CHAPTER 6

MEDIA CHARACTERISTICS AND ONLINE LEARNING TECHNOLOGY

Patrick J. Fahy
Athabasca University

Introduction

The decision to adopt online technology (defined here as predominantly Internet-based delivery, with provision for interaction throughout the process), even on a limited basis, is always complex and can be risky, especially if the adopting organization lacks structural, cultural, or financial prerequisites (Welsch, 2002). A discussion of some attributes of media and of the modes of teaching presentation and learning performance they support, in relation to some influential learning models, might help to clarify some of the implications in the choice of any specific delivery or presentation medium.

Other chapters in this volume address learning theories and styles (see Chapters 1 and 2). The analysis of media characteristics in this chapter draws directly upon Fleming's (1987) six-element typology of teaching tasks and objectives: 1) attention, 2) perception and recall, 3) organization and sequencing, 4) instruction and feedback, 5) learner participation, and 6) higher-order thinking and concept formation. The following media and modes are considered because they are common and familiar, and also because they constitute the tools most available to online teachers, trainers, and learners: 1) print and text, 2) still graphics and illustrations, 3) sound and music, 4) video and moving graphics, and 5) multimedia.

[1] Bloom did in fact deal with the issue of prerequisite knowledge in other work (1956, 1976), as did others (Carroll, 1963), but in his mastery learning model, this element received reduced emphasis, and does not constitute one of the "alterable variables" that emerged from mastery learning research.

Teaching Tasks and Learning Theories

Before applying Fleming's typology, it might be useful to determine how this conception of learning relates to some well-known pre-online learning models and standards. Figure 6-1 shows the correspondence of Fleming's categories to those of Bloom's alterable variables of learning (1984), Chickering and Gamson's (1989) seven principles of good practice, and Moore's needs of distance learners (in Garrison, 1989). The point to note is that most of the attention in the three pre-online learning models is focused on direct teaching and student involvement tasks, while pre-learning tasks, such as attention, perception, and recall, are not specifically addressed. The task of organization and sequencing (which assumes that instructional materials and activities may vary in response to individual needs and circumstances) is found only in two of the models[1].

Figure 6-1 suggests that older models of learning, which the above represent, may not address all of the elements necessary for efficient learning. Fleming's (1987) framework is more complete, addressing as it does the pre-learning elements of attention, perception, and recall. For designers and users of online learning, Fleming's model also draws attention to key learning activities which media might help to accommodate and monitor, as described in the following discussion.

Analysis of the Requirements of Teaching Tasks

This section contains a summary of conclusions about media in learning, drawn primarily from Fleming's (1987) work. The purpose of this review is to provide a basis for the observations contained in Figure 6-1, and those to be made later in the chapter regarding uses and limitations of multimedia.

Attention

Given the importance of attention in learning, it is surprising that the learning models displayed in Figure 6-1 do not mention it specifically. (To be fair, gaining the attention of the learner may simply be

Learning and best-practice models	Attention	Perception & recall	Organization & sequencing	Instruction & feedback	Learner participation	Higher-order thinking & concept formation
Bloom (1984)				Quality tutorials; reinforcement and feedback; cues and explanations	Learner participation; time on task	Reading and study skills improvement
Chickering & Gamson (1987)			Respond to learners' diversity	Feedback; contact with instructor	Cooperation among learners; active learning; time on task	High expectations communicated to learners
Moore (in Garrison, 1989)			Guidance; support	Understand-able teaching; feedback	Active involvement	

Figure 6-1. Learning and best-practice models, and learning tasks.

assumed to be an outcome of other activities, an element of quality learning materials, or an outcome of contact with the instructor or other learners, for example. The message of Figure 6-1 is more the importance of the task and the possible usefulness of media, than a critique of these models, which are used here because they have otherwise proven useful, even classic, in their scope and influence.)

A key learning principle, according to Fleming (1987), is that attention by the learner to appropriate instructional stimuli is fundamental to learning. To be effective, training must attract and hold the learner's attention. Instruction must also recognize that attention tends to be

- individual—the capacity to be attentive varies among individuals, and it varies for any individual at different times (e.g., fatigue or lack of background can cause attention to wander sooner than usual).
- selective—at any one time, a learner’s attention can be focused on only a small part of the learning content.
- fluid—as a teaching topic changes, the learner must know when and how to shift attention; however, some learners may become distracted, confused, or otherwise lose the main point during shifts in attention.
- especially attracted to novelty, to moderate levels of complexity, and to the contents of more focused, less complex displays.

Perception and Recall

Perception requires that the learner selectively focus on and make sense of stimulation in the environment, including the learner’s own internal states and responses (thoughts, feelings, and physiological states). In a sense, all education and training is intended to make learners capable of finer and more articulate perceptions and distinctions (Bourdieu, 1984). Recall involves the ability to remember and make use of relevant prior learning, as well as of the learning acquired in a given situation.

Perception and recall in teaching draw on principles such as those below (Fleming, 1987).

- Organization affects perception; that is, events, ideas, words, concepts, and other stimuli that are not organized in some meaningful way are more difficult to understand and remember than those that are.
- Perception and recall can be aided by comparison and contrast; similarity and grouping also assist recall.
- Presentations that focus on differences are distinguished better by learners, and their contents may be easier to recall.

Organization and Sequencing

Organization and sequencing are present in the learning models represented in Figure 6-1. In Chickering and Gamson's (1987) model, responding to diversity in learners' needs suggests the possibility of reorganizing and resequencing materials and activities. In regard to Moore's (in Garrison, 1989) model, providing guidance and support has direct implications for organization and sequence. (Bloom's [1984] "quality tutorials" could also extend to organization and sequence, depending upon the definition of "quality.")

For Fleming (1987), the organization and sequencing of materials is an important task in instructional planning. The general principles listed below particularly apply to media design.

- The first and last items in a sequence are especially important; introductions and summaries represent key learning opportunities.
- Modeling and demonstrations can result in learning. While learners eventually must become active in the process of acquiring skills and knowledge, students can also learn while watching. Active internal states produce intellectual engagement, just as psychomotor activity accompanies the learning of physical skills.
- Repetition and review increase learning up to a point. Repetition can be used to increase skill, automaticity, and speed; however, power (depth of understanding, breadth of proficiency) is usually not increased by repetition alone.

Instruction and Feedback

While learners require skilful instruction, they also require feedback to enable them to monitor their progress, to discover errors or misconceptions, and to recognize what they should do differently (or continue to do) to gain further proficiency. Not all feedback is equally useful, however, and not all learners require the same kind of feedback (Fleming, 1987). Principles applicable to media design and use include those listed below.

- The more mature the learner, the more informative the feedback should be.
- With mature learners, correct answers should simply be marked "correct." Mature learners tend to dislike excessively demonstrative praise (Grow, 1991).
- Feedback should be prompt, but it does not have to be immediate. Learners should know how much delay to expect in test results and marking.
- Exceptions to the above point occur when feedback on previous steps is needed before subsequent ones can be taken; when there is a safety concern (i.e., previous steps must be correct or later ones could result in a dangerous situation); or when the task is highly complex.
- Feedback can be reduced as the learner becomes more experienced and more proficient. Initially, feedback should be frequent for most learners, to ensure that they have a positive initial experience.

All of the models in Figure 6-1 recognize that quality instruction includes the presentation to the learner of appropriate explanations, with the option for additional feedback. Chickering and Gamson's (1987) reference to student-instructor "contact" implies this element in their model. Importantly for this discussion of media-based learning, none of the models assumes that contact or interaction need be face-to-face to be effective.

Learner Participation

Learning requires engagement with the subject matter, and engagement often implies some kind of performance. In the case of psychomotor skills, the activity is usually physical, with evaluation dependent on observable outcomes. Occasionally, however, an activity may be completely or largely mental, according to the following principles (Fleming, 1987; Mayer, 2001).

- Activities that encourage the formation in the learner of mental images increase learning. Activities that require the learner first to process and then to reproduce a version of the original information do more to encourage learning than do rote reproduction and imitation alone.
- Language use accompanying or providing context for newly learned concepts increases learning; for example, composing a verbal narrative while learning complex or abstract material assists in retention. This principle can even extend to psychomotor skills, which is the reasoning behind "visualization" exercises in sports.

The use of experience and practice in learning requires willing learner participation and the conscientious application of new skills and knowledge for proficiency to develop. Peter Garrison (2001) quotes Galison's observation that moving from declarative knowledge (knowing that something is true, or how something might theoretically be done), through procedural knowledge (knowing how an activity is performed), to craft knowledge (being able to perform a procedure or to use knowledge with expert proficiency) requires practice, feedback, and application. Craft knowledge, the distinction between the novice and the expert, is the objective of many kinds of academic learning, and all higher-level skill training.

As are the tasks of instruction and feedback, learner involvement is common to all three learning models under discussion here (Figure 6-1). Time on task is added to show that participation must be purposive and relevant. The noun "cooperation" and the adjective "active" in Chickering and Gamson's (1987) model add the notion that the learner's involvement should be more than passive observation of others' efforts or conclusions, a position with definite implications for media implementation.

Concept Formation and Higher-order Thinking

The learning of concepts or principles is often intended to be part of a process leading to engagement with other, related concepts. In formulations such as Gagne's (1970), below, the learning sequence is hierarchical, and as the learner moves up the sequence, more complex orders of reasoning are required:

1. *signal learning*—involuntary responses; for example, the startle response, or removing a hand from heat.
2. *stimulus-response learning*—voluntary, selective responses; for example, signaling in response to a specific cue, or imitating an action.
3. *motor-chain learning*—performing a sequence of actions in a certain order; for example, dancing, parallel parking, or replacing a light bulb.
4. *verbal association or verbal chaining*—reciting correct responses to cues; for example, singing the lyrics of a song, reciting the alphabet, or translating a word from one language to another.
5. *multiple discrimination*—responding differently to similar stimuli; for example, distinguishing individual but related members of a group, or giving an appropriate English equivalent for a foreign word.
6. *concept learning*—responding to new stimuli according to properties they share with previously encountered stimuli, or comparing properties of phenomena; for example, estimating the characteristics of similar objects based on knowledge about their composition (a large rock vs. a large pillow), identifying members of a group (saltwater vs. freshwater fish), and distinguishing examples and non-examples of a class or phenomenon (vegetables vs. non-vegetables).
7. *principle learning*—putting two or more concepts together in a relationship (without necessarily being able to explain the underlying rule governing the relationship); for example, applying

physical laws ("matter expands when heated") or mathematical theorems.

8. *problem-solving*—recalling previously learned principles and using them in combination to achieve a goal; for example, selecting and combining facts in an essay to persuade, analyzing a problem to determine its cause, or solving a complex problem by selecting and applying previously learned facts and principles.

Higher-order thinking skills (HOTS) are a challenge in technology-based learning. A persistent criticism of computer-assisted learning (CAL) and case-based learning using intelligent agents and artificial intelligence algorithms has been their failure to move beyond the mere identification and use of facts, to creative and synergistic linking of concepts (Bridges, 1992; Ihde, 1993; Cooper, 1993; Newby, Stepich, Lehman, & Russell, 2000).

In Figure 6-1, HOTS are present by implication in two of the models, in references to improved reading and study skills (Bloom, 1984), and in the objective of communicating high expectations to learners (Moore, in Garrison, 1989). However, the lack of specific reference to concept formation or higher-order thinking in these models, and the other apparent gaps in the resulting table, may be less a lapse than a reminder in this discussion that *somehow* these tasks must be addressed in media-based learning. The developers of the pre-online models represented in Figure 6-1 undoubtedly accept that higher-order outcomes are preferred. The challenge to media developers is to make this objective specific and achievable, as discussed below.

Implications

The implications of the above observations for the design and use of technology in general teaching include the following (Fleming, 1987).

Attention

- Change and variety can help to create and sustain attention.
- Skill in interpreting cues embedded in materials, and in shifting

focus appropriately within the instructional environment, should be taught.

- In graphics, captions increase learning by focusing attention on appropriate elements of illustrations.
- Learner expectations can be increased and attention focused by instructional design, including pre-reading questions and cognitive organizers, embedded cues and questions, skimming and scanning exercises, advance instructions, knowledge of objectives of an activity, pre-testing, and summaries.
- Mental sets are associated with some learning media or activities. For example, TV can be associated with trivial content or passivity, and the Internet with nonlinearity, or a "surfing" mentality. The learner's attention may be distracted if mental sets differ from the intention of the instruction.
- Mental sets may, on the other hand, assist learning: the expectation that a CAL program will contain useful information, or that a simulation will be intense and realistic, can be an advantage.
- Moderate uncertainty about what will happen in instruction, or about the eventual outcome of a presentation, may increase and help maintain attention.

Merrill's (1996) caution about the use of attention-getting strategies, especially on the computer, continues to be relevant. He notes that screen motion and animated movement are very powerful in attracting attention. The program should be careful about asking a user to do more than one thing at a time, such as requiring reading during an animated display (p. 112). Audio, however, might be used effectively with animation, since listening should not distract from watching the graphic display (Mayer, 2001).

Perception and recall

- Captions aid recall.
- To make distinctions easier to perceive, displays should especially highlight differences (ideally moving from more obvious differences to finer ones).

- Vision and hearing comprise perception. Vision is most acute in the center of the spectrum of visible light (yellow and yellow-green are the most visible colors, especially in dim light); and hearing is most acute in the center of the range of audible sound.
- Similarity, predictability, and routine aid the process of perception. The use of familiar designs and displays with new material permits learners to use previously learned perceptual skills when focusing on salient elements of new material.

Organization and sequencing

- In organizing and structuring opportunities for learning and practice, the designer or teacher should consider, and where possible accommodate, individual differences. If the information or skill is new to the individual learner, they will usually need more time to acquire it and to bring it to proficiency and automaticity. Novice performance is typically slow, self-conscious, and awkward; with proficiency, execution becomes more fluid, automatic, and natural ("craft knowledge"; Garrison, 2001).
- Practice is effective in facilitating long-term memory; if long-term retention is desired, practice should be spaced rather than massed. "Cramming" does not promote long-term retention.
- Repetition with variety (paraphrasing, rephrasing, and other forms of learner processing of information) is more effective for long-term retention than rote reproduction. Regurgitation of information is less likely to produce learning than reworking and rephrasing it.

Feedback

- With fully mature learners, all incorrect responses should be accompanied by some explanatory feedback, not simply a "wrong" mark.
- For mature learners, correct responses should not be indicated by sound effects or other displays; a simple "OK" is sufficient.
- If feedback is to be delayed (for any reason, deliberate or otherwise), trainees should be told how long the delay will be.

Learner participation

- Participation in learning may take many forms, limited chiefly by the creativity of the participants, the resources, and the technologies available. Possible examples include questions, activities, seminars, learning teams, small-group discussions, case studies, team learning, peer and cohort groups, written assignments, tests, field trips, labs, oral presentations of written reports, debates, expert panels, etc. (Cannell, 1999).

Higher-order thinking and concept formation

- In any discipline, the solving of authentic problems is the best test of a learner's mastery of facts, data sources, reasoning processes, and fundamental principles.
- In Bloom's terms, concept formation occurs at the higher levels of the taxonomy, specifically in activities that call for analysis, synthesis, and evaluation.
- Non-examples are helpful in enabling learners to develop concepts. They illustrate the differences between a concept and others that are similar. Similarly, non-examples can help learners to distinguish and clarify examples. When using examples and non-examples, the contrast between them should initially be large, and should be made progressively smaller as the learner demonstrates the ability to discriminate.
- Concrete concepts are generally easier to grasp than abstract ones, and thus may be useful in illustrating abstractions. It is easier to learn abstract (or concrete) concepts when constructs such as examples, models, analogies, descriptions, synonyms, and definitions are used.

Constructivism and Media

The use of media for teaching assumes that learning, as both an individual and a social activity (Haughey & Anderson, 1998), may be facilitated by intentional interaction. *Constructivism* is a general term for the view that the world is often too complex for general principles to be useful in teaching, and that the best learning results when the learner processes and integrates new experiences into his or her existing constructs (Coleman, Perry, & Schwen, 1997).

Constructivist teaching tends to be more holistic, more collaborative in method, and more encouraging and accepting of learner initiatives, including greater freedom and variety in assignments and assessments (Henriques, 1997). The role of the instructor also changes in constructivist teaching from "sage on the stage" to "guide on the side," or coach (Burge & Roberts, 1993; French, Hale, Johnson, & Farr, 1999). Constructivism is discussed further in Chapter 1 of this volume.

In relation to Figure 6-1, constructivist teaching addresses the teaching tasks shown by emphasizing the learners' unique background and consequent preparedness. Constructivist learning outcomes strive to apply real-world standards, and to assure that learning outcomes are applicable beyond a merely academic context. "Higher-order" constructivist outcomes have the potential to be relevant in daily life to real problems or situations.

The uses of technology may vary, too, in different constructivist environments. *Social* and *radical* constructivists view interaction as of greater importance to learning than mere access to information, while *information processing* and *interactive* constructivists view information, facts, and contact with a wide circle of informed people as critical to the student's development of a fully adequate construction of the world (Henriques, 1997).

In common, constructivists tend to use technologies for purposes such as those identified by Jonassen (1998):

- acquainting and involving students with real-world problems and situations.
- modeling the analytic and thinking skills of the instructor and other experts, which learners then apply, with appropriate feedback, to their own problems and constructs.
- working within an authentic problem context that reflects as much as possible the problem's real context and characteristics.

Overall, the contribution online media often make to constructivist teaching is in expanding the range and variety of experiences usually available in classroom-based learning. Because online media are by definition linked to networks of external resources, they can provide access to people, ideas, and information beyond those found in the classroom. Whether the result is a nearly self-sufficient *collaborative learning environment* (Jonassen, 1998), or, more simply, a forum for problem-based learning (Bridges, 1992), the result is an opening-up of the learning space to a wider variety of ideas and points of view.

Media, Modes, and Learning

Background Concepts

Technologies, as *channels* through which *modes* (symbols acting as stimuli) pass, differ in the responses they evoke in users. For example, text is a mode of presentation. Print-on-paper is one possible *medium* (channel) for text, but there are others: a computer monitor, an overhead projection, a television screen, film (moving or still), etc. Wherever it is used, text remains text, and must be read to be comprehended.

Despite their different characteristics, useful online training technologies have in common the effect of somehow bringing students into contact with their tutors, the content, and their peers (Moore, 1989). In this way, media may help to reduce "transactional distance" in learning—the communication gap or psychological distance between participants which may open in a teaching-learning situation (Chen & Willits, 1998). Although similar in producing these outcomes, the differences in how various technologies accomplish their effects are important to their potential usefulness.

Human and Technology-based Teaching

Technologies differ from one another, and instruction delivered online differs from human-delivered teaching. Consider, in the analysis below (Figure 6-2), the effects of media-based training compared with training done by stand-up, face-to-face instructors (Fischer, 1997).

A conclusion following from Figure 6-2 is that, as in most instructional design decisions, there are trade-offs related to the needs of the users and the resources available. An analysis such as that presented above may assist in identifying the trade-offs involved in the choice of one online technology over another approach.

Training element	Human trainer	Technology-based training
Planning and preparation	Can design training to correspond to the training plan, then assure subsequent consistency with the plan	Must be systematically designed to conform to the training plan
Expertise	Presenters hired from industry represent the most current knowledge and highest expertise	May depart from industry standards if subject-matter experts are not carefully selected, or if materials are not kept current
Interactivity	Tend to train the group, ignore individual needs	Can focus on individual needs for content, pacing, review, remediation, etc.
Learning retention	Retention rates vary	Can be up to 50% higher than for instructor-led group training
Consistency	Tend to adapt to the audience, lose consistency	Rigorously maintains the standards set for it, but may also adapt to learner's performance or preferences, if designed to do so
Feedback, performance tracking	Humans are especially good at ongoing evaluation, and response to trainee performance	Better at keeping records and generating reports of outcomes; designing systems to adapt instruction based on feedback (a cybernetic system) is costly, complex

Figure 6-2. Comparison of human and technology-based instruction.

Elements: Fischer, 1997, pp. 29-30.

Interestingly, it appears from Figure 6-2 that human trainers are superior in exactly those activities shown to be overlooked in Figure 6-1: planning and preparation, and feedback and performance tracking (in relation to higher-order outcomes). Human trainers can deftly detect and respond to unexpected needs, if disposed and permitted to do so, while technology-based training programs must be specially designed to assess and respond to unanticipated outcomes. Fleming's (1987) framework again appears to be superior for analysis of media's design needs.

Media Characteristics and Impacts on Learning

Five types of media, from print to multimedia (defined as "the integration of video, audio, graphics, and data within a single computer workstation"; Bates, Harrington, Gilmore, & van Soest, 1992, p. 6, cited in Oliver, 1994, p. 169), are discussed below. The intention is to make distinctions among media in relation to modes of delivery and presentation commonly used in teaching and training. The argument here is that, as technologies continue to evolve, it will be increasingly possible, technically, to use ever more complex media, including multimedia as defined above, to deliver instruction. Criteria will be needed, therefore, for making wise choices among the options, and for designing and supporting instruction based not only on the capabilities of the technology to deliver it, but also on the ability of learners to make effective use of the tools.

Print and Text

There is no medium more ubiquitous than print, and no mode more familiar than text in its many forms. Print was part of the first teaching machine—the book—and books were the first mass-produced commodity (McLuhan, 1964, p. 174). Print has been the dominant medium to date in distance education (Scriven, 1993, p. 73), and distance students have traditionally spent most of their time studying alone, often using print materials only (Bates, 1995, p. 52). The question is whether this situation is likely to continue. The answer requires consideration of the strengths and weaknesses of text and print. The chief strengths of print and text have traditionally included

- cost—Bates (1995, p. 4) reports that print is one of the lowest cost one-way technologies.
- flexibility and robustness—print scores highest on these features (Koumi, 1994).
- portability and ease of production—with desktop publishing hardware and software, printing has become enormously simpler and its quality much higher (Bates, 1988). In addition, costs can be reduced with local production.
- stability (Kozma, 1991)—organization and sequencing are positively affected, since text-only printed and online materials can be reorganized and resequenced with relative ease by cut-and-paste operations, using word-processors and HTML editors.
- convenience, familiarity, and economy—instruction and feedback are facilitated by the medium's familiarity, as, for adept learners and the highly literate, are higher-order thinking and concept formation (Pittman, 1987).

Ironically, the major disadvantages of print are related to some of its advantages, and include those listed below (Newby et al., 2000).

- Print is static, and may fail to gain adequate involvement from low-functioning readers. Attention, perception and recall, and active learner participation may thus be lower for less able learners.
- Print is relatively non-interactive, or at least non-responsive, and may lead to passive, rote learning.
- Print often requires substantial literacy levels.

Print is accessible (to the literate), and comparatively low in cost; furthermore, online text is easy to produce, translates well across various platforms and operating systems, and in some of its forms, may be manipulated by the user if desired. However, print may be seen by some as the "slightly seedy poor relation" (Pittman, 1987) of other instructional media. Text's lack of appeal is exacerbated by the alternatives to reading which are increasingly appearing, and which use multimedia (especially audio and graphics) and improvements in voice recognition and reproduction technologies to make reading less critical for users. As a result, non-print multimedia-based technologies could come to be regarded as cost-effective, especially in cultures or industries where high levels of literacy cannot be assumed, or where the costs of reading inefficiencies are high. Developments such as instant text messaging and e-paper could reverse this trend, giving print and print-based materials new life, at least until e-paper-based multimedia evolve to make text less important once more (Mann, 2001).

Still Graphics and Static Displays

A wide and growing selection of graphic technologies is available to online programmers, from older technologies, such as overhead projectors and 35mm slide projectors, broadcast TV, and pre-produced videotapes, to various forms of digital video (interactive and non-interactive), computer-generated video, and interpersonal communications tools such as group and desktop video-conferencing using Voice over Internet Protocol (VoIP).

Graphics can increase the motivation of users to attend, prompt perception, and aid recall, and assist in the development of higher-order thinking and concept formation. Furthermore, still graphics combine high information content (they can illustrate abstract or unfamiliar concepts) with relatively low production and distribution costs. Online compression formats, such as .jpg, permit low-bandwidth distribution of high quality graphics.

Screen resolution can be an issue in the use of graphics. The size at which a graphic is captured is key: capture at a high resolution and display at a lower resolution will result in a much larger image, which, depending upon the monitor's settings, may not be completely visible on the viewer's screen; conversely, an image captured at a lower resolution than that at which it is displayed will appear smaller. The end-users' likely technology platform should be the standard, to ensure that graphics will be viewed as intended. Online users should always be advised about which settings are optimal.

Online static visual displays which draw upon established design principles, including those listed below (Dwyer, in Szabo, 1998, p. 20), are more likely to be successful.

- Visuals that emphasize the critical details relevant to learning are most effective. Unnecessary visuals may be distracting, especially to learners with limited attention spans or discrimination skills.
- The addition of detail and realism to displays does not increase learning. Unnecessary detail can add to learning time without increasing achievement, and in online situations can increase transfer times dramatically. Depending on the relevance of the cues to the learning task, simple line drawings tend to be superior to photographs or more realistic drawings.
- Winn (in Szabo, 1998, p. 21) cautions that diagrams, charts, and graphs should not be assumed to be self-explanatory, but may require the learner to process the information given and to understand certain conventions. He suggests that graphics should routinely include supporting captions.

With the exception of instruction that directly employs color for teaching (e.g., identifying color-coded elements), there is little evidence that color enhances learning. Color may even distract some learners (Dwyer, 1970, in Szabo, 1998, p. 27). Some other generalizations about color are given below (Dwyer, 1970, in Szabo, 1998, pp. 27-28).

- Color may increase the speed at which lists can be searched.
- The use of too many colors may reduce the legibility of a presentation. A maximum of four colors was suggested in one study, but up to eleven colors in screen displays were found to be acceptable in another.
- The most highly recommended colors are vivid versions of green, cyan, white, and yellow.
- The heavy use of color may degrade performance of some older microcomputers and monitors, or may be displayed differently on various systems.

Based on his review of the data, Szabo (1998) concluded that “The disparity between effectiveness and perceived effectiveness is nowhere as great as it is in the realm of color” (p. 27).

Some further advice on the use of color in media production is presented below (Rockley, 1997).

- End-users should control the color of displays, given the prevalence of color-blindness (found to some degree in 8% of men and 0.5% of women).
- The best color display combinations are blue, black, or red on a white background, or white, yellow, or green on a black background.

For online uses of still graphics, the following characteristics of the computer as a delivery medium must be accommodated by developers (Rockley, 1997).

- A PC screen is about 1/3 of a piece of paper in display area, and most monitors are less sharp than the best laser printers or photographic reproductions. Screen positioning is critical: important information should go to the top-left; the lower-left is the least noticed area of the page/screen. What works on paper may not work, without translation or redesign, on a computer screen. (Designers should not assume users have superior equipment; design should be for displays of mid-range quality and size.)
- Single-color backgrounds, with a high contrast ratio between the background and the text, are easiest for readers; white or off-white is best for the background.
- Textured backgrounds display differently on various systems, and should be used with care, if at all.
- Sans serif fonts, with mixed upper and lower case, are best for legibility and reading ease.
- The size of the font depends on the purpose. For extended reading, smaller (12-point) fonts are suitable; for presenting information that will be skimmed or scanned, larger fonts may be more appropriate.
- Font changes can be effective for emphasis (size and type), as can capitals, underlining, and especially the use of bolding. The use of color alone should be avoided for emphasis, as systems handle color differently. All of the above techniques should be used sparingly, to preserve their impact.

Sound and Music

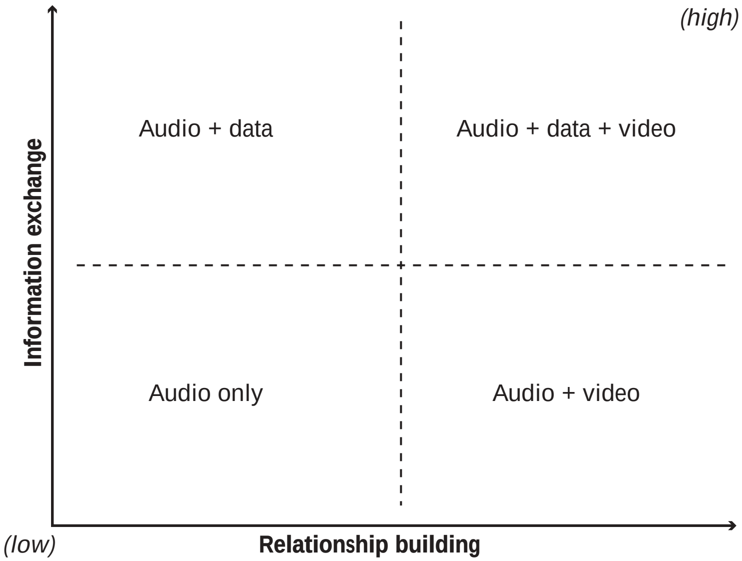
The principal issues in online audio are technical (storage and bandwidth) and pedagogical. For maximum effect, materials must not simply be a recorded version of another medium (e.g., a lecture), but should be rescripted to incorporate and interrelate with other modes of presentation (Koumi, 1994).

Online audio (including, when file sizes are large, distribution by CD and DVD) can be particularly useful in teaching for several technical reasons, presented below.

- An audio summary of previous material can aid recall, help retention, and lead to concept formation and higher-order thinking.
- Although CDs and DVDs are one-way technologies (non-interactive, like a lecture), they have the great advantage of learner control.
- CDs and DVDs are easy and cheap to produce and ship, and so reduce cost and improve accessibility.
- The technology of discs is easy to use and familiar. Operating systems (Windows, Apple OS, and Linux) now usually offer built-in sound reproduction technologies for both streamed and static sound files.
- The mode of presentation most often found on this medium, the human voice, is a familiar and powerful teaching tool.
- Audio may be more motivating than print alone, and together with print may form a powerful alternative and aid to reading alone (Newby et al., 2000).

A key issue in selecting a mix of other technologies to be used with audioconferencing is the relative importance of *relationship building* vs. *information exchange*. Picard (1999) sees audioconferencing's key contribution in its ability to promote relationship building in work or learning. The need for other technologies, according to Picard, is dependent upon the degree to which there is also a need to exchange information (for which, she warns, audio is not particularly effective). The schema presented in Figure 6-3 emerges from Picard's analysis.

Figure 6-3. Association of audioconferencing, data, and video with information exchange and relationship building objectives.



In Picard's (1999) analysis, when relationship building and information exchange needs are both low, audioconferencing alone may suffice. When both needs are high, however, audioconferencing, video, and data (including text) should all be present. Relationship building can be enhanced by combining audioconferencing and video together with data, especially text. (Text has formidable relationship building capabilities, as anyone who has ever had a pen-pal knows, but it assumes considerable skill on the user's part.) Video increases the likelihood that interaction will promote relationships, but audio alone is less capable of promoting this outcome. Data exchange alone seems to do little to promote relationships among those with access to other forms of interaction.

As technological evolutions permit more audio-based delivery, both interactive (e.g., VoIP) and one-way (streaming audio clips), research findings about audio's teaching capabilities become applicable (Szabo, 1997, 1998).

- Learning gains from one-way audio alone are at best weak.
- Learners possessing higher verbal skills usually do not benefit from audio added to text.

- There are few or no apparent significant immediate recall effects between text-only and text plus audio presentation, except that sometimes audio may lengthen the time required to complete instruction (see also Mayer, 2001).
- Audio may limit the ability of learners to proceed through material at their own individual rate.
- The quality and utility of digitized speech depends upon the amount of compression, the sampling rate, and the bandwidth available to the user.
- Users may relatively quickly become accustomed to synthetic speech; however, more cognitive effort is needed, and increased demands on short-term memory may reduce retention. (Synthesized speech may be more useful in reading back a learner's work, for example from a word processor, than in presenting unfamiliar learning content.)
- For general audiences, the possible benefits of audio must be weighed against the increased costs. Exceptions include uses such as language training, music instruction, and as an aid to the visually impaired.
- Where possible, the learner should be able to decide whether or not to use available audio.

The key limitation to the use of synchronous (live) audio on the Internet continues to be bandwidth, but impressive advances in VoIP audio programs are reducing the limitations. Some VoIP packages permit only point-to-point voice communications between two computers, while others permit point-to-multipoint group interaction, much like a teleconference, and require as little bandwidth as 56 Kbps. This online technology is expanding rapidly in business: in 2001, the proportion of companies of 100 employees or more using VoIP for business communications rose from 7% to 26% (Net Talk, 2001).

Video and Animation

Video suffers from the same kinds of limitations as audio, but to an even greater degree; bandwidth is the primary limitation to greater video use online. According to Roberts (1998), video

- adds a sense of direct involvement and physical presence among geographically dispersed learners.
- provides quality learning opportunities (as good as or better than those offered by other methods and technologies).
- gives distant sites live, interactive learning opportunities.
- enables the delivery of global expertise to remote learners.
- eliminates or reduces travel time and time away from jobs and family.

The following strengths of video for learning and teaching can be exploited, with appropriate instructional strategies.

- The social presence and cohesion that video fosters among users is often valued, especially by participants new to distance education, and may improve motivation.
- The technology permits the sharing of various visual resources.
- Group-based learning activities may be more attractive and feasible with video technology support.
- Well-designed and appropriately implemented uses of video can help in the teaching of abstract, time-protracted, hazardous, or unfamiliar concepts.

The advantages in actual practice of various forms of video continue to be debated. In some studies, animation has been shown to result in a reduction in study time, "suggesting that animation results in more efficient learning" (Szabo, 1998, p. 30), with learning effects persisting over time (Mayton, in Szabo, 1998, p. 30). There is, however, also some indication that, when compared with "highly imaginative examples and illustrations," the advantages of animated simulations were less obvious (Rieber & Boyce, in Szabo, 1998, p. 30). Szabo concluded from his analysis that "any widespread belief in the superiority of animation over non-animated instruction within the context of computer-based instruction is at odds with the research" (1998, p. 31).

According to Roberts (1998), critical issues in the delivery of video-based training include those listed below.

1. Proper training of instructors.
2. User self-consciousness.
3. Integration of other media into video presentations.
4. Optimum length of sessions and size of groups.
5. Session variety.
6. Technical design and support.
7. Professional quality visual elements. (p. 96)

Obviously, video delivery is complex, potentially costly, and of uncertain benefit for some teaching tasks over simpler, more economical media. A clear pedagogic and business case is obviously needed for its use.

Multimedia

As Oliver (1994, p. 169) notes, the term *multimedia* has not always designated computer-based media, as it does now, but originally referred to combinations of audio, visual, and print materials delivered by various media. Now, however, "the term has been adopted by the computer industry and re-defined to mean 'the integration of video, audio, graphics, and data within a single computer workstation' (Bates, Harrington, Gilmore & van Soest, 1992, p. 6)" (Oliver, 1994). Roblyer and Schwier (2003, p. 157) note that the term has become "too slippery" to define easily, that consensus about its characteristics is rare, and that as a concept it is converging with others, including hypermedia.

While multimedia applications offer advantages and benefits, these do not come without costs, awareness of which may help users to make informed decisions about the true advantages of the medium (Grabe & Grabe, 1996, 243-247). The key concerns include unnecessary duplication of existing instructional materials; teachers untrained in design becoming bogged down in the production of low-quality multimedia; problems of assessment using multimedia materials, which occur because learners using hyperlinks in multimedia do not always cover the same material in the same sequence; and high technical demands, with technical difficulties arising because of the complexity of some multimedia applications.

Obstacles to the widespread use of multimedia are myriad, and arise in part from the fact that multimedia applications, even if instituted carefully and with the intention of altering the learners' experiences, are an example of change and innovation, and so may provoke resistance, including such obstacles as (Helm & McClements, 1996):

- reluctance on the part of teachers to see materials transformed.
- the fear felt by users (staff and learners) over the level of technical knowledge required to get involved.
- the need of many tutors for special training (which may or may not be conveniently available) to use multimedia effectively.
- the significant challenge and expense of "adapting and transforming material intended for traditional delivery methods into new media" (p. 135).
- the desire to tinker endlessly and mindlessly on presentations, with negative results for productivity (Fahy, 1998). This effect, called "the futz factor" (Fernandez, 1997), has been estimated to cost US $5600 yearly for every corporate computer (Dalal, 2001). Futzing may be a "revenge effect" of technology, an unexpected and troubling result of the interaction of computer technology with the "real world" (Tenner, 1996).

Despite these potential limitations and weaknesses, multimedia also has potential strengths when used appropriately. Newby et al. (2000, p. 108) list the following advantages of multimedia for instruction:

- multiple, active learning modalities.
- accommodation of different learning styles and preferences, including disabilities.
- effective instruction across learning domains, including affective and psychomotor (with simulations, case studies, and other representational and interactive uses), promoting development of higher-order thinking skills, and concept formation.

- realism, especially when coupled with graphics and video.
- potential interactivity.
- individualization, with use of computer branching capabilities and CML (computer-managed learning).
- consistent experiences, compared with group-based face-to-face instruction.
- potential for high levels of learner control.

The impact of multimedia in teaching is ultimately dependent upon the incorporation of certain principles that govern its usefulness and effects. Mayer (2001) has suggested seven such principles, based on empirical evidence from his ongoing research on multimedia and actual learning. These principles not only describe the various impacts of multimedia on learning, they also constitute a good basic primer for instructional designers working with media generally.

1. *Multimedia principle:* Students learn better from words and graphics or pictures than from words alone (p. 68).
2. *Spatial contiguity principle:* Students learn better when corresponding words and pictures are presented near rather than far from each other on the page or screen.
3. *Temporal contiguity principle:* Students learn better when corresponding words and pictures are presented simultaneously rather than successively.
4. *Coherence principle:* Students learn better when extraneous words, pictures, and sounds are excluded rather than included (p. 117).
5. *Modality principle:* Students learn better from animation and audible narration than from animation and on-screen text (p. 135).
6. *Redundancy principle:* People have only limited capacity to process visual and auditory material presented simultaneously (p. 152); therefore, students learn better from animation and narration than from a combination of animation, generation, and onscreen text (p. 153).

7. *Individual differences principle:* Design effects are stronger for low-knowledge learners than for high-knowledge learners, and for high-spatial-ability learners than for low-spatial-ability learners (p. 184). (*Spatial ability* is the ability mentally to generate, maintain, and manipulate visual images, see p. 172.)

The Internet

As noted at the outset of this chapter, "online learning" almost always denotes learning "on the Internet." The Internet offers both advantages and challenges to educators and trainers. The advantages arise from the Internet's enormous capacity to link participants with information and with each other (Haughey & Anderson, 1998). But problems with navigation, structure, interactivity, complexity, security, and sheer consumption of time must be addressed.

The Internet is potentially a powerful linking and communication vehicle. Heinich, Molenda, Russell, and Smaldino (1996, p. 263) suggest that the Internet's power lies in its capacity for providing numerous connections to engrossing, multi-sensory experiences, suited to individual needs. The fact that these can be constructed by teachers themselves, and can incorporate knowledge of their students' needs and feature meaningful student-student collaboration and student-teacher interaction, also makes the Internet a revolutionary learning tool. At the same time, the Web's inherent lack of structure may result in some users getting unintentionally "lost in cyberspace," or making poor use of time ("surfing," or exploring interesting but irrelevant minutiae). Also, Internet materials often fail to exploit the medium's potential for interactivity, consisting of one-way presentations of information. The reliability of online information may also be suspect, unless its provenance is known. And successful use of the Internet currently demands proficient literacy and computer skills. (As noted earlier, this may change as bandwidth availability makes supplemental audio and video more available.)

In relation to Figure 6-1, the Internet offers a means for gaining the attention of learners, and of presenting opportunities for focusing perceptions and prompting recall. Learner participation can also be supported, especially with CMC and use of collaborative learning projects. Providing instruction, and assuring appropriate organization, sequencing, and higher-order outcomes are less easily accomplished with the Internet, for reasons discussed here.

Limitations such as those mentioned above may account for some of the increasing class of former users called "Internet dropouts." Of those who have stopped using the Internet, only 28% expect to return, having concluded that they have "no need" for the Web. While other reasons include cost (cited by 17% of dropouts) and lack of convenient access to a computer (14%), the fact that lack of utility is the most common reason indicates a serious potential problem for future Internet growth: unless a tool has a perceived legitimate purpose, it may not prosper, or even survive (Crompton, Ellison, & Stevenson, 2002).

Two related Internet-based media show particular instructional promise for those with the skill and discipline to use them well, especially in relation to organization and sequencing challenges presented by the Internet: *hypermedia* and *hypertext.* Hypermedia is the linking of multimedia documents, while hypertext is the linking of words or phrases to other words or phrases in the same or another document. Internet delivery may be hyperlinked or linear. As a technology, hypermedia has existed for decades, but with advances in hardware, software, and human-computer interfaces, it is now technically feasible to incorporate hypermedia systems routinely in teaching, and dozens of hypertext and hypermedia development systems now exist.

While hypermedia permit huge amounts of information from a variety of media to be stored in a compact and easily accessible form, the sheer amount of available information may also overwhelm learners, especially if they are unable to refine a search or conduct an exploration successfully (with focus). Users require skills (some technical, others related to organization and self-discipline) to make efficient use of hypermedia materials (Marchionini, 1988, p. 3*ff*.). Although the results of hypertext use in teaching have previously been somewhat mixed (Szabo, 1998, pp. 36-38), the promise is in the potential to offer self-directed learners the option to control the details of their own learning to a much greater extent than is possible in group instruction. With emerging online communications capabilities, the ability for teachers to oversee and monitor this kind of learning also increases. The problem, as in many of these new implementations, is to overcome the users' tendency only to "focus on facilitating access to information," and not on actual learning outcomes (Szabo, 1998, p. 52). This is an important distinction, and one that could be applied to any of the media discussed here.

Conclusion

Online learning is still in its early infancy. There are many outstanding, and, in some cases, vexing issues: costs are declining, but still limit widespread access; many users (teachers, trainers and learners) feel they do not have all the skills they need to make mature use of online learning's potential; administrators and policy-makers often overstate the likely impacts of going online (Nikiforuk, 1997); and the relation of learning outcomes to technology use, for specific populations and in particular circumstances, has not been clearly identified, and is not well understood (Garrison, 2000).

Although these realities prove that there must be evolution before online learning can be seen as mature, at the same time there are promising signs. Access to the Internet is improving, especially for some previously disenfranchised groups; for example, women as a group now exceed men in numbers of Internet users (Pastore, 2001). Some consensus about good practice is emerging, including examples of clearly successful uses of technology to meet persistent learning needs. Finally, in-service training is increasingly available to potential users.

Will these trends continue? Change has been a constant in the online learning world, and as technical capabilities come out of the lab, they are quickly packaged and made available to users by entrepreneurs. Education could keep pace, and could avoid the costs and uncertainties of invention, by merely following the technological lead of the corporate sector.

Whether online learning follows this path or not, it has a good chance to grow because online access to information—wired or wireless, structured or user-driven—and interaction using various computer-based technologies are established social and economic realities (Mehlinger, 1996; Machrone, 2001; Networking, 2002; Rupley, 2002). Whether one deplores or applauds this reality, it is nevertheless a fact that as a culture we now go online for many purposes. Consequently, every educator—and especially every distance educator and trainer—should consider the potential of online media as an element of their practice.

References

Bates, A. W. (1988). Technology for distance education: A 10-year prospective. *Open Learning, 3*(3), 3-12.

Bates, A. W. (1995). *Technology, open learning and distance education.* New York: Routledge.

Bates, A. W., Harrington, R., Gilmore, D., & van Soest, C. (1992). *Compressed video and video-conferencing in open and distance learning: A guide to current developments.* Unpublished manuscript, The Open Learning Agency, Burnaby, BC.

Bloom, B. S. (1976). *Human characteristics and school learning.* Toronto: McGraw-Hill.

Bloom, B. S. (1984, June-July). The 2-sigma problem: The search for methods of group instruction as effective as one-to-one tutoring. *Educational Researcher,* 4-16.

Bloom, B. S., Engelhart, M. D., Furst, E. J., Hill, W. H., & Krathwohl, D. R. (Eds.). (1956). *Taxonomy of educational objectives: The classification of educational goals. Handbook 1: Cognitive domain.* New York: David McKay.

Bourdieu, P. (1984). *Distinction: A social critique of the judgment of taste.* Cambridge: Harvard University Press.

Bridges, E. M. (1992). Problem-based learning: Background and rationale. In E. M. Bridges, *Problem-based learning for administrators.* ERIC Documents: ED347617.

Burge E. J., & Roberts, J. M. (1993). *Classrooms with a difference: A practical guide to the use of conferencing technologies.* Toronto: University of Toronto, OISE Distance Learning Office.

Cannell, L. (1999). *Review of [distance education] literature.* Unpublished paper. Distance education association of theological schools, Winnipeg, MB.

Carroll, J. B. (1963). A model of school learning. *Teachers College Record*, *64*, 723-733.

Chen, Y., & Willits, F. (1998). A path analysis of the concepts in Moore's theory of transactional distance in a videoconferencing environment. *Journal of Distance Education, 13*(2), 51-65.

Chickering, A., & Gamson, Z. (1989, March). Seven principles for good practice in undergraduate education. AAHE Bulletin, 3-7.

Coleman, S., Perry, J., & Schwen, T. (1997). Constructivist instructional development: Reflecting on practice from an alternative paradigm. In A. J. Romiszowski (Ed.), *Instructional development paradigms* (pp. 269-282). Englewood Cliffs, NJ: Educational Technology Publications.

Cooper, P. (1993). Paradigm shifts in designed instruction: From behaviorism to cognitivism to constructivism. *Educational Technology, 23*(5)12-19.

Crompton, S., Ellison, J., & Stevenson, K. *Better things to do or dealt out of the game? Internet dropouts and infrequent users.* Retrieved January 27, 2004, from the Statistics Canada Web site, http://www.statcan.ca/english/indepth/11-008/feature/star 2002065000s2a01.pdf

Dalal, S. (2001, October 26). Futzers draining production budgets. *The Edmonton Journal*, pp. F-1, 8.

Fahy, P. J. (1998). Reflections on the *productivity paradox* and distance education technology. *Journal of Distance Education, 13*(2), 66-73.

Fernandez, B. (1997, October 4). Productivity improvements not computing. *Edmonton Journal*, p. J16.

Fischer, B. (1997, Jan.-Feb.). Instructor-led vs. interactive: Not an either/or proposition. *Corporate University Review, 5*(1), pp. 29-30.

Fleming, M. (1987). Displays and communication. In R. M. Gagne (Ed.), *Instructional technology foundations* (pp. 233-260). Hillsdale, NJ: Erlbaum.

French, D., Hale, C., Johnson, C., & Farr, G. (Eds.). (1999). *Internet-based learning.* London: Kogan Page.

Gagne, R. M. (1970). *The conditions of learning* (2d ed.). New York: Holt, Rinehart and Winston.

Garrison, D. R. (1989). *Understanding distance education: A framework for the future.* New York: Routledge.

Garrison, D. R. (2000). Theoretical challenges for distance education in the twenty-first century: A shift from structural to transactional issues. *International Review of Research in Open and Distance Learning, 1*(1). Retrieved July 14, 2003, from http://www.irrodl.org/content/v1.1/randy.html

Garrison, P. (2001). Analyzing the analysts. *Flying, 128*(3), 95-97.

Grabe, C., & Grabe, M. (1996). Integrating technology for meaningful learning. Toronto: Houghton Mifflin.

Grow, G. (1991, Spring). Teaching learners to be self-directed. *Adult Education Quarterly, 41*(3), 125-149.

Haughey, M., & Anderson, T. (1998). *Networked learning: The pedagogy of the Internet.* Montreal: Chenelière/McGraw-Hill.

Heinich, R., Molenda, M., Russell, J. D., & Smaldino, S. E. (1996). *Instructional media and technologies for learning* (5th ed.). Englewood Cliffs, NJ: Prentice Hall.

Helm, P., & McClements, R. (1996). Multimedia business training: The big thing or the next best thing? In J. Frankl & B. O'Reilly (Eds.). *1996 EDEN Conference: Lifelong learning, open learning, distance learning* (pp. 134-137). Poitiers, France: European Distance Education Network.

Henriques, L. (1997). *Constructivist teaching and learning.* Retrieved March 14, 2000, from http://www.educ.uvic.ca/depts /snsc/temporary/cnstrct.htm

Ihde, D. (1993). *Philosophy of technology.* New York: Paragon House.

Jonassen, D. (1998). Designing constructivist learning environments. In C. M. Reigeluth (Ed.), *Instructional theories and models* (2d ed.) (pp. 1-21). Mahwah, NJ: Erlbaum.

Koumi, J. (1994). Media comparisons and deployment: A practitioner's view. *British Journal of Educational Technology, 25*(1), 41-57.

Kozma, R. (1991). Learning with media. *Review of Educational Research, 61*(2), 179 -211.

Machrone, B. (2001). The price of wireless shopping. *PC Magazine, 20*(6), 77.

Maier, P., Barnett, L., Warren, A., & Brunner, D. (1996). *Using technology in teaching and learning*. London: Kogan Page.

Mann, C. (2001, March). Electronic paper turns the page. *Technology Review, 104*(2), 42-48.

Marchionini, G. (1988). Hypermedia and learning: Freedom and chaos. *Educational Technology, 28*(11), 8-12.

Mayer, R. E. (2001). *Multimedia learning*. New York: Cambridge University Press.

McLuhan, M. (1964). *Understanding media, the extensions of man*. Toronto: McGraw-Hill.

Mehlinger, H. (1996, February). School reform in the information age. *Phi Delta Kappan, 77*(6), 400-407. Retrieved July 16, 2003, from http://www.dodccrp.org/antch12.html

Merrill, P. F. (1996). Software evaluation. In P. Merrill, K. Hammons, B. R. Vincent, P. L. Reynolds, & L. B. Christensen, *Computers in education* (3d ed.) (pp. 109-119). Needham Heights, MA: Allyn & Bacon.

Moore, M. G. (1989). Three types of interaction. *American Journal of Distance Education, 3*(2), 1-6. Retrieved July 14, 2003, from http://www.ajde.com/Contents/vol3_2.htm#editorial

Net Talk. (2001). *PC Magazine, 20*(19), p. 27.

Networking (2002, May). CA*net 4 coming down the pipe. Retrieved July 14, 2003, from http://thenode.org/networking /may2002/briefs.html#1

Newby, T., Stepich, D., Lehman, J., & Russell, J. (2000). *Instructional technology for teaching and learning* (2d ed.). Upper Saddle River, NJ: Merrill.

Nikiforuk, A. (1997, Oct. 4). The digerati are bluffing. *The Globe and Mail*, p. D15.

Oliver, E. L. (1994). Video tools for distance education. In B. Willis (Ed.), *Distance education strategies and tools* (pp. 165-173). Englewood Cliffs, NJ: Educational Technology Publications.

Pastore, M. (2001). *Women maintain lead in Internet use*. Retrieved July 18, 2002, from http://cyberatlas.internet.com /big_picture/demographics/article/0,,5901_786791,00.html

Picard, J. (1999, June 10). *Creating virtual work teams using IP videoconferencing*. Presentation at the Distance Education Technology '99 Workshop, Edmonton, Alberta.

Pittman, V. V. (1987). The persistence of print: Correspondence study and the new media. *The American Journal of Distance Education, 1*(1), 31-36.

Roberts, J. (1998). *Compressed video learning: Creating active learners.* Toronto: Chenelière/McGraw-Hill.

Roblyer, M. D., & Schwier, R. A. (2003). *Integrating educational technology into teaching, Canadian edition.* Toronto: Pearson Education Canada, Inc.

Rockley, A. (1997). *Intranet publishing.* Stouffville, ON: The Rockley Group.

Rupley, S. (2002). I2, near you. *PC Magazine, 21*(4), 21.

Scriven, B. (1993). Trends and issues in the use of communication technologies in distance education. In G. Davies & B. Samways (Eds.), *Teleteaching* (pp. 71-78). North-Holland: Elsevier Science Publishers.

Szabo, M. (1997). *A survey of research on selected components of interactive multimedia on learning, efficiency and attitude.* Unpublished paper, the University of Alberta, Department of Educational Psychology, Edmonton.

Szabo, M. (1998). *Survey of educational technology research.* The Educational Technology Professional Development Project (ETPDP) Series. Edmonton, AB: Grant MacEwan Community College and Northern Alberta Institute of Technology.

Tenner, A. T. (1996). *Why things bite back: Technology and the revenge of unintended consequences.* New York: Knopf.

Welsch, E. (2002). Cautious steps ahead. *Online Learning, 6*(1), 20-24.