learners (Cousineau, 1998).

7) Effective learning materials promote critical literacy skills.

One of the strengths of multimedia learning materials is the fact that they allow learners access to a wide range of information. For example, a concept, an issue, a process, an event, a biography, and so on, can be presented in many different ways. Developers need to keep in mind, however, that the choices that they make around content and presentation are never value neutral. They need to recognize that all knowledge is socially constructed, and that what counts as legitimate knowledge within the learning environment will be shaped in part by their choices. Certain information will inevitably be omitted or stressed; and examples may emphasize or ignore different social, gender, or cultural perspectives.

The responsibility for fostering critical literacy is neither easy nor straightforward. It is not simply a case of assuring that appropriate numbers of different groups are represented, that groups are not stereotyped, or that language is non-sexist, although these issues are of course important. Products that adopt visible story lines, for example, may openly value some "perspectives" over other equally legitimate ones, Bigelow's (1996) review of the popular CD-ROM historical simulation *Oregon Trail* ZZ, illustrates this challenge. He points out that while attention has been given to multicultural and gender-fair characteristics in terms of who is included in the simulation, it is the experiences of white male settlers that are highlighted. He urges teachers and learners to develop critical computer literacy skills so that they can challenge these kinds of implicit and explicit cultural biases.

A number of review frameworks have highlighted the importance of considering how products represent different social, gender, and/or cultural perspectives (e.g., Manitoba Education and Training, 1998; McFarland, 1995; Swan & Meskill, 1997-98). This consideration might take the form of encouraging the learner to explore, express, and/or examine multiple interpretations of events. It could mean that there are a range of meaningful responses to a problem (Druin & Solomon, 1996; Honebein, Duffy, & 1993). It might refer to the representation of different perspectives in order to encourage the learner to see an issue from the point of view of various stakeholders and to examine how different social groups might frame a "problem" or "solution" (Morgan, 1995). In a similar vein, it might provide a range of discourses, allowing learners to explore whose voice gets heard and whose gets ignored in the

material they create as well as in the information that they access and examine. It can also mean the opportunity for the learner to co-create interpretations with other learners, to place these interpretations in the "public domain", and to critically evaluate the kinds of information presented and generated.

8) Effective learning materials support equitable learning environments.

In terms of equitable learning environments, a number of software evaluation frameworks have highlighted the importance of ensuring that multimedia products reflect linguistic, social and cultural diversity. For example, the Nova Scotia guidelines for evaluating software present an extensive list of points to consider when assessing potential bias in software (Nova Scotia Department of Education and Culture, 1998). According to these guidelines, visual and textual content needs to be examined to determine to what extent gender, age, race, culture, ethnicity, and class issues are taken into account. Shade (1996) and Haugland and Wright (1997) support these recommendations for equity and also include attention to diverse family structures and ability.

For Canadian learners, additional attention also needs to be placed on representing and respecting Canada's multicultural makeup as well as its French- and English-speaking communities. This seems particularly important given the proliferation of products developed in the U.S. For example, humour, music, popular and cultural images and icons, as well as language and historical perspectives, often vary across cultural groups, In some cases, these differences may warrant the development of a separate and distinct product rather than a more straightforward translation of a product into the other official language. Also, products that hope to make their way into English- and French-Second-Language classrooms, need to take into account the special needs of these groups. For example, optional support could take the form of word pronunciation, simplified definitions, grammatical exercises, structured role-plays or simulations, and the like.

A number of writers (e.g., Comber, Colley, Hargreaves, & Dorn, 1997; Crawford, 1998; Larsen, 1995; Prickett, Higgins, & Boone, 1994; Tapscott, 1998) have highlighted the issue of accessibility to equitable learning environments for diverse learners. Multimedia developers should consider that many learners won't have top-of-the-line hardware and that options should be considered about how to make the experience accessible and motivating to more disadvantaged groups. Also, in terms of sensitivity, despite growing evidence that the differences between male

and female learners regarding accessibility to computers, use of computers, and confidence levels may be narrowing, it is important that products assure gender-fair environments that respect the special needs and interests of both groups (Goodnow, 1998; Hodes, 1995-96; Tapscott, 1998; Yates, 1997). A similar point can be made with regard to fostering multicultural and antiracist environments. Regarding learners with special challenges, customizing options, clear and consistent interfaces, and structured guidance are a few examples of how a product can support their learning. The province of Newfoundland maintains a particularly good web site regarding technology issues for special needs populations (Newfoundland and Labrador Department of Education, 1996).

Good learning environments permit learners to "see themselves" in authentic ways. One simple example of how developers can take a proactive stance regarding the issues that have been highlighted above is the cautious use of clip-art images. Some writers (Binns & Branch, 1995; Buck, 1995) have pointed out that while visual images represent powerful aids to the learning process, many visuals--especially clip-art images--are culturally biased. In a similar vein, products that allow learners to select personal features (for example, by selecting the gender and ethnicity of a given character) help learners see themselves within the experience. Multimedia products that are sensitive to cultural, gender, and special needs factors offer great potential for promoting equitable learning opportunities for all learners. The challenge for developers is to strive to turn that potential into actual product design.

9) Effective learning materials intended to support formal schooling take into account regional and local needs and requirements.

Multimedia learning materials may link explicitly, implicitly, or not at all to a provincial, territorial, or state school curriculum (Squires & McDougall, 1994). If the goal of a product is to explicitly link to a particular aspect of a curriculum, close collaboration with knowledgeable curriculum experts is essential. For example, Saskatchewan's SchoolNet Grassroots Program has developed evaluation criteria which stress the point that projects funded by them must "directly correlate to one or more Saskatchewan Curriculum guides" (Saskatchewan Education, 1997).

Of course, developers who hope to see their products used within classrooms and resource centres as supplementary learning materials would be wise to carefully take into account the curriculum and teaching needs of those potential users. For example, edutainment products that stress education more so than entertainment as well as

general education reference products, if appropriately developed, certainly have the potential to complement and supplement school-based teaching and learning. Surprisingly, however, it appears that many developers neglect to develop their product with formal schooling needs in mind (Druin & Solomon, 1996).

It *is* helpful to keep in mind, for example, that education scholars (e.g., Haugland & Wright, 1997; Shade, 1996; Squires & McDougall, 1994; Swan & Meskill, 1997-98), along with ministries of education (e.g., Manitoba Education and Training, 1998; Nova Scotia Department of Education and Culture, 1998) are currently developing, and regularly revising, guidelines for evaluating the pedagogical quality of multimedia learning materials in an effort to foster informed purchase choices. Keeping abreast of current and emerging standards of quality seems essential if a given product hopes to receive formal endorsement. In a similar vein, it is also helpful to keep in mind how important it is to develop (and market) a product that responds to the needs of today's teachers, who "now buy many of their own resources for their classes and take them with them when they transfer to another school" (Thayer, 1998).

10) Effective learning materials provide comprehensive pedagogical support to educators.

Despite some of the rhetoric suggesting that most schools and classrooms are integrating multimedia learning materials into regular class activities, many experienced teachers probably remain multimedia novices. This seeming disadvantage presents special "professional development" opportunities for savvy product developers, however. For example, products could include explanatory videos and/or written documents that help teachers learn how to navigate within an environment and how to build their own knowledge through guided practice with a product's authoring tools. A more comprehensive approach could be to develop, within the product, a set of pilot-tested, pre-packaged workshop modules that "lead teachers" could use to assist colleagues in developing confidence and competence with the product.

A well-developed and *easily accessible* (e.g., optional print versions) educator's guide could provide tangible help in integrating the materials into the curriculum. Such a guide could include such ready-made resources as electronic slides and overheads; pictures, posters, or maps related to the topic; student handouts; lists of up-to-date resources (for example, bibliographies and descriptions of commercially available audiotapes or videotapes, URLs, atlases, biographies, children's books);

and creative examples of ways to use the product across curricular areas and for specific problem-solving and knowledge-building activities. Providing field-tested time estimates for carrying out common tasks can provide support by helping teachers plan for and cope with the tight time constraints that are an inherent part of classroom life.

Educator guides can also help teachers envisage themselves less as "content experts",explainers" and "initiators" (the educator as "sage on the stage") and more as co-creators (Squires & McDougall, 1994) who encourage learners through argumentation; debate; provocative, open-ended, and critical questioning; collaborative use of concept-mapping tools; demonstrations of effective search strategies; tolerance of effective, yet partial solutions to complex problems, and the like (the educator as life-long learner and "guide-on-the-side"). A product could also support a web site to provide learner- and classroom-tested ideas and supportive materials to educators. The web site for *Inspiration* (a concept-mapping tool), for example, includes many examples of success stories and actual project outcomes from learners and educators who have used the product. In a similar vein, partnerships or strategic alliances, along the lines of Canada's long established SchoolNet initiative, the more recent TACT initiative (TeleApprentissage Communautaire et Transformatif/ Technology for Advanced Collaborative Teaching), or the recently launched American initiative MarcoPolo (Woodall, 1998) could provide ongoing support to educators using a range of multimedia materials.

In terms of learner-learner dynamics, educator guides can also offer suggestions about how the product might be used individually or independently by learners, by learners working in dyads or small groups, and as large-group teaching and learning tools. Even simple suggestions adopted from popular co-operative learning approaches such as three, then ask me" (where students are asked to seek three other sources of help before turning to the teacher) fosters independent and co-operative problem solving and also recognizes the leadership potential of other learners, many of whom may have greater experience within multimedia environments than their teachers. In a similar vein, simply pointing out the advantages of "managing by walking around" can help educators monitor progress, encourage co-operative problem-solving, spot emergent problems, and discourage indiscriminate "channel hopping" across programs (Ragsdale, 1997).

Available technology also makes possible secure performance assessment functions for use by teachers. For example, pre-tests and special recorded exercises can help them customize a product according to the special needs of an individual learner or group of learners and can help identify specific areas where additional support is required. At the same

time, teachers need to be able to override these diagnostics if they so choose. Also, record-keeping components such as journals, concept maps, portfolios, or placement tests need to be easy to set up and operate, and need to be able to accept any number of learners or groups of learners. Finally, products that chart learner progress and then develop meaningful reports for learners, the instructor, and parents can provide an ongoing and long-term perspective on learner progress (Prokopanko, 1998).

Conclusion

The principles presented above offer exciting challenges and possibilities for those embarking on a multimedia initiative that aims to incorporate pedagogical value. It is doubtful, however, that those challenges and possibilities can be realized without the ongoing participation of a range of experts and stakeholders. Increasingly, the use of interdisciplinary design teams (Druin Solomon, 1996) and formative evaluation and responsive design processes are considered essential for ensuring quality product development. When team membership includes representation from content and discipline experts, teachers and other educational practitioners, educational scholars, and learners themselves, as well as from instructional and technical design experts, the possibility of producing a multimedia product which ensures optimum learning is enhanced. For example, content experts can help assure meaningful, accurate, comprehensive, and up-to-date content; educational scholars can help assure pedagogically sound and socially responsible strategies for working with the content; teachers and other practitioners can help assure user receptivity as well as sensitivity to classroom constraints; learners can help developers see strengths and weaknesses "through the eyes" of those who interact most with the product; and instructional and technical design experts can help teams make technologically realistic choices and also assure that the product rests on sound design principles,

The principles that have been developed within this paper are intended to serve as guidelines for generalists in their role as overseers of, participants within, and consultants for multimedia product development teams. Of course, it should be kept in mind that there is no such thing as a "perfect" product; any given initiative will have pedagogical limitations. Depending on a range of factors (for example, financial and human resources, agreed-upon purpose and scope of the project), some initiatives may build in pedagogical quality through more extensive attention to some principles more so than to others. That said, our research leads us to believe that all of the principles need to be considered during product

development, Even the most basic designs and simplest products can be enriched in a pedagogical sense through thoughtful and judicious choices.

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Theorizing Audioconferencing: An Eclectic Paradigm

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An eclectic paradigm of audioconferencing that incorporates the notion of transactional distance in flexible learning and that caters for cultural contextualization of learner, lecturer, and academic setting is developed in this paper. This paradigm includes aspects of objectivist, constructivist, and critical theory models of learning and teaching within a multiple cultural mode1 which seeks to address the logic of the academic, the mainstream, and the minority cultures. A case study based on this paradigm and involving Indigenous Australian students and their lecturers is reported. Results indicated that the students perceived audioconferences as a highly useful part of their learning, that lecturers were generally able to incorporate the cultural context factors into their subjects, and that students valued the experience of the academic culture albeit at a distance. It seems highly likely that this paradigm is appropriate for audioconferencing involving Indigenous students undertaking tertiary studies.

Cet article présente un paradigme éclectique de conférence audio qui incorpore le concept de distance transactionnelle en apprentissage flexible et qui satisfait à la contextualisation culturelle de l'apprenant, de l'enseignant et de l'environnement académique. Ce paradigme includes aspacts des modèles objectivistes, constructivistes et théorie critique de l'apprentissage ainsi que de l'enseignement avec des modèles culturels multiples qui veulent addresser la logique des cultures académiques, générales et minoritaires. Une étude de cas fondée sur ce paradigme, impliquant des étudiants Indigènes Australiens ainsi que leurs cours est décrite. Les résultats indiquent que les étudiants perçoivent les conférences audio comme étant hautement utiles dans le processus de leurs apprentissage, que les enseignants sont habituellement capables d'incorporer les facteurs de contexte culturel dans leurs sujets d'étude et que les étudiants apprécient l'expérience de la culture académique en dépit de la distance. Il semble fort probable que ce paradigme soit approprié pour la conférence audio implicant des étudiants Indigènes qui entreprènent des études poste secondaires.

In the early 1990s there was a small flurry of interest in audioconferencing as an educational communications medium in the distance education literature. Some papers presented case studies, for instance, Burge and Howard (1990), Hiebert and Balshaw (1993), Lalande

(1995), and one relevant to this paper by Schmidt, Sullivan and Hardy (1994) because its context concerns academic and minority cultures.

Garrison (1990) presented a critical paper arguing that communication between teacher and student as well as student and student are vital, and that audioconferencing can "begin to approach the ideal educational transaction" (p. 17). He coherently argues, that without interactive cognitive transactions, the traditional distance education approach to private isolated print-based learning is unlikely to ensure adequately that the learner: (a) Challenges pre-existing values and ideas, (b) avoids indoctrination through critical discussion of lecturer-presented information, and (c) assimilates and validates knowledge gained.

Anderson and Garrison (1995) reported a study of how two instructional design models of incorporating audioconferencing into a distance education program impacted transactional issues in distance education. The Community of Learners model held frequent audioconferences, developed a virtual classroom milieu, and emphasized developing, extracting and refining understandings while the Independent Learning Support model held infrequent audioconferences that still allowed students to have valued synchronous contact with the lecturer and other students but for the purpose of troubleshooting and clarifying mostly assignment issues. Not surprisingly, their study found that the learners in the Community of Learners model perceived theirs to be a more critical community of learners than did the Independent Learning Support model. Drawing on earlier work in the area (Kirby & Boak, 1989; Stallings & Kaskowitz, 1974), Cookson and Chang (1995) offered a new model, the Multidimensional Audioconferencing Classification System (MACS), intended to serve as a principled research approach to the identification, analysis, and recording of audioconferencing instructional interactions. None of the authors attempted to develop a theory of audioconferencing.

Since 1995, even a cursory look at the literature reveals that, as a discrete topic, audioconferencing has been increasingly sidelined while the newer learning-teaching, computer transactional communication technologies, particularly the World Wide Web and E-mail, strut their stuff. Yet, the undervalued low-tech audioconference remains a focal element in world wide distance education, open learning, or flexible learning, as it is often now designated.

This paper attempts a theory of audioconferencing in open learning. Drawing on earlier work by Henderson we propose a flexible eclectic paradigm that incorporates: (a) A theory of transactional distance in open learning, (b) aspects of behaviorist, constructivist, and critical theory approaches to teaching and learning, and sets both within (c) a theory of multiple cultural, not multicultural, contextualization of

educational interactive communication. The paradigm draws on Vygotsky's socio-historical-cultural theory of learning, with emphasis on his notion of the Zone of Proximal Development. The paper discusses a case study of the theory in practice: audioconferencing in a cross cultural program that delivers the same on-campus Bachelor of Education degree in an off-campus mode to Australian Indigenous students in their home communities.

An Eclectic Paradigm of Audioconferencing

Transactional Distance in Open Learning

In developing the eclectic theory of audioconferencing, key concepts concerning educational transactional communication were drawn from Moore's (1980; 1983; 1989) seminal theory of distance education. Moore (1980) defined his concept of "transactional distance" as a function of "structure" and "dialogue". Structure was seen as a measure of how responsive an educational program was to learners' individual needs while dialogue was delineated as the extent to which the educator and learner were able to respond to each other. Transactional distance, then, was defined as a function of the variance in structure and dialogue as they related to each other. From this perspective, "distance" in education is determined by the level of structure and dialogue, not by geographic proximity (Moore, 1983). Saba (1988) proposed a model to represent the relationship between dialogue and structure and tested it (Saba & Shearer, 1994) to reveal that by varying the rate of these two variables, the educator or learner could control the level of transactional distance in a purposeful instructional setting, for instance, audioconferencing. Increasing the lecturer's control of the dialogue decreases learner interaction thus encouraging learner passivity, increasing the rigidity of structure through curtailing chances for student-raised concerns and, hence, widening the level of transactional distance. By increasing learner control in communication conferencing, dialogue increased and structure decreased, as did the level of transactional distance. It could-be argued that decreased transactional distance has close links with a constructivist pedagogy while increased transactional distance has more affinity with objectivist pedagogy. We contend that both increased and decreased transactional distance in the structure and dialogue levels of audioconferences have a role in an eclectic paradigm that caters for cultural contextualization of learner, lecturer, and academic setting.

Objectivist-Constructivist-Critical Theory Dimensions

This paper argues that open learning and the instructional design of audioconference sessions are situated in what Reeves (1997) identifies as the "eclectic-mixed methods-pragmatic paradigm." He asserts that " . . . it is the one approach most capable of handling the complexity that is the hallmark of contemporary society and technology" (Reeves, 1997). The eclectic paradigm openly caters for a combination of certain components found in objectivist and constructivist learning and teaching models and, additionally, those from a critical theory paradigm.

Jonassen, Wilson, Wang, and Grabinger (1993, p.87) succinctly describe the assumptions of objectivism: "Objectivist beliefs assume that the world . . . is structured, and that its structure can be modeled for, and acquired by, the learner . . . [M]eaning reflects reality which is external to the understander." The goal of educators is to interpret the real world, so that learners can replicate these interpretations in their thinking. In audioconferences, the learner is therefore situated in a rather passive role as the recipient of the information transmitted through a linear sequence of procedures (Jonassen & Reeves, 1996).

At the heart of constructivism is the notion that knowledge is constructed and exists in the mind of the knower. Knowledge is personally constructed within, as is maintained in Vygotskian theory, a social context within a social community that accepts the assumptions underlying that perspective (Cunningham, 1991). Thus, although reality exists independent of the knower, what is known is individually and collectively constructed from "our experiences, mental structures, and beliefs . . . There is no single reality or any objective entity" (Jonassen, 1991, p.29). Instructional design of audioconference communication, based on constructivist theory, aims to place learners in "mindful" learning situations with built-in scaffolding support so that they can construct their own interpretations of reality.

Described by Reeves (1997) as the "critical theory-neomarxist-postmodern-praxis paradigm," the critical theory paradigm is concerned with issues of control, power, and epistemology as social constructions and how these function to exclude various interests, including those of students, particularly minority students. The neutrality of instructional design and the lecturer is questioned, and, by so doing, seeks to expose the hidden curriculum underlying the cultural, gender, and class assumptions inherent in the design process of, and the designed artifact, the audioconference (Henderson, 1996).

Multiple Cultural Paradigm

Any instructional design paradigm, including that of academic audioconferences, is grounded in a cultural context. Far from having to bring it into the matrix, cultural contextuality is always a variable. The many dimensions of audioconferences are social constructs and have meaning because of the selective academic traditions in which they are situated. This is further refined when different ethnic/racial subjectivities, ideologies, and pedagogies are considered. Multicultural education is the most accepted model to incorporate society's multiple realities. However, it has generally been implemented within a narrow framework because it adopts a reductionist approach that diminishes the issues to one of inclusion of various elements of the minorities' cultures, particularly aspects that do not structurally impinge on those of the dominant group, and sees this as rectifying educational injustices (Henderson, 1996). On the other hand, a multiple cultural model strives for a coherent partnership among three cultural logics: those of the academic, mainstream, and student (or minority) cultures.

First, a multiple cultural model needs overtly to incorporate the specific requirements of mainstream academic culture. These are expressed through the content to be taught, types of assessment, written and oral genres, research methodologies, and culturally-specific ways of promoting cognitive development within an academic environment. Second, as academic culture is embedded in an institutional culture that is rooted in society's dominant culture, aspects and values of these differently scaled macro cultures, including systemic issues to do with power, control, and disadvantage, need to be included in the instructional design and delivery of audioconferences. Third, it is also necessary that instructional design and delivery incorporate the students' (or minority's) culture, knowledge, and preferred ways of thinking and doing in a manner that goes beyond tokenism. In this way, the multiple cultural model does not merely encourage, but stipulates, the integration of shared value systems.

What we immediately think of when the word "culture" is mentioned is ethnicity. So, a multiple cultural model relevant for the Inuit would include tertiary academic culture, the culture of the institution embedded in society's wider economic and political culture, and the culture of the Inuit. However, a multiple cultural model has validity for students of various (sub)cultural backgrounds. For instance, a business multiple cultural model would involve the corporate culture of the company, the wider economic-political culture that includes global influences, and the shop-floor culture of the factory worker; or a school multiple cultural

model would incorporate the academic school culture, the school's institutional culture set within the culture of an educational system anchored in society's mainstream culture, and the popular youth culture of the students.

Multiple (academic, mainstream, and minority) cultural contextuality affects the dialogue-structure parameters of transactional distance as well as the objectivist-constructivist-critical theory components in an eclectic theory of audioconferencing

Vygotsky's Theory of Learning

In Vygotsky's theory of cognitive development, knowledge acquisition is essentially and inescapably a socio-political-cultural process. The accumulated achievements (language, ways of thinking and doing, etc.) of particular cultural groups mold the intellectual development of the individual. For instance, for Australia's two Indigenous student groups, Aborigines and Torres Strait Islanders, social activity within their Indigenous cultures ensures cognitive development in culturally appropriate ways. As university students, their thinking is simultaneously mediated by the different accumulated achievements of Anglo-Australian academic culture. Thus, thinking has its basis in social activity that becomes internalized. It follows then that guided social interactions serve a cognitive function which occurs in the Zone of Proximal Development (ZPD) which, simplistically, is the difference between what a learner can do independently and what can be accomplished cognitively with guided support from more knowledgeable others (Gallimore & Tharp, 1990). According to Cole (1985, p. 155), the ZPD should be as "the structure of joint activity in any context where there are participants who exercise differential responsibility by virtue of differential expertise." This, of course, is one of the ingredients of academic audioconferencing as is directing the process of moving the learner from assisted performance to greater self-assisted and self-regulatory competence. Audioconferencing as a scaffolding tool within the ZPD and the lecturer or other students as the more knowledgeable mediator fit comfortably within Vygotskian theory.

Drawing on multiple theories, the eclectic paradigm allows triangulation of complex phenomena in order to design and implement more effective educational interactive communication in open learning. Variability and flexibility are obvious instructional design features of audioconferencing based on transactional distance in an eclectic paradigm that aims to provide students with interactive learning experiences that

incorporate various ways of learning and teaching, reflect society's multiple cultural realities and, hence, promote equity of learning outcomes. Transactional education communication is thereby centered such that the instructional design and delivery of audioconferences positions student groups and individuals in their ZPD, not as objects but as subjects, that is, as active participants who are given and take responsibility as receivers, agents, transmitters, and actors in the cultural contextualized learning paradigm.

A Case Study of an Eclectic Theory of Audioconferencing

The Context

The paper highlights relevant aspects of transactional audioconferencing in a specific open learning Bachelor of Education program, the Remote Area Teacher Education Program (RATEP). The program is offered by James Cook University in Townsville, Queensland, Australia (Figure 1), to non-urban Aborigines and Torres Strait Islanders, Australia's two Indigenous groups, all of whom have or-third language.

Students through RATEP are awarded one year's credit towards the four year Bachelor of Education degree or a two year Diploma in Teaching from the Far Northern Institute of Technical and Further Education, Cairns, Australia. Currently, there are 43 university students enrolled through RATEP across the three years of the degree program.

The RATEP program offers the same on-campus degree to fifteen to thirty Indigenous students in any year's intake, but utilizes interactive multimedia computer courseware, audioconferencing, facsimile, electronic mail, print materials, and an on-site tutor at each site. The location of each RATEP center is usually at the local school in small remote Indigenous communities with populations ranging from 300 to 1500 people, few of whom are transitory non-Indigenous people (see Figure 1). A typical center consists of one classroom which houses the audioconference phone and conference table, a power-Macintosh computer per four students, a modem, a printer, a facsimile machine, a photocopier, video equipment, as well as the students' and tutor's study desks. The tutors are trained teachers who are employed at each site to assist the students in all aspects of their studies. RATEP lecturers are those who teach the same courses with the same types of assessment in the on-campus Bachelor of Education.

Most Aboriginal and Torres Strait Islander university level affirmative action education programs in the past have been typified by high withdrawal and failure rates. RATEP has consistently achieved an unprecedented graduation rate averaging 85% in its eight years of operation, arguably better than any other similar national or international program (York, 1997). RATEP mode students graduate as fully qualified teachers, with the same degree as on-campus students, certified to teach anywhere throughout Australia. Since 1992, RATEP has graduated 57 qualified Indigenous teachers, one with honors; four have become elementary school Principals. This number comprises over twenty-five percent of Queensland's Indigenous teachers.

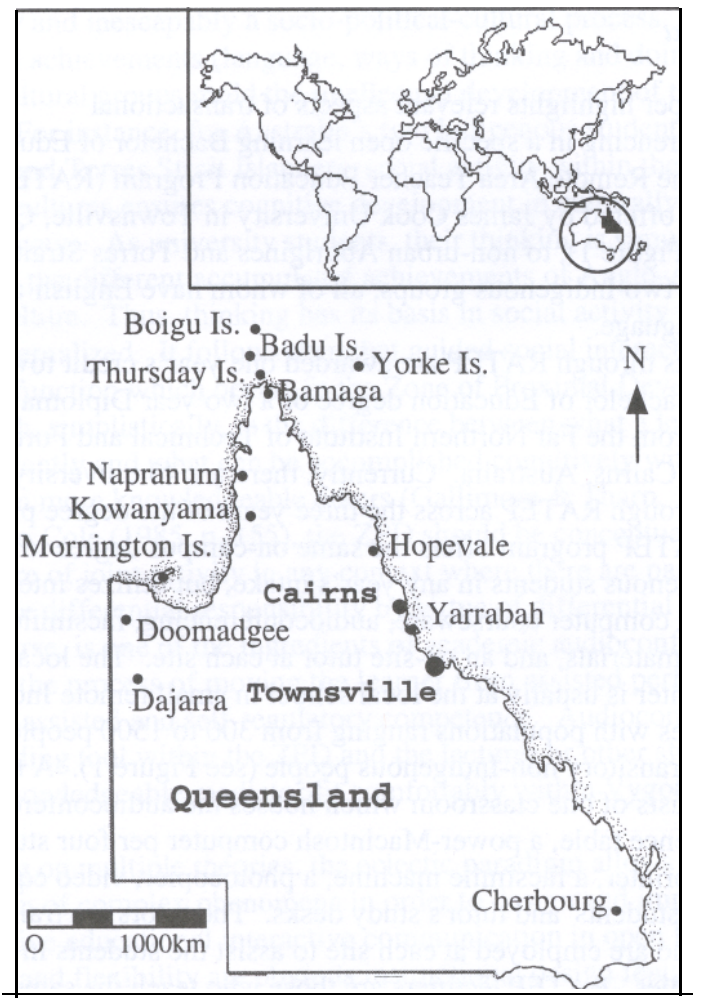

Figure 1. RATEP sites.

The case study draws on relevant research (Lang, 1993; Macindoe & Henderson, 1991; Henderson & Putt, 1993; Putt & Henderson, 1997; York, 1997) involving 93 students who enrolled in undergraduate teacher education through RATEP at James Cook University between 1990 and 1997; there was no intake in 1991. (The figure, 93, includes two intakes of students who have not graduated and are, therefore, not part of the 83% graduation rate calculation,)

Audioconferencing in RATEP

RATEP adopts an eclectic paradigm (Henderson, 1996) but those involved continue to refine audioconferencing as an educational tool (Putt & Henderson, 1997). RATEP's intensive audioconference schedule is an integral part of coursework in all but three courses, with audioconferences occurring usually weekly, sometimes fortnightly, for 30 to 60 minutes duration with approximately 10 students from different sites per teleconference.

In terms of transactional distance, nearly all the audioconferences in the Bachelor of Education courses through RATEP nurture Anderson's and Garrison's (1995) Community of Learners model, with high interactive communication and "low structure", the latter being defined in Moore's (1980) terms as the high ability of the lecturers' to meet the needs of the students. Thus, audioconferences are mainly used as either tutorials to previous e-mailed agendas, student-led seminars, problem-solving discussions, or other group activities commonly undertaken in face-to-face sessions on campus. They also allow for guest speaker input. One course may combine a number of these strategies over the 15-week semester. This would imply that the design and conduct of such audioconferences would comfortably fulfil1 relevant requirements within Vygotsky's learning theory and the students' ZPDs, the multiple cultural model, and the overall eclectic paradigm. That is so, but it would be incorrect to assume only a constructivist pedagogy. Rather, there is a deliberate inclusion of instructivist (behaviorist) and constructivist strategies; in doing so, we argue that this ensures that the audioconference has a decidedly low structure as it definitely meets the needs of the students.

Students are adamant that they need to be engaged in the audioconference (Putt & Henderson, 1997). For them, "engagement" is not, initially at least, mainly a matter of interactive discussion. Rather, engagement consistently means involvement in preparation for the audioconference by taking responsibility for designated participatory roles. This has many elements of teacher-directed instructivist pedagogy.

It parallels certain Indigenous current-traditional ways of doing. (The term, "current-traditional," has been coined to emphasize the fact that cultural ways of learning are not static.) Small groups and individuals are given responsibility for tasks, such as orchestrating the dancing or corroboree, preparing the vegetables, digging the pit for the cup-murri, and so on for special cultural events. The students appreciate this approach to their academic learning, which is seen as having parallel seriousness. Hence, in a study by Putt and Henderson (1997), students awarded the lowest rank to audioconferences without prior agendas. For students, "there's nothing more tedious/boring [sic] than ad lib audioconferences. A well prepared audioconference is the only way." The highest ranking was given to present problems and questions, particularly those that designated the students at each RATEP center to be especially responsible for clarifying and promoting discussion about their specified problems and questions (a) collectively and (b) increasingly individually as students became more comfortable in the audioconference academic milieu. Student-led seminars were also seen as empowering by the students. As each took turns at being joint seminar leader, they were perceived as the "experts" on the topic, and were given and took ownership of the learning activity as they allocated tasks to their peers at other sites.

The granting of ownership responsibility also connected with their current-traditional ways of perceiving credibility. This meant that unstructured discussion with other students was ranked fairly low by students as a preferred way of conducting audioconferences (Henderson & Putt, 1997). Students explained that they feel that working with peers is initially "distracting . . . [We] don't have the patience to listen to someone who doesn't know" (Henderson & Putt, 1993, p. 229). In current-traditional learning, the learner approaches the person who possesses the relevant knowledge and who will give precise information devoid of extraneous or doubtful content. This explains why structured audioconferences with lecturers and student-led seminars were given high ranking in students' perceptions of the contribution to their understanding.

Researchers -- Burge and Howard (1990) who conducted a Canadian national survey of tertiary distance education students and Schmidt, Sullivan, and Hardy (1994) who taught algebra to migrant students via audioconferencing -- found that the students perceived they were not adversely affected by the absence of visual cues in audioconferencing. Our research (Henderson & Putt, 1993; Putt & Henderson, 1997; also see Lang, 1993; York, 1997) supports this. Indeed, although it is often argued in the literature that Indigenous people's preference is for face-to-face teaching or its equivalent, videoconferencing, we maintain that

audioconferencing is cognizant of Indigenous preferred ways of learning as well as those promoted in academic contexts. For example, the audioconference seminar combines Indigenous oral teaching and learning strengths with the language, analysis, and questioning requirements of academic education genre. Students comment that audioconferencing allows them to manipulate the cultural context too. For instance, the lecturer's and other community site students' nonverbals that would be perceived as negative, particularly the latter's teasing nonverbals, cannot be seen and therefore cannot damage the speaker's self esteem. In order to help prevent shaming themselves in public, students also turn off the microphone to allow private discussion between those at one site before giving an answer. This quickly diminishes, as the students become familiar with the lecturer.

Instructional designers need to be aware of possible mismatches between the academic and minority cultures and implement strategies that do not blame and disadvantage the student. For instance, questioning and justifying the validity of statements and analysis are endemic to academic discourse but are generally unacceptable in Australian Indigenous current-traditional ways of learning and teaching. Other Western teaching strategies are also at loggerheads with certain current-traditional Indigenous pedagogy: any child or adult has the right not to demonstrate their mastery when asked but has the responsibility to do so at a self-selected time when they feel that they have mastered the task. Thus in one scenario, evaluation of Indigenous students who are having difficulty with justification questions or do not answer questions when called upon, can categorize the learners as deficient and remedial and, consequently, the lecturer could design audioconferences that are consistently lecturer-dominated and totally objectivist. In another scenario based within a multiple cultural academic context, it is understood that Indigenous acceptance of the rationale for questioning and interrogating the knower (the White lecturer and other students) and providing evidence based on objective research (rather than tradition and the authority of the elders) will need a cognitive apprenticeship approach (Henderson, Patching, & Putt, 1994a, 1994b).

Hence, constructivist scaffolding support within the students' ZPDs has been embedded in the audioconference. For instance, to assist students to articulate their thinking in academic genres, most lecturers include metacognitive activities as well as taking on the challenge to model this type of reasoning. Lecturers coach and model questioning techniques by, for instance, asking one student a question, redirecting their answer for another student to amplify, and redirecting once more for another to critique the answers. Research (Henderson, Patching, & Putt,

1994a, 1994b; Putt & Henderson, 1997) has shown that students studying through RATEP have developed an enthusiasm for replication of cognitive activities appropriate to a particular socio-cultural learning environment.

One factor that helps promote this acceptance is that students perceive " . . . lecturers learn from the students about traditional matters and cultural protocol" (Van Tiggelen, 1996). Students thereby share the multiple cultural process of teaching and learning. Audioconferences become a two-way exchange empowering the student and the lecturer.

The RATEP experience allows lecturers to rethink their pedagogy to cater for academic requirements, the students, and the new, at least to them, delivery techniques: "This RATEP alternative technology has gotten me to think much more explicitly about my own pedagogical processes to translate the knowledge in my course" (cited in Lang, 1993, p. 86). Such experiences continue to have a flow through effect. Many lecturers admit to refining their skills as face-to-face teachers. By having to redesign their subjects to take account of audioconferencing and the other delivery modes, lecturers have improved the structure of on-campus versions of their RATEP subjects and other subjects they teach.

Of course, not all academics are committed to the eclectic paradigm. Three out of the 26 lecturers maintain an objectivist Independent Learners Support model (Anderson & Garrison, 1995) for the duration of their course, holding infrequent lecturer-dominated audioconferences that have a high transactional distance structure with little dialogue (Saba & Shearer, 1994). Their purpose is mainly to give explanations of the assessment and answer consequent student queries. The lecturers hold a model of the distance learner as isolated from, and independent of, the lecturer, and take little account of the students' cultural ways of learning and doing or, for that matter, academic learning and teaching styles that tap constructivist pedagogies within the student's ZPD. Students acknowledge the value of the information presented in such audioconferences but constantly query a pedagogy and commitment that they perceive as "short-changing" them (Henderson & Putt, 1997).

The critical theory parameter of the eclectic paradigm is presented most easily through the content of the courses, for example, in "Contemporary Australian Society" and "Curriculum: Aboriginal and Torres Strait Islander Issues". Students are also quick to critique the conduct of audioconferences, initially, as condoned in current-traditional practices, with the tutors as a go-between to broker for them. As they continue their studies, they adopt greater direct negotiation with the lecturers. As well, students engage in lobbying when the institutional economic rationalists decide on cost-cutting measures that threaten the

continuance of the Community of Learners model of audioconferencing in RATEP.

Another critical theory strategy is deconstructing the audioconference. Unfortunately, few too lecturers pose the following sorts of questions: What effect on meaning has the structure of the content and conduct of the audioconference? What aspects of institutional and societal political and economic reality and whose knowledge has the audioconference amplified, simplified, reduced, or ignored? Are multiple perspectives presented? Is each perspective as valid as the other is? What values are embedded in the audioconference? In what ways have you, the students, appropriated the audioconference to suit your learning style? From many of the examples given in this paper, it is clear that the students have been cognizant of how they - and some of the lecturers - have considered and reflected on at least some of these questions. By asking students such questions, lecturers are providing students with analytic tools to deconstruct the audioconference "text" and its conduct, and self-question the way in which they, as students, use audioconferencing as a learning and reflective tool.

Audioconferences are given firm approval by RATEP students who consistently list them among the two most satisfying aspects of their program; the interactive multimedia computer courseware is given top billing by most students (Macindoe & Henderson, 1991; Lang, 1993; Putt Henderson, 1997; York, 1997). Audioconferencing will not disappear. It provides regular experiences that cannot be obtained, currently, as effectively via e-mail, the WWW, or desktop camera systems: for instance, synchronous verbal contact with lecturers and other students; hearing the lecturer, a native English speaker's intonation and pausing pattern, particularly when using academic genres; and becoming comfortable and versatile with the Western tradition of posing and answering questions, particularly "why" questions and those calling for justification in a verbal synchronous situation as will be required of them as professional teachers; and taking and giving public critique of their interpretations and understandings as well as those of other students and their lecturers.

Conclusion

It is apparent from this case study that the eclectic paradigm of audioconferencing has been successful in the design and delivery of meaningful learning experiences to Indigenous Australian students studying through the off-campus RATEP mode. The paradigm has

allowed seemingly disparate cultural and pedagogical elements to be brought together coherently and cogently through audioconferencing.

While the lecturers did not always find it easy to move outside their traditional pedagogical parameters in developing their subjects for optimal learning, an understanding of, and commitment to, the multiple cultural model was evident. Taking account of the students' culture in the design and delivery of audioconferencing flags to the students that their knowledge and ways of thinking and doing are legitimate and relevant in contemporary tertiary education. Students appreciate that their current-traditional pedagogies are being incorporated in the conduct of their audioconferences, and have demonstrated that these can then be used as places from which to branch into mastering academic genres and valuing and implementing other pedagogic and philosophical approaches to learning and teaching.

Both lecturers and students were empowered as they shared the cross cultural process of teaching and learning. Students now have high expectations of lecturers and are vocal critics of unsatisfactory audioconferences. The challenge for lecturers in RATEP is to continue to develop their skills at designing and implementing different types of audioconferences for different learning purposes and not to see deconstruction of the audioconference as controversial. The goal is to implement, during audioconferencing in any one subject and over the duration of the semester, examples of objectivist, constructivist, and critical theory pedagogical approaches as well as those that affirm Indigenous, and promote Western academic, ways of learning and teaching.

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Conducting Research on Visual Design and Learning: Pitfalls and Promises

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The study identifies gaps in research using instructional technology with respect to the screen aspect of visual design. Theories of how learning takes place in a visual space are briefly reviewed. Several similarities and differences between views of designers of instruction and artists are identified. For illustrative purposes, an empirical study is summarized which suggests subjects who used a lesson created with good design principles require less study time, have a higher completion rate and achieve the same as those use a lesson created using poor design principles. Finally, a series of challenges to conducting research on visual and screen design are presented.

Cette étude identifie les écarts en recherche sur la technologie éducative, en fonction de l'écran que constituent les esquisses. On recense brièvement les théories sur l'apprentissage spatio-visuel. On décrit plusieurs analogies et plusieurs différences entre les opinions des créateurs de programmes de formation et les opinions des artistes. Pour fins d'illustration, on résume une étude empirique selon laquelle les sujets utilisant une leçon créée à l'aide bons principes de présentation ont besoin de moins de temps d'étude et ont un taux de réussite supérieur à ce qu'on observe chez les sujets utilisant un matériel dont qui ne respecte pas les principes d'une bonne présentation. Enfin, l'article expose divers défis que présente toute recherche sur des éléments visuels.

Introduction

The purposes of this paper are to (1) discuss the literature on visual design, visual cognition, and the principles of visual design (2) summarize the results of an experimental research study that was designed to determine if screens that use the principles of visual design influence the learning process, and (3) identify challenges encountered in conducting research on screen design with respect to achievement outcomes.

A review of the literature reveals that expert writers and designers of computer-based instruction recognize that effective programs are those that use both words and visuals to communicate and support the

organization of material (Benson, 1985). The design of effective computer screens using both words and visuals, according to Heines (1984), requires knowledge of "the special characteristics of computer-driven screens, an artistic sense of layout and balance, creativity and sensitivity to the characteristics of the people who will be viewing the screens" (p. ix). Note that at one time, Heine's license plate read "CBI IS ART" (Heines, 1991). Faiola and DeBloois (1988) cite research that shows that good screen design is a critical interface factor and conclude that "thoughtful utilization of text and graphics has proven to be: (1) Significant in aiding insight and understanding the relationship between concepts, and (2) valuable in illustrating processes" (pp. 12-13). They further claim that proper screen design can result in improved performance through maintaining the interest of the learner, reduction of confusion, eye strain, and fatigue that is often caused by poor screen design. Adams and Hamm (1989) state that "studies confirm that the power and permanency of what we learn is greater when visually based mental models are used in conjunction with the printed word. Inferences drawn from visual models can lead to more profound thinking" (p. 7). Yang and Moore (1996) suggest that "to discover the meaning of abstract concepts, learners should have basic and concrete knowledge first . . . Graphics provide more cues, such as spatial and transitional relationships, to help learners decode and remember the knowledge content" (p. 9). Considine and Haley (1992) corroborate these statements; their studies show that "visualization often facilitates comprehension of verbal or printed language" (p. 28). Research by Teng-Mei Chao, Cennamo and Bruanlich (1996) show that graphics, when combined with text, "exert a positive effect, encourage deep processing, and improve fact retention. These findings are particularly true for poor readers. Recall is generally enhanced when graphics depict information central to the text, when they represent new important content, or when they represent structural relationships mentioned in the text" (p. 41). Alesandrini (1987) found that the use of visuals in the learning process increases the amount learned by adults; Pressley (1977) found this to also be true in children. Soulier (1988) states that learners are more likely to read text that is associated with a visual image and that the use of visuals is one of the most important ways to attract and hold a learner's attention. Reiber and Kini (1991) confirm that computer graphics, when designed appropriately, enhance learning in computer based instruction They also cite research that claims that graphics can aid in the visualization of spatial relationships between concepts and rules in short-term memory. In addition, according to Paivio and Caspo (1973) and Pressley (1977), graphics can act as powerful mnemonics for remembering

verbal information and concrete concepts. Clearly, according to much of the literature, effective screen design uses both words and visuals.

Problems with the Research Literature

As is indicated in the introduction, there are substantial amounts of information in the literature on the topic of effective screen design which make claims that learning is enhanced with the use of text and visuals (see also Aspillaga, 1991; Baek and Layne, 1988; Duin, 1988; Gullingham, 1988; Livingston, 1991; Rubens and Krull, 1985; Steinberg, 1991). However, a closer look at the literature on screen design reveals that many authors cite and review previous authors' works-rather than providing a contribution to the literature with original research. Confounding this problem is another problem: much of the original research cited has been conducted on paper platform (not used on computer screens) and/or the computer equipment used in the research is outdated. Research conducted with computer screens prior to the 1990s may only marginally related and should be generalized with much caution. The reason, according to Misanchuk and Schwier (1995), is that technologies available today are considerably better at displaying visuals than in the 1980s when most computer monitors were either CGA or MGA with low pixel densities. On this topic Misanchuk and Schwier suggest that currency does not invalidate generalizations (or transferability), however, we need to question whether investigations conducted on hardware made prior to the 90s should be used in today's rapidly shifting technological world without proper validation. Specifically, according to Misanchuk and Schwier, "the rapid emergence and widespread dissemination of high resolution, bits-deep colour monitors throws into question generalizations derived from studies conducted on relatively coarse-grained monitors capable of displaying only six or eight colours" (p. 14). In addition, many of the research articles do not even state the type of hardware used for their research or the research cited.

Another problem area with determining the effectiveness of visuals in the learning process, based on current literature, relates to the *instructional situation.* Specifically, it is difficult to discuss research on screen designs out of the context that it serves (Misanchuck and Schwier, 1995). Specifically, what is effective screen design on a title page may be ineffective for content dissemination, databases, or testing screens. Moreover, much of the literature on this topic cites other research articles that are not sufficiently similar in tasks. There is a general consensus that "a high degree of similarity between a research task and real life is

essential. That fact seems to have been glossed over in some of the recent research in screen design" (Misanchuk & Schwier, p. 17).

There is also some evidence in the research literature to indicate that the mere presence of visuals does not automatically guarantee better instruction (Steinberg, 1991): "Appropriately designed displays enhance learning. Designed without an understanding of how people gain meaning from them, displays can have no effect or can even interfere with learning" (p. 144). A study by Ruthkosky, O'Neil and Dwyer (1996) investigated the combination of an illustration with a verbal organizer; the results of this study provide support for Steinberg's claim. That is, the results of their study indicated that adding a visual to a verbal organizer "does not significantly increase the students' achievement of different educational objectives" (p. 38). Other studies indicate that not all visuals are equally effective in all instructional environments. For example, studies by Dwyer (1978) indicate that the effectiveness of visuals is primarily dependent upon: (a) The amount of realistic detail contained in the visualization used; (b) the method by which the visualized instruction is presented to students (externally paced vs. self-paced); (c) student characteristics, i.e., intelligence, prior knowledge in the content area, reading and/or oral comprehension level, etc.; (d) the type or level of educational objective to be achieved by the students; (e) the technique used to focus student attention on the essential learning characteristics in the visualized materials, e.g., cues such as questions, arrows, motion, verbal/visual feedback, overt/covert responses, etc.; and (f) the type of test format employed to assess student information acquisition, e.g., for certain types of educational objectives visual tests have been found to provide more valid assessments of the amount of information students acquire by means of visualized instruction (pp. xiiv-xiv).

Kirrane (1992) provides a summary of the research in visual learning that further supports some of these findings by Dwyer (1978). Studies cited by Crane (1992) have found that some pictures and graphics may be counterproductive for learning when they are excessively elaborate or too realistic.

However, these studies are in direct conflict with what graphic designer Tuft (1990) maintains are essential attributes resulting in effective visuals for envisioning information. For example, it is Tuft's opinion that when designers need to clarify a visual design, they should add detail. Specifically, Tuft states (in direct contradiction with Dwyer's research studies and the research cited by Kirrane):

> What about confusing clutter? Information overload? Doesn't data have to be "boiled down" and "simplified"? These common questions miss the point, for

> the quality of detail is an issue completely separate from difficulty of reading. *Clutter and confusion are failures of design, not attributes of design.* Often the less complex and less subtle the line, the more ambiguous and less interesting the reading . . . . Confusion and clutter are failures of design, not attributes of information. And so the point is to find design strategies that reveal detail and complexity-rather than to fault the data for an excess of complication. Or, worse, to fault viewers for a lack of understanding. (p. 50-53)

Although these claims by Tuft (1990) are not based on empirical research, they are supported by many critics and philosophers of art and design such as Lauer, (1979), Greenberg and Jordan, (199 1) and the seminal writings of Ducasse, (1955) and Graves, (1941). When these art and design critics evaluate visual images they do not look for and criticize designs with too much detail. These experts in the field of art and design look for the following principles of design: unity (harmony), focal point (dominance, emphasis), balance, and colour. These principles of design are achieved through the use of the following design elements (or tools) that a designer uses to express creative ideas: line, shape (form), texture, space, scale (proportion), and rhythm.

Could it be, then, that failure to use design principles are what make some visuals less effective than others in the learning process? And not, as Dwyer (1978) and others (Kirrane, 1992) claim: too much detail? According to Tuft (1990), "Showing complexity is hard work. Detail micro/macro designs are difficult to produce" (p. 50). Are the visual designs created by the researchers in these studies done without design strategies that resulted in a design failure-or what Tuft (1990) refers to as *confusion and clutter?* Was there harmony between the text and line that requires "sensitive appraisals of prolific interaction effects"? (Tuft, p. 62). In addition, even a design with too much white space can result in visual clutter: "It is not how much empty space there is, but how it is used. It is not how much information there is, but how effectively it is arranged" (Tuft, p. 50). Perhaps research on the use of visuals in the learning process needs to move toward focusing on how compositions are arranged, rather than the examination of the amount of detail, learner characteristics, and instructional environments. One empirical research study was found that investigated the placement between text and visuals. A study by Aspillaga (1991) investigated whether displaying text information overlapping onto relevant parts of a graphic enhances learning. The results showed that "learning was enhanced by the availability of the whole picture, plus the label, which was not blocking relevant aspects of the graphic" (Aspillaga, p. 91).

Visual Cognition

When trying to understand why visuals might enhance the learning process, a review of the literature on perception and memory provides insightful information. It has been claimed by Guilford (a research psychologist in the late 1940s) that there is a three-dimensional cube of intellectual abilities that can be assessed and trained (Guilford in Peterson, 1996). Guilford's factorial approach to intellectual abilities has the following components: semantic, symbolic, and figural. The semantic aspect includes word abilities, the symbolic dimension deals with the ability to construct relationships, and the main component of this schema is the figural dimension that primarily includes the visual abilities. According to Peterson, while the semantic and symbolic languages are used in learning, it is most often the figural that stimulate discovery and facilitates communication of the information in the learning process. Widely quoted statistics by Treichler (1967) that we generally remember 10% of what we read, 20% of what we hear, and 30% of what we see supports Peterson's claim.

Based on this information, we can assume that visual cognition is an important element that facilitates the learning process and helps to explain why we remember things better when visuals accompany words. Visual cognition is the process of how we perceive and remember visual information (Pinker in Rieber & Kini, 1991). As indicated, research has confirmed that we seem to be exceptionally good visual learners (Kobayashi, 1986) and that visuals may enhance the learning process (Adams and Hamm, 1989; Alesandrini, 1987; Benson, 1985; Considine and Haley, 1992; Dwyer, 1978; Duin, 1988; Soulier, 1988). There are currently two major conflicting theories about how information is stored in our memory: 1) propositions forms theory (Pylyshyn in Rieber and Kini, 1991) and 2) dual coding theory (Paivio, 1991). One of these theories provides an explanation of why we remember information better when it is presented with a visual image.

The propositions forms theory contends that information is stored in our memory based on its meaning in complete and logical statements. Specifically, Pylyshyn (in Rieber & Kini, 1991; see also Steinberg, 1991) claims that visual images are stored in memory in terms of their meanings, not as images. Specifically, according to this theory, when we process the meaning of pictures, we are converting the visual images to a series of statements in a manner somewhat analogous to how a computer converts analog data to digital format. This theory has not been widely adopted as it does not provide an explanation of why visual images enhance the learning process.

The dual coding theory, on the other hand, argues that we perceive and store words and visual images in two systems. One system is verbal and the other is perceptual (Paivio, 1967). According to Bagui, (1998), this theory contends that we process information from our environment by the use of our senses (eyes, ears, taste, smell, hearing and touch). This information is stored in our short-term memory and from here the information is processed in working memory and finally stored in long term memory. The information in our long-term memory becomes our knowledge base. When we are able to retrieve information from this knowledge base, we can assume that the information has been learned.

This theory argues that visual perceptions are not the same as verbal perception, processing, storage, and retrieval. That is, the process of selectively attending to and scanning a stimulus, interpreting important details, and perceiving meaning is perception (Levie, 1987; and Steinberg, 1991). The perceived stimulus is processed through one of two channels. One channel processes verbal information and the other processes images. According to the dual coding theory, learning is enhanced when information is processed through both channels rather than just one. This dual processing produces an additive effect because there are more cognitive paths to retrieve the information (Paivio, 1967; 199 1). The information retrieval, then, is greater due to the availability of two mental representations, rather than one. Specifically, when one memory representation is absent, the other representation remains accessible (Paivio and Caspo, 1973). Moreover, according to research cited by Reiber and Kini (1991), when the information is intensely imaginable, there is a greater likelihood of dual coding to occur.

Thus the dual coding theory provides us with an explanation of why the use of visuals enhances the learning process: "when learning from texts and pictures occurs, pictures can always be retrieved from both memory systems" (Molitor, Ballstaedt and Mandl in Mandl and Levin, 1989, p. 7). Dual coding enhances memory in terms of allowing us to absorb information from the environment using both the verbal and visual processes and helps in reducing the cognitive load in our working memory (Bagui, 1998). To test a prediction that information retrieval would be enhanced if both processing channels are tapped simultaneously, Szabo, DeMelo and Dwyer (1981) found that achievement scores were significantly higher when testing included the same visuals that were used during instruction. Research by Shih and Alessi (1996) also revealed that pictures facilitated learning on both recall and retention.

However, research in artificial intelligence shows that knowledge is stored in a unique memory system in a propositional format, irrespective of whether it was decoded as linguistic or visual information (Molitor,

Ballstaedt and Mandl in Mandl and Levin, 1989). Specifically, according to studies by Baggett and Ehrenfeucht (cited in Mandl and Levin, 1989), that both verbal and visual cueing can be equally effective in recall learning, indicating that cueing is not medium dependent, as the dual coding theory proposes. This research is incongruent with the dual coding theory which means that, although the dual coding theory provides us with an explanation of why visuals enhance the learning process, it lacks strong support from empirical research.

Design Principles

Noticeably absent in the contribution to the instructional technology literature on screen design are the views and opinions by *artists and art critics.* Generally, most artists and art critics would accede that design principles (e.g., unity, focal point, balance and colour) and the elements of design-which are the tools a designer uses to express creative ideas (line, shape, form, texture, space, scale, proportion, and rhythm)-are necessary to create a good visual design (Graves, 1941). According to the seminal writings of Graves (194 1) design principles are the basics of any visual design. Readers who wish more information on basic design principles should consult Bates, 1960; Greenberg and Jordan, 199 1; Lauer, 1979; Poore, 1967; Riddell, 1984; Szabo & Kanuka, 1999; and Taylor, 1981.

Upon closer examination of the goals of the graphic designer and those of the instructional technologist, it becomes evident that both have much in common. In addition to creating visually pleasing layouts, goals of the graphic designers include (1) attracting and holding the viewer's attention, and, (2) communicating easily understood information that aims to have the viewer remember the information. To achieve these goals, most graphic designers use the principles of design. Is it possible for instructional technologists to apply these design principles to achieve similar goals? Do variations in visual design have an impact on learning as measured by objective performance outcomes?

An Illustrative Research Study

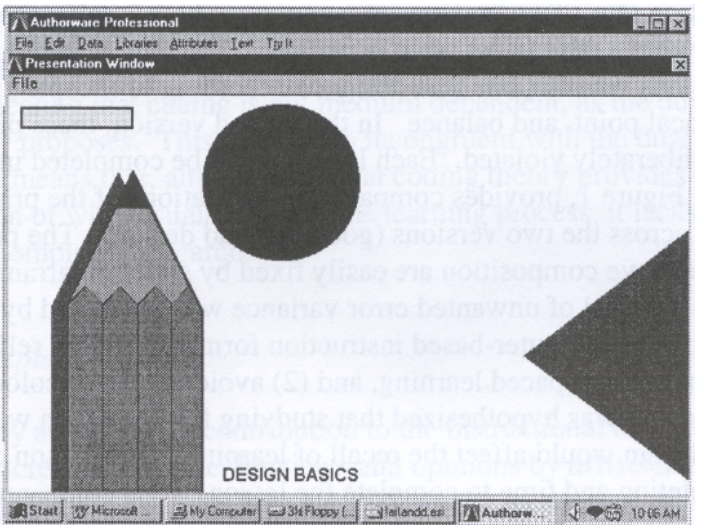
In stark contract with the vast amounts of writing on visual design, there is a paucity of research that directly addresses the effects of visual design on the quantity or quality of learning or other measures of performance in the classroom. To address this gap in the research, an experimental study was conducted (Szabo & Kanuka, 1999) to test the

hypotheses that visual (screen) design affects learning, study time and completion rate. Two versions of a computer-based, self-paced lesson on how to write a term paper were developed. The only difference between the versions was that one was designed according to accepted principles of unity, focal point, and balance. In the second version, these principles were deliberately violated. Each lesson could be completed in a single setting. Figure 1, provides comparative illustrations of the principle of balance across the two versions (good and bad design). The problems with the above composition are easily fixed by simply rearranging the objects. Control of unwanted error variance was attempted by (1) creating the lessons in computer-based instruction format to enable self-paced rather than group-paced learning, and (2) avoiding use of (gray scale was used). It was hypothesized that studying from a lesson with good screen design would affect the recall of learning of the lesson content, rate of completion and time to complete the lesson, when compared with a lesson using poor screen design. The findings of the study, using 87 adults revealed equivalent recall achievement test scores across the two treatments while the good design group's completion rate was higher (74% vs. 45%) and their time to complete the lesson was 21% lower than the bad design group's lesson.

Discussion

On the surface, the results of this study seem to reveal that following good screen design principles appears not to influence recall learning one way or the other. In addition, this study showed that poor use of design principles increases instructional time and reduced completion rate, or persistence. Screen design is a complex issue. Some questions that need to be discussed to attempt to understand these complex issues include: why would design principles not influence achievement? how do design principles influence time on task and completions rates? why does a pleasing design result in shorter time on task? how does poor visual design lower completion rates? what role does motivation play? There are a number of possible explanations that could be provided to explain these results.

The most probable explanation is that the participants, who were enrolled in a certificate program at a university, were already knowledgeable on the subject of the lesson (how to do a term paper). This prior knowledge likely nullified the differences in achievement scores. Upon a review of the post test scores, there is further evidence to support this explanation. The average for the good design lesson was 31 (out of a



This composition lacks balance because the pencil, circle and rectangle are placed on the left part of the screen, leaving only the triangle shape on the right. This composition also suffers from a lack of unity and an inappropriate focal point where the dark tip of the pencil leads the viewer's eye to the narrow rectangle and out of the composition.

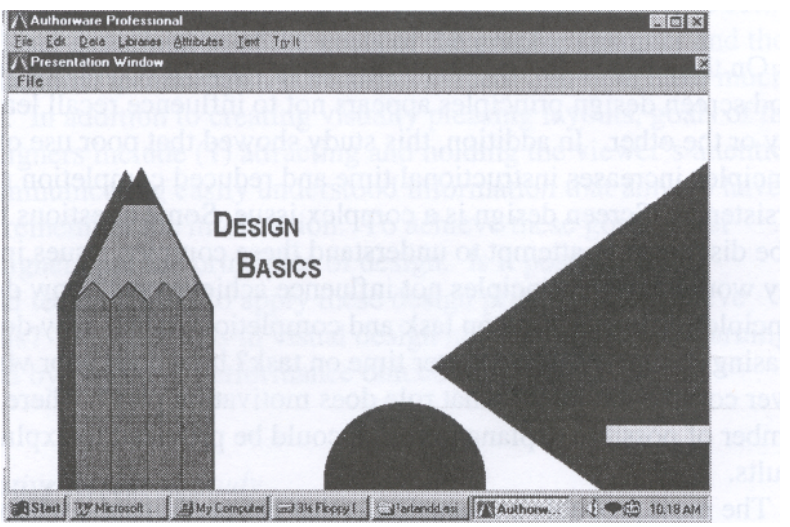


Figure 1. Example of poor versus good screen design.

possible 36) and the average for the poor design lesson was 29 (out of a possible 36). Conducting a pretest may have revealed that the sample had considerable prior knowledge on the topic; unfortunately, the absence of pre-treatment data makes it impossible to account for any initial group differences that may have been present. As a result, the researchers cannot conclude whether the differential mortality that occurred in the study on any of the dependent variables was due to a sampling error or to the treatment. As mentioned, a pretest was not conducted to avoid pretest sensitization. However, further research might shed light on this issue if a study was conducted using pre-treatment data such as general grade point averages or the results of previous writing assignments, This would give the researchers the ability to assess and account for group differences and prior knowledge without introducing pretest sensitization. In addition, further research should analyze the actual performance of writing a term paper of the participants, rather than a posttest, to determine the influence of design principles on achievement. Specifically, submission of a term paper and a description of the process followed to achieve it might be a more appropriate measure of achievement than recall learning.

Several questions also arise when reviewing the data that showed poor screen design results in increased instructional time and reduced persistence. An important question to ask here is: why would a pleasing design not result in longer time on task? Would learners not enjoy lingering in the aesthetically pleasing environment? Or does a pleasing design result in a shorter time on task because learners can move swiftly through the instruction when they are not obstructed by poor design? There are several plausible answers to these questions, Screen designs may vary in terms of complexity, which is in part of function of the learner's prior knowledge. Hegarty, Carpenter and Just (1991) concluded that learners execute more visual inspections when reading from illustrated text when the diagrams become more complex. Furthermore, coherent visuals increase the speed of detection of an object within a visual (Biederman, Glass and Stacy, 1973). If poor screen design increases the perception of complexity or incoherence, increased inspection time might be lead to longer overall study time without a concomitant gain in achievement.

Does quality affect task persistence, which is often used as an indicator of motivation to learn? Instructors are familiar with negative student reactions to spelling and typographical errors in the written materials. This may raise the question, if the writers can't get the spelling right, can the content be accurate; can the materials be of sufficient quality that they bear attention? A parallel in the airline industry is that if passengers see dirty coffee trays, they may question if the mechanics are also sloppy

about maintenance and safety. If it is perceived that content or quality is suspect, the motivation to continue with the high level of effort may be diminished.

Students of science have learned to read science texts and attend to the visuals slowly and in depth. They experience a shift when reading texts from the humanities (and vice versa). One might say switching from science to humanities texts (or vice versa) interrupts a pattern which has become somewhat automatic, a topic studied by Shiffrin & Schneider (1977). This is but one example of automating our learning control processes for minimizing cognitive disruption, An example from the psychomotor world is the all too often realization that while driving a car, one suddenly realizes they have no recollection of the scenery just passed!

Suppose that students are used to well-designed instructional material in which the basic design principles have been carefully followed. Suddenly they encounter material that violates the design principles. Their automatic processing is now interrupted, not unlike the result of the driver on 'automatic pilot' who encounters traffic, a siren, or a stoplight. Could it be that good design principles promote automaticity in learning while poor design principles result in less automatic, less efficient learning?

We can also ask if an interruption to automated processing might have a measurable effect upon learning a topic that is new or unfamiliar to the learner. Presumably more than one person in the Szabo & Kanuka (1999) study has had experience in writing term papers, experience that overrode any other differences in achievement scores.

The Szabo & Kanuka study was delimited to the use of a subset of design principles; the instructional graphics served a representative function. To gain greater confidence in the findings from this study, it is necessary to replicate this study, with changes to correct for design and execution concerns. General suggestions for further research to extend our understanding include the following:

- Extending the study beyond recall achievement to include higher levels of achievement. For example, this study could be extended beyond recall achievement to include the ability to do a term paper (the quality of performance) and/or to include the time required to do a term paper. Effects on performance in writing a term paper might yield different results.
- Using an achievement instrument that reflects the design criteria used in the lessons.
- Extending the study to other learners who have limited term paper writing experience.

- Conducting the study in a controlled environment, rather than having participants complete the lessons on their own time.
- Replicating this study with a balanced number of genders in each group to determine if gender is an influencing factor.
- Conducting interviews with the participants on how they interacted with the material and how they saw the designs contributing to or inhibiting their learning experience.

One area in particular that needs to be examined further is the completion rates between participants using screen layouts with design principles and those that do not. In the Szabo & Kanuka study, 74% of the students completed the lesson using good design whereas only 45% completed the lesson using the poor design. As dropout rate in self-paced or distance education is a persistent problem, this is an area that should be explored further.

Issues Surrounding Screen Design Research

In addition to the general issues and difficulties noted above, which commonly arise in the course of research on learning, there are several unique challenges to be considered in the area of screen design. We present a sample of these for future research considerations.

Are screen design elements simply hypothetical constructs or is there in fact some basis to suggest they may have an observable effect on learning? Identification, classification and measurement in a reliable and valid way raise numerous issues. A good parallel is the hypothetical construct of intelligence and the numerous problems and issues surrounding its assessment and interpretation. Studies using different design principles and graphics with different functionality should be conducted to shed more light on this area of instruction. Attempts should be made to isolate and determine which, if any, of these design principles have a greater influence on time and completion rates.

Numbers of Screen Design Principles

Do the three principles of screen design identified in the literature and used in this study (unity, focal point and balance) comprise the complete

and definitive set of principles? If there are, and without apriori theoretical guidance, the researcher may resort to simply evaluating them all, individually and in combination, The logistics become more complex if one allows the possibility of interactive effects; e.g., unity and balance may have no effects individually but in combination may influence the criteria chosen.

Theoretical Rationale

It is not clear what the various learning theories predict about how people learn with visuals; the depth and detail of our understanding are not sufficient to be prescriptive. There are myriad points of view or references which may be consulted in approaching this, such as behaviorism, information processing, constructivism, memory, perception, motivation, (visual) learning styles and length and quality of exposure, to name a few.

In the absence of a strong theoretical rationale, practical issues are often substituted. For example, as with research on color in learning, it is generally assumed that screen design has an effect, usually positive, on learning. Further research has shown these common assumptions to be questionable in the case of color and now for screen design.

Criteria

What outcomes can we expect to be sensitive to variations in screen design, and why? We have a bewildering array of cognitive and performance areas from which to choose. Furthermore, there is the issue of accurate (reliable and valid) assessment of those outcomes.

Individual Differences

Are there individual differences among learners that interact significantly with screen design elements to enhance or inhibit attainment of the criteria? For example, are visual learners or those with extensive training in graphic design more or less likely to be affected by variations in the treatment? What is the basis for predicting or hypothesizing such aptitude by treatment interactions as an exercise in designing research?

Sensitive Assessment Techniques

It can be argued that treatment effects may be lost when they are ignored in the assessment techniques. For example, Szabo et al (1981) showed that the same visuals, when incorporated into both the instruction and the assessment process resulted in greater learning than when assessment did not use the visuals. Similarly, one could argue that assessment used in research should include the variables of interest, e.g., good or poor screen design for optimal sensitivity.

Function of Screen Design

Levin, (Anglin, Towers & Levie, 1996) identified five different purposes or functionalities of instructional graphics in text learning; decoration, representation, organization, interpretation and transformation. Are the five functions of visuals identified by Levin real constructs which can be operationalized and examined for effects upon various cognitive or performance criteria of learning? Is there an interaction between these functions and screen design principles with respect to learning outcomes?

Conclusions

The research study discussed in this paper is a first attempt to show that good screen design influences learning when delivered with computer based instruction. It is the opinion of the researchers that understanding the principles of design and visual cognition are important theoretical foundations upon which the identification of appropriate design considerations would be practiced for computer based instruction. This is an important issue as more and more instructional materials are being delivered in highly visual, self-paced, individually directed study environments using computer-mediated communication and the World Wide Web. This places screen design in a paramount role to maintain interest and perseverance for the learners.

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Barriers to Online Teaching in Elementary, Secondary, and Teacher Education

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A review of the literature regarding the barriers to the use of educational technology in primary and secondary education was done. An emphasis was placed on the diffusion of computers in the schools, since the focus of this study is to determine what should be expected as computer-mediated communication (CMC) is used in schools to teach in online environments. A categorical framework, similar to one used by the first author for analysis of barriers to the use of CMC in higher education, was used (Berge, 1998). The nine categories of barriers are: academic, fiscal, geographic, governance, labor-management, legal, student support, technical, and cultural. The literature review of barriers to the use of educational technology in K- 12 using this framework suggested the primary areas of concern are academic, cultural, and technical. Secondary areas of concern are labor-management and fiscal issues, with little or no mention of geographic, governance, student support, or legal aspects of diffusion of technology. To test whether the use of CMC as one important area of educational technology entering K- 12 teaching and learning, a recently published four volume series of books titled, *"Wired Together: Computer-Mediated Communication in K-12"* was analyzed. Taken together, the seventy-two (72) chapters in these four books, mostly case studies, represent a considerable body of experience in online teaching and learning in K-12, pre- and in-service teacher training. The content analysis was done 1) to determine how many different barriers to online teaching were mentioned across all the contributors, i.e., to indicate the range of the obstacles, and, 2) to determine how often each particular category of barriers was mentioned, i.e., to indicate the perceived severity of these issues. The results are quite consistent when compared to the more general review of literature regarding educational technology.

Une étude de la documentation sur les obstacles à l'utilisation des technologies éducatives aux niveaux élémentaire et secondaire a été effectuée. On a mis l'accent sur la diffusion des ordinateurs dans les écoles, puisque le but de cette étude est de déterminer à quoi il faut s'attendre suite à l'usage de la communication par ordinateur dans les environnements d'enseignement en direct. On a utilisé un cadre catégorique analogue à celui qui a été utilisé par le premier auteur pour l'analyse des obstacles à la communication par ordinateur en éducation supérieur (Berge, 1998). Les neuf catégories d'obstacles sont les suivantes : académique, fiscal, géographique, administratif, patronal-syndical, juridique, aide aux étudiants, technique, culturel. Cette étude de la

documentation sur les obstacles à l'utilisation de la technologie éducative dans l'enseignement primaire et secondaire indique que les principaux problèmes sont d'ordre académique, culturel et technique. En deuxième lieu viennent les problèmes patronaux-syndicaux et fiscaux. Il y a peu ou pas de problèmes d'ordre géographique, administratif, aide aux étudiants, juridique quant à la diffusion de la technologie. Pour vérifier si l'utilisation de la communication par ordinateur constitue un volet important de la technologie éducative dans l'enseignement et l'apprentissage aux niveaux élémentaires et secondaires, une série de quatre livres publiés récemment sous le titre « Wired Together : Computer-Mediated Communication in K – 12 » a été analysée. Globalement, les 72 chapitres de ces quatre livres (ces études de cas, en majorité) constituent une somme d'expériences en matière de télé-enseignement et de formation des maîtres avant et pendant leur carrière. Une analyse de contenu a été effectuée pour 1) déterminer combien d'obstacles au télé-enseignement ont été mentionnés par les personnes (pour préciser l'étendue des obstacles), et 2) pour déterminer à quelle fréquence apparaissait chaque catégorie d'obstacles (pour préciser la gravité subjective de ces problèmes. Les résultats se comparent à ceux que donne une étude plus vaste de la documentation relative à la technologie éducative.

To prepare for success in the workplace, children need to become independent, critical thinkers while also learning to work collaboratively in teams (CCSSO, 1992). They must learn to find information, manipulate it, and effectively express their own ideas and the ideas of other people (Haddad, n.d.). The use of educational technology, particularly for online teaching and learning, has been recognized as helping people, young and old, in these areas of their learning.

Despite increasing acceptance of online teaching and learning there are still significant barriers to be overcome.. The pur-pose of this article is review selected literature regarding inhibitors to the use of educational technology in K-12. Further, we will identify barriers to online teaching in elementary, secondary, and teacher education environments and compare these results with what we would expect from the more general literature review.

Computer-mediated Communication in the K12 Classroom

The Argument for Using Educational Technology

Over the past two decades, computer technology has been credited with higher achievement by students, motivating students to learn, aiding

instruction for special needs students, improving student attitudes toward learning, and motivating teachers while freeing them from some routine instructional tasks (Software Publishers Association, 1996). Additionally, an increase in the effective utilization of computers, networking, and other technologies has been a common element in many of the proposals made in support of a broad program of systemic and curricular reform in K-12 education (PET, 1997). Far reaching policy decisions, such as the passing into law of the *Goals 2000: Educate American Act* in 1994, means a significant increase in a number of provisions designed to promote the application of technology within K-12 schools.

The Argument for Using Computer-Mediated Communication

The use of computers, standing alone and connected to the Internet is growing in K-12 education. At least one study provided evidence that students with online access perform better in certain intellectual skills. In 1996, CAST (Center for Applied Special Technology) conducted a study that isolated the impact of online use and measured its effect on student learning in the classroom.

"The Role of Online Communications in Schools: A National Study," compared the work of 500 students in fourth-grade and sixth-grade classes in 7 urban school districts (Chicago, Dayton, Detroit, Memphis, Miami, Oakland, and Washington DC)--half of the students had online access and half did not. The results showed significantly higher scores on measurements of information management, communication, and presentation of ideas for experimental groups with online access than for control groups with no online access. Therefore, under the conditions found in this study, online learning was determined to "help students become independent, critical thinkers, able to find information, organize and evaluate it, and then effectively express their new knowledge and ideas in compelling ways" (CAST, 1996, n.p.).

Inhibitors of the Use of Educational Technology in Primary and Secondary Schools

A review of literature indicates one historical approach is to present the large picture of technology from its earliest days to the present use of personal computers in the classroom. (Merrill et al., 1992; Poole, 1997). This basic chronological approach places the beginning of computing with the use of the abacus in 4000 BCE, called the beginning of "mechanical

computing." An even earlier period is described as "pre-mechanical computing" during which people counted on their fingers and made marks on cave walls and animal bones to keep count. After the abacus, the mechanical computing period featured such highlights as the creation of the slide rule in 1621 and the invention of Boolean Logic in 1854. Developments in counting problem-solving machines in the first half of the twentieth century led to the creation of the first computers. Although the first computers were developed in the late 1940s, they were too large and expensive for use in the schools. The revolution for school computing occurred in 1976 with the creation of the personal computer system.

Technology continues to change and affect children. Throughout history, there have been significant barriers perceived by persons who believe the infusion of technology in the classroom can help teaching and learning. The following examples of barriers mentioned in the educational technology literature serve as a starting point in developing a comprehensive list of such obstacles. Leggett and Persichitte (1998) examined the history of barriers and determined that the same basic four barriers are consistently sited by teachers: time, access, resources, and expertise. They provided a detailed description of each barrier and added a fifth one: support.

A review of the literature supports Leggett and Persichitte's contention that those five factors are very important. Viewed historically, the barriers occur repeatedly. Loughary (1966) mentions limited resources and lack of support as potential barriers to the implementation of computers in the classroom. O'Shea and Self (1983) examine the factors that affect the teachers as they try to grapple with new technology. These factors included poorly designed materials and lack of technical support, teachers' anxiety and resentment concerning the new technology, and the lack of administrative support.

Schofield (1995) provided a detailed look into the barriers of technology use. One important factor was the belief by teachers that computer use would add little of value to current practice. Another belief that she reported was that existing educational software was not useful in the classroom. Computer anxiety based on the teachers' unfamiliarity with computers was a major barrier since this fear affected the teachers' sense of competence and authority in the classroom. The lack of incentives and the presence of disincentives played a role, as did the infrastructure problems, such as repairs, trouble-shooting, and maintenance. Finally, a lack of adequate training was an important barrier, especially the lack of coordination and timing between training and hardware purchase, the inability to match training to the teachers'

level of knowledge and instructional concerns, and the lack of concentrated experiential training.

Merrill et al. (1992) breaks the barriers into three basic categories: ethical issues, legal issues, and cultural issues, This approach is a departure from the earlier focus on the nuts and bolts issues of poorly designed equipment, lack of support and confusion. In the 1990s, the literature reflects a deeper analysis of the types of barriers that exist for teachers, schools, and students. Collis et al. (1996) also focuses on the possible negative side effects across cultures that are caused by computer use. The equity issue of the disparity of use between boys and girls in the classroom is mentioned. Collis notes that there is a lack of knowledge about the future negative impacts of technology on students.

Starr (1996) provides a similar assessment of barriers in the classroom. The barriers include inequality for minorities and low-income students, lack of high-end uses of technology for primary and secondary education, as compared to higher education, and the need for inexpensive connectivity and low-cost access to content that are provided on many websites for a fee.

Fisher, Dwyer, and Yocam (1996) focus on the equity issue as a barrier to technology infusion. In addition to the barriers of lack of technical support, limited funds and resources, lack of time for preparation, implementation, and review, the authors also highlight the issue of lack of access to computers by all students, as well as access to the Internet. Montgomery (1996) also addresses the issue of access and inequality for minorities and low-income students. The author also note that concern regarding the quality of the new media culture and the effect of a media that is highly commercialized and unregulated.

Sandholtz, Ringstaff, and Dwyer (1997) report somewhat similar results. The main barriers include limited access, lack of equity, potential for jealousy or greed among teachers, and a large number of technical problems. Poole (1997) noted that the barriers of inequities, such as rich versus poor, girls versus boys, whites versus minorities, and lack of equal access to information based on disparities in funding and management of different school systems were of great concern to educators.

Turkle (1997) provided a different approach to the barrier issue. Her analysis of the problem focused less on the logistics and obvious causes of difficulties. Rather, she discussed the actual role of the computer in the classroom and its impact on learning. This interesting perspective provided three inherent concerns. The first is the "seduction of simulation" and the possibility that the computer activities might lessen the students' desire to question and think through problems carefully. Also, she wonders if the attraction for using simulations is based on the

fact that it may be easier to buy a software package that allows students to conduct virtual experiments than hire and fund an additional science teacher. The second problem is the resentment felt by teachers for computer applications that serve as "overblown video games." The third potential barrier is that the computer may be creating students that are "fluent users" of technology rather than "fluent thinkers" of technology. Turkle observed a student who could use a particular software package correctly, and boasted to Turkle of her prowess. However, the student could not explain why a particular situation occurred, what the repercussions might be, or criticize or judge what she is learning. Turkle describes her as a "someone who can pronounce a word in a book but does not understand what they mean."

The slow pace of successful implementation of computer technology in the classroom is discussed by Sulla (1998). Sulla argues that it takes from three to seven years to successfully infuse technology by teachers. The stages are defined as "dynamic disequilibrium, contrived equilibrium, and reflective practitioner." The difficulty and length of time involved in the implementation of technology appears to have remained consistent over the past few decades. As computers become more and more popular in the classroom, the need for a long-term perspective is critical.

Using a framework I developed elsewhere (Berge, 1998) (see Table l), the literature reviewed above along with others (e.g., Abdal-Haqq, 1995; Evans-Andris, 1996; Oppenheimer, 1997; Rice, 1995), suggests barriers to the use of technology in the primary and secondary classroom as falling generally into these categories: academic, cultural, and technical. Secondary areas of concern indicated in the literature involve labor-management and fiscal. Very little or no mention is made in the literature discussing barriers to the use of technology in K-12 regarding student services, legal, governance, or geographic areas.

Barriers to Online Education

Although technologically-mediated learning holds many advantages and promises for educators and learners, it is not well suited, nor available for all learners or in all learning situations. Social, economic, physical, or learning barriers exist and schools lack the resources to make computer/telecommunication systems available, thus denying them the advantages that technology may offer.

While the technological infrastructure is improving and access to the internet is increasing in elementary and secondary schools, there are still significant hurdles to such teaching and learning. Lack of computer

access, increased time demands, differences in individual preferences, student and teacher resistance to new methods, and lack of student and faculty support services, and the lack of adequate training and technical support are all common problems faced by both students and teachers (e.g., DoIT, 1996; Furst-Bowe, 1996; Galusha, 1997; Morrison & Lauzon, 1992).

The Study

Recently a four volume series was published entitled *"Wired Together: Computer-Mediated Communication in K-12"* (Berge & Collins, 1998a, b, c, d). Taken together, the seventy-two (72) chapters in these four books represent a considerable body of experience in online teaching and learning in K-12, pre- and in-service teacher training. Online teaching and learning is one major type f technologically-mediated learning. The content of these books was analyzed: 1) to determine how many different barriers to online teaching were mentioned in these books, i.e., to indicate the range of the obstacles, and, 2) to determine how often a particular barrier was mentioned, i.e., to indicate the perceived severity of each barrier.

Methodology

Best and Kahn (1989) stated that document analysis serves to describe prevalent conditions and to discover the relative importance of, or interest in, certain issues (p. 91). The *Wired Together* books were first read to find keywords that indicated barriers to online teaching. The following list of keywords were found and later used to electronically search the text of all four books: *barrier, limitation, difficult, inhibitor; impede; hamper; obstruct; roadblock; thwart; delay; encumber; foil; restrain; retard; arrest; obstacle; hurdle; hinder; reticence;* and *lack of*. Upon each occurrence of these words, the context (sentence or several sentences around the word), was read to determine if it indeed was used to indicate a barrier to online teaching and learning. This was done independently by the two authors and any discrepancies were discussed and agree upon. "Barriers," as indicated by the list of keywords above, is used here to mean "any perceived problem standing in the way of an online teachers work."

Limitations and Research Issues

When selecting from a list of items or recalling items that have previously been heard or read, it has been shown that individuals often select the items at the beginning or end of the list. In this literature this is called *primacy and recency effects* (Weiner, 1985). A different phenomenon that is often an issue in studies similar to this is *attribution.* Attribution theory suggests that people tend to explain the causes of their own behavior in a manner that is self-promoting (Bar-Tal, 1978; Nisbett and Ross, 1980). For instance, an individual may want to avoid attributing a performance problem in the workplace to their own behavior, and instead falsely tell themselves or others that the cause is an environmental issue out of their control (Dean, 1996; Weiner, 1980). Reports on behavior may also be significantly different simply depending upon whether the individual is self-reporting his/her behavior leading to the performance, or is an observer reporting upon others behaviors. Jones and Nisbett, (1971) suggest that actors attribute the cause of their poor performance on the environment, whereas observers focus on the people they are observing and their behaviors. Since subjects in this study were not given a list of barriers from which to react, the potential problem of primacy and recency effects are not an issue. This issue was mentioned here main with regard to issues that may threaten validity to further research. With regard to attribution effects, the reader is cautioned that this effect may account for some of the weightings found in this study. Some of the contributors to the *Wired Together* books were online teachers themselves while others were more or less observers (i.e., researchers; teacher educators).

While the findings herein may be interesting and useful as a start for further research, the reader is cautioned about some additional threats to both validity and reliability. An exhaustive literature review was conducted regarding barriers to distance education in primary and secondary teaching and learning in preparation for this study. Still, the current study itself reports on contributions in only the four books in the *Wired Together* series. With the scope being limited, these findings should be considered exploratory and generalizability is not possible.

Secondly, the categories that were derived were done so by the researcher and are based on work done in policy for higher education and the review of literature. Additionally, the study is based on the *perceptions* of the contributors to both the literature reviewed and those writing for *Wired Together.* No independent observers or other means were used to attempt to verify what was reported by these authors.

Finally, each of the barriers mentioned by the subjects were forced into one category by the researchers. While we may agree on the category, it is certainly recognized by us that many barriers could be listed in multiple categories. As one example only, it is hard to conceive that the barrier listed as "intellectual property rights/ownership" and placed here in the "Labor-Management" category, could not be placed as in the "Legal" category with as much justification by someone else. Our purposes here are not to split hairs in categorizing, but rather to explore and identify as comprehensively as possible all barriers to online teaching as one significant form of distance education.

Findings and Discussion

Of the 72 chapters examined, 52 (72.2%) mentioned barriers using the search terms listed above. This is significant in itself. While the instructions from the editors to the authors did not specifically ask authors to include barriers, there were suggestions that they discuss "lessons learned" and provide "tips to online teachers" based on their experiences. Most chapters that mentioned limitations to online teaching contained only a couple of the keywords. In fact, 49 of the 72 chapters (68.1%) indicated no more than four barriers. The chapters containing the highest number of "barrier" terms appear to be overview chapters written by the editors, or chapters written by teacher educators; it does not seem that online teachers ordinarily write about widespread barriers to online teaching.

Table 1 lists the barriers and their frequencies as identified in the *Wired Together* book series. The teachers and teacher educators authoring 52 chapters used at least one barrier term, with a total of 261 throughout the 4 books. The barriers seemed to cluster in in mainly the following areas: academic (n = 30, 11.5%), labor-management (n = 29, 11. l%), technical (n = 67, 25.7%), and cultural (n = 89, 34.1%). As expected from the review of literature, little mention of barriers were found in these books in the areas of legal, student support, and geographical.

The barriers mentioned most often by the authors of the chapters in *Wired Together* were:

- Concerns about the cultural change process necessary for the successful implementation of distance education.
- Concerns about the pedagogical changes necessary for the effective implementation of distance education.
- Lack of support for teachers/faculty members (including technical training), or mention of the lack of experience teachers/faculty have in distance education methodologies.

Table 1. Barriers to Using CMC in the Online K- 12 Classroom.

Policy Area	Key Issues	#
Academic	Academic calendar; inadequate course integrity/design; transferability; transcripts; evaluation process; curriculum approval process; accreditation; inequality (e.g., disabilities; gender; race); questioning the value added by technology/software; ethical issues; lack of student time; large class size; lack of teacher support for student learning to use technology	30
Fiscal	Tuition rate; technology fee; FTE's; consortia contracts; state fiscal regulations; business model; marketing; lack of hardware/software/people; sustainability and reliance on business and community support; revenue sharing with departments; competition with other business entities	1.5
Geographic	Service area limitations; different time zones; local versus out-of-state tuition; consortia agreements; cross-cultural issues	**9**
Governance	Single versus multiple board oversight; staffing; existing structure versus emerging structure (e.g., forming subsidiaries for distance education); administrative support/issues; strategic planning; school scheduling; admission standards	14
Labor-Management	Compensation and workload; promotion and tenure; development incentives; intellectual property rights/ownership; faculty training; congruence with existing union contracts; lack of teacher/faculty time	**29**
Legal	Fair use; copyright; faculty, student and institutional liability; computer crime, hackers, software piracy, computer viruses	4
Student Support	Advisement; counseling; library access; materials services delivery; student training; test proctoring	4
Technical	Lack of systems reliability; lack of connectivity/access; inadequate amount/type hardware/software; setup problems; inadequate infrastructure; inadequate technical support; inadequate maintenance of hardware/software	67
Cultural [1]	Faculty or student resistance to innovation/new methods; resistance to change; difficulty recruiting faculty or students; lack understanding of distance education and what works at a distance; lack of shared vision/mission; cross-cultural issues; slow pace of change; lack of teachers who can model effective use; information overload	89

[1] The cultural barriers are included in this table for the convenience of the reader. However, change to organizational culture is not an area that policy can be directly applied. Rather organizational culture is changed by changing such things as the structure, practices, communication systems and reward systems within the

- Lack of access (connectivity) for students or teachers/faculty members.
- High cost to the district or institution, or lack of the necessary infrastructure for delivering or receiving education at a distance.

For Further Research

One purpose of this study was to determine indicators to future research areas. Some of those discovered by this research are:

- Overall, the barriers listed by K12 online teachers and teacher educators are very similar to those described by online teachers in higher education (Berge, 1998). The weighting may be different, however. For instance, it seems that K-12 educators mention fiscal issues somewhat more than higher education.
- The barriers mentioned may change depending upon the level of the experience of the individual teacher has with teaching online.
- While different perceptions based on the experience level of an individual may not be surprising, it can also be hypothesized that barriers are perceived differently depending upon the level of experience with online teaching found within the institution or school. An instructor working in a district in which online teaching has never occurred may often perceive different barriers than that teacher she he/she be in a district that has a long history of delivering or receiving online courses (such as infrastructure issues).
- The subject area being taught may also affect the barriers experienced.
- This study involved online teachers and teacher educators using technology. Other types of participants, (i.e., important stakeholders such as school administrators; parents; students), exist and may have significantly different perceptions about the barriers to online teaching and learning within their institution.

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