CHAPTER 1

A Pragmatic Rationale for Evaluation

Objectives

After reading Chapter One, you should be able to:

• state a pragmatic rationale for evaluating interactive learning systems for education and training that emphasizes the utilization of information by a wide range of people to improve decision making;
• distinguish among various forms, architectures, and theories of interactive learning; and
• distinguish among various technological delivery vehicles for interactive learning.

A decision-oriented, pragmatic rationale for evaluation

Throughout the last decade, interactive learning systems have been the subject of much attention, ranging from enthusiastic advocacy (Perelman, 1992; Pittinsky, 2003) to heavy skepticism (Cuban, 2001; Oppenheimer, 1997). The complexities of interactive learning derive from competing theoretical foundations (such as behavioral versus cognitive psychology) and an often bewildering array of technological delivery options. Similarly, the field of evaluation has evolved into a contentious one with many competing models and several conflicting paradigms. In the face of these complexities, we have written this book to promote a pragmatic perspective for evaluating interactive learning systems in which the primary aim of evaluation is the collection of information to support day-to-day decision making by people just like yourself: project managers, instructional designers, and implementers of interactive learning systems.

When selecting a site for a restaurant, it is commonplace to say that the three most important criteria are “Location, Location, Location.” Similarly, in the process of evaluating interactive learning, it can be said that the three most important criteria are “Decisions, Decisions, Decisions.”
In short, your primary focus should be on the decisions that evaluation must influence. As a developer, manager, or implementer of interactive learning systems, you must make decisions, similar to those of other professionals. Before rendering a diagnosis, a physician collects the medical history of the patient, conducts a thorough examination, and runs various tests. Before building a case for the defense, a criminal lawyer interviews the client, reviews police records, and conducts private investigations. In fact, the quality and reputation of a physician or lawyer are determined largely by how skillful he or she is in conducting “evaluative” acts such as interviewing, testing, and examining.

If you are serious about developing or managing interactive learning systems, you must become skilled at conducting various evaluation activities before making decisions. For example, in the process of producing a Web-based training program, you likely will ask content experts to review draft scripts, observe trainees using prototype versions of the program, and subject the program to thorough usability testing (Nielsen, 2000). None of these activities (interviewing, observing, or usability testing) is especially complicated in and of itself. In fact, most evaluation activities, whether medical, legal, or instructional, involve activities that are relatively simple in concept. However, all of these procedures require skillful application at appropriate times. The major purposes of this book are to describe practical evaluation activities that you can carry out to improve decision making and to provide you with the basic tools to make your evaluative efforts more effective.

This is exactly the data we need to decide on the learning management system for our e-learning initiative.

To put it another way, this book is based on a simple premise: Decisions informed by sound evaluation are better than those based on habit, ignorance, intuition, prejudice, or guesswork. Our experience indicates that far too often people make poor decisions about the design and implementation of interactive learning systems because they lack pertinent information. Frankly, we would not have spent our time writing this book if we were not convinced that evaluation, done well, will help you and your clients make better decisions and improve the quality of learning outcomes.
Interactive learning: Forms, architectures, and theories

In Gustave Flaubert’s Madame Bovary, the narrator muses: “Language is a cracked kettle on which we tap out crude rhythms for bears to dance to while we long to make music that will melt the stars.” Certainly, proponents of interactive learning systems have long struggled to find terminology to suggest, much less capture, the exciting potential of this approach to education and training. In a field burdened by a history of disappointing instructional innovations (e.g., programmed instruction, teaching machines, and computer-assisted instruction) (Cuban, 1986, 2001), newer buzzwords for interactive learning (e.g., e-learning, m-learning, and virtual reality) inspire enthusiasts and exasperate skeptics.

Of course, all learning is interactive in the sense that learners interact with content to process, tasks to accomplish, and problems to solve. Who would disagree that highly interactive learning occurs when a French tutor coaches a pupil to develop better enunciation skills? However, in this book, we define interactive learning specifically as a process involving some form of digital mediation between a teacher or designer and a learner. From this perspective, an interactive learning system requires a digital device equipped with a microprocessor (e.g., a computer) and at least one human being (a learner). The steel worker completing mandatory safety training via a multimedia CD-ROM, the undergraduate playing the role of a gorilla in a Web-based simulation of primate behavior, and the three-year-old practicing color-matching skills with Big Bird via a Sesame Street DVD program are all engaged in interactive learning.

The meaning of the term “interactivity” is the subject of considerable debate (Rose, 1999; Sims, 2000), especially now that the optimistic prediction that intelligent tutoring systems would dominate education and training by the year 2000 has been proven false (Lajoie, 2000). In our judgment, the essence of what makes a learning system interactive is the task in which the learner is engaged (Herrington, Oliver, & Reeves, 2002). Forms and levels of interactivity are influenced by many aspects of the design of interactive learning systems, but none is more important than the task the learner is trying to accomplish or the problem he or she is trying to solve.

Forms of interactive learning
An early and influential attempt to describe forms of interactive learning was Taylor’s (1980) classic model of the roles of computers in education as “tutor, tool, and tutee.” In the tutor role, the computer is consid-
ered to act as a surrogate teacher. As a tool, the computer is used by learners to do things that would be too laborious, slow, or complex to do without it, for example, writing papers with a word processor, calculating budgets with a spreadsheet, or organizing taxonomies of phenomena with a database program. And when the computer is a tutee, the learner enhances his or her own knowledge by programming it to do something unique, for example, display an original graphic or run an algorithm to model a business process. Numerous educators, trainers, and commercial entrepreneurs have predicted that computers would revolutionize teaching and learning through one or more of these roles. Unfortunately, none of these approaches has lived up to its promise. We attribute much of this dismal record to a lack of appropriate and timely evaluation as well as poor educational research aimed at gathering supportive data for flawed applications of technology (Reeves, 2000).

Consider the tutor role wherein the computer is supposed to instruct the learner, usually via a predefined “interactive lesson.” The results of these interactive lessons have been found to be positive, albeit somewhat modest (Coley, Cradler, & Engel, 1997; Hannafin, Hannafin, Hooper, Rieber, & Kini, 1996). Even the staunchest proponents of computer-based instruction (CBI) and intelligent tutoring systems (ITS) must acknowledge the lack of impact these computer-as-tutor applications have had on mainstream education and training (Lajoie, 2000; Lajoie & Derry, 1993; Shlechter, 1991). Part of this failure stems from an overly restrictive perspective of students as passive perceivers or recipients of educational communications, a perspective that has dominated instructional designs for interactive tutors. Another factor contributing to the lack of success of intelligent tutoring systems has been the technical difficulties inherent in building student models and facilitating human-like communications. These challenges have been underestimated by proponents of the “tutor” model (Shute & Psotka, 1996).

The computer-as-tool approach has also disappointed many of its proponents, although there have been some successes when tools have been embedded within innovative pedagogy, such as a whole language approach to literacy development (Bruce & Rubin, 1993). In many cases, software tools such as word-processing, spreadsheet, and database programs have failed to improve teaching and learning significantly because they have not been integrated with an appropriate instructional design. Goodlad (1984) describes the teacher-directed, textbook, and workbook-dominated curriculum that has characterized educational practice for decades. Instead of being employed as “cognitive tools” (Jonassen, 1999; Jonassen & Reeves, 1996; Lajoie, 2000) to solve challenging problems, pursue personal learning goals, or accomplish authentic tasks, computer tools have often been regarded as objects for study themselves and subjected to direct, formal instruction.
For example, consider computer-aided design (CAD) software, which has revolutionized professional practices and dramatically increased productivity in engineering, architecture, and other design fields. Industrial arts teachers (now called “technology educators”) enthusiastically adopted CAD software into their classrooms, but instead of engaging students in authentic tasks, they have tended to “teach” students the command sets for the software outside of any meaningful contexts. Not surprisingly, students ended up failing to perceive the relevance and value of such programs within the design professions. As pointed out by Salomon, Perkins, and Globerson (1991), “No important impact can be expected when the same old activity is carried out with a technology that makes it a bit faster or easier; the activity itself has to change” (p. 8).

Despite the religious fervor with which the computer-as-tutee role has been embraced in some circles (Papert, 1980, 1993), the results of this method have been much less spectacular than promised. According to proponents of the computer-as-tutee approach, students develop higher-order thinking skills and creativity by teaching the computer to perform tasks (e.g., draw a flower) through the use of “friendly” programming languages such as Logo (Papert, 1980). Studies of the effects of Logo (Pea & Kurland, 1987) have failed to demonstrate the cognitive advantages promised by Papert and others. Defenders of this approach maintain that the implementations of Logo investigated in most studies were too brief and unfocused. Indeed, many applications of Logo and other microworlds described in the literature appear to lack the “mindful engagement” that Salomon and Globerson (1987) argue is necessary for learning. Intensive Logo applications that have engaged students in meaningful tasks over longer periods of time have demonstrated stronger effects (Harel, 1991; Kafai, 1995).

There is a new perspective on interactive learning that has developed within the context of computer-mediated learning environments such as Web-based instruction and training (Khan, 1997, 2001). This perspective is supported by evidence that interactions between learners through online discussion forums, chat rooms, and other technologies can enable authentic learning opportunities that are more powerful than those conceived of within traditional interactive formats such as the aforementioned “tutor, tool, and tutee” models (Kearsley, 2000). These rapidly evolving technologies circumvent travel, time zone, and geography limits allowing learners located at different sites within a global company to share knowledge bases and collaborate to solve complex problems. Through such instructional designs and technologies, the dreams of the “learning organization” can be realized (Hedberg, Brown, Larkin, & Agostinho, 2001; Senge, 1992). The interactivity inherent in this approach is derived from the authentic dialogue that occurs when real people work together to solve difficult problems or accomplish complex
tasks. This type of interactivity is not limited to the corporate world. For example, high school and college students from different cultures who are separated by many miles can engage in rich discourse and collaboration that can lead to profound learning (Cummins & Sayers, 1995).

**Architectures for interactive learning**

A powerful contemporary perspective on interactive learning is provided by Roger Schank, founder of the Institute for the Learning Sciences at Northwestern University, and now with Carnegie Mellon University. Figure 1.1 summarizes the five teaching architectures Schank has defined for interactive learning systems. An interactive introduction to Schank’s provocative ideas and software descriptions can be found on the Web, and additional material can be found in his books, including *Virtual Learning: A Revolutionary Approach to Building a Highly Skilled Workforce* (1997) and *Coloring Outside the Lines: Raising a Smarter Kid by Breaking All the Rules* (2000).

According to Schank and Cleary (1995), the “transmission-of-content” approach to education “flies in the face of everything scientists have discovered about children’s natural learning mechanisms, which are primarily experimentation and reflection — in other words, learning by doing.” Schank and his team have developed interactive learning environments for each of the teaching architectures in his model.

For example, for “Simulation-Based Learning by Doing,” they developed an English language simulator called “Dustin” to help new employees at Accenture (formerly called Andersen Consulting) who are not native speakers of English. Dustin allows employees to enhance their English skills within the context of the actual environment they will encounter when they attend business meetings at the company’s U.S. corporate headquarters near Chicago.

Dustin includes a series of video scenarios (clearing customs at O’Hare airport, checking into a hotel, and ordering food) that all new employees will encounter. When a trainee keys in his or her responses to the scenarios, the computer parses the language to judge a response. If the trainee is successful with a given scenario, he or she goes on to the next. But if the trainee is unsuccessful, he or she still learns. In fact, “failing” is quite valuable within Schank’s model:

> Failure is a key element in Dustin. Students realize what they need to do to learn in a very direct way. They fail at a task and become interested in finding out what they need to know to succeed. In some sense, then, they instruct themselves by seeking the information they need to complete the task. (Schank & Cleary, 1995, p. 82)

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**WEB LINK**

Roger Schank’s Web site can be found at: [http://socraticarts.com/](http://socraticarts.com/)
| **Simulation-Based Learning by Doing** | This architecture aims to have students learn every possible skill through learning by doing. Because the doing of the task is what prepares the student for real life, it is important that the student be able to actively engage in such tasks. Simulations of all kinds can be built, although the challenge of designing high-fidelity simulations should not be underestimated. The Simulation-Based Learning by Doing Architecture is critical when the subject matter to be learned is experiential at heart. Of course, much of natural learning is the accumulation of experience. |
| **Incidental Learning** | Not everything is fun to learn. In fact, some things are terribly boring to learn. But people do habitually learn a variety of information that is quite dull, without being completely bored by it. Often, they do this by picking up the information “in passing,” without intending to learn the information at all. The Incidental Learning Architecture is based on the creation of tasks whose end results are inherently interesting, and which can be used to impart dull information. |
| **Learning by Reflection** | Sometimes a student doesn’t need to be told something, but rather needs to know how to ask about it. It could be that the student has a vague plan he/she wishes to mull over. Or perhaps the student has a problem and needs to figure out a way to approach it. Or maybe the student has finished a project and wishes to think back on how the project could have been done better. In such cases, a teacher’s job is to open the student’s eyes to new ways of thinking about the situation, to help the student articulate the situation and generate ways of moving forward. |
| **Case-Based Teaching** | This architecture depends upon these two ideas: experts are repositories of cases, and good teachers are good storytellers. The task of this architecture is to tell students exactly what they need to know when they need to know it. When students are learning by doing, they experience knowledge failures, times when they realize that they need new information in order to progress. These are the times when Case-Based Teaching can provide the knowledge that students need. Isolated facts are difficult for students to integrate into their memories; useful knowledge is typically best presented in the form of stories. |
| **Learning by Exploring** | The previous architectures deal with the difficult problems of getting students involved in their own learning and letting them learn through performing tasks that they care about. Students naturally generate questions, and they are ready to learn from those questions. An important method of teaching is to answer a student’s questions and carry on a conversation about the issues in the questions, answering whatever follow-up questions the student generates. The Learning by Exploring architecture is intended to provide such answers in a conversational format. |

**Figure 1.1.** The five teaching architectures defined by Schank and Cleary (1995).
For the second architecture, “Incidental Learning,” Schank’s team invented intrinsically motivating simulations such as “Road Trip.” The “Road Trip” program helps young students learn geography by using maps to negotiate their way around the U.S. in search of video clips of interest to them, such as sports or music. (A similar architecture underlies the popular “Carmen Sandiego” software series in which students “incidentally” learn geography, history, and other subjects while chasing international thieves.) In “Road Trip,” students do not study maps, but they do use them to find the videos they desire. According to Schank and Cleary (1995), evaluations of “Road Trip” with fourth graders found that the most important outcome was that students learned to plan road trips using an atlas. In addition, students who knew very little geography significantly improved their scores on standardized tests, and all levels of students reported the simulation to be highly appealing.

“Learning by Reflection,” the third teaching architecture in Schank’s model, is closely related to “metacognition,” that is, the ability to think about, evaluate, and modify one’s own learning processes (Short & Weissberg-Benchell, 1989). Research has demonstrated that better learners ask themselves questions, explain examples to themselves and others, and change learning strategies based upon their needs. Schank’s “Sounding Board” program is designed to help a learner solve problems or accomplish tasks by asking a series of critical questions. (The program appears similar to therapy simulators that have been developed to mimic the interactions a patient might have with a psychologist.) The “structured brainstorming” that results from “Sounding Board” is especially effective when the learner is trying to create something new, such as a sales strategy. Similar software has also been designed to help students reflect upon books, films, and artworks.

To exemplify the fourth architecture, “Case-Based Teaching,” Schank and his team produced “Creanimate,” a program that allows children to design animals with unusual features such as a frog with wings. The program asks open-ended questions such as “Why would your frog want to fly?” It also shows pertinent videos such as a “flying fish” video. By posing questions about the rationale behind a learner’s design decisions, and the impact the decisions would have upon the animal’s survival, “Creanimate” enables the student to learn important biology concepts. Three critical parts of the case-based learning architecture are having numerous appropriate cases related to the subject, providing a complex task for the learner to pursue, and enabling flexible indexing so that the cases are accessible when the learner can best learn from them. Schank and Cleary (1995) state that students interact with programs such as “Creanimate” differently depending upon their unique learning styles.
The last, but certainly not least, of the teaching architectures in Schank’s model is “Learning by Exploring.” To help learners learn by exploring, Schank argues that it is more important for them to be engaged in a meaningful dialogue about the information they find than to spend most of their time finding information. He and his colleagues have developed what they call “ASK Systems” to help learners find needed information as quickly as possible and to engage them in a simulated dialogue about that information. One example of an “ASK System” was designed for the U.S. military to help officers learn to schedule transportation for personnel and supplies during a crisis such as the Gulf War. The officer selects a role, a task, and a specific problem from the options in the “ASK System,” and then is provided with stories that help the officer/learner complete the logistics plan. The interface has been designed to enable the learner to ask questions in many different ways while possible solutions to a problem are explored.

Schank and his colleagues do not represent their teaching architectures as the final word in how to design interactive learning, but as a work in progress. One of the hallmarks of their work at the Institute for the Learning Sciences at Northwestern University was that their design efforts were guided by rigorous research and evaluation studies. Most recently, Schank has focused his energies on the development of a new “e-learning” company called Socratic Arts.

Other architectures (or instructional models) have resulted in award-winning examples of education software. For example, the work by the Cognition and Technology Group at Vanderbilt University has produced the Jasper Woodbury series of problem-based learning resources (Bransford, Brown, & Cocking, 1999). The Vanderbilt “anchored instruction” approach revolves around situating (anchoring) the learning within an authentic context, and thus the elements of the context motivate teams of students to solve the problems posed (Cognition and Technology Group at Vanderbilt, 1992). For example, to develop pragmatic (as opposed to inert) math skills, students collaborate to build a playground supported by a high-fidelity multimedia simulation.

Interactive multimedia software has extended innovative learning architectures even to creative disciplines such as drama. The award-winning CD-ROM, StageStruck, from the Interactive Multimedia Learning Laboratory at the University of Wollongong in Australia, enables students to direct performances based on scenes from professional playwrights or to write their own scenes. The context is sufficiently realistic to require the same decision-making issues in the simulated theater as required in real-world production.
Theories underlying interactive learning

Since the earliest days of teaching machines, behavioral learning theory has had a pervasive influence on the design of interactive learning systems. Debunking behavioral psychology has become fashionable, but behaviorism continues to be the underlying psychology for many forms of interactive learning. According to classical behavioral psychology (Skinner, 1968), the important factors in learning are not internal states that may or may not exist, but behaviors that can be directly observed. From the behaviorist perspective, instruction consists primarily of shaping desirable behaviors through the scientific arrangement of stimuli, responses, feedback, reinforcement, and other contingencies. First, a stimulus is provided, often in the form of a short presentation of content. Second, a response is demanded, often by asking a question. Third, feedback is given regarding the accuracy of the response. Fourth, positive reinforcement is given for accurate responses. Fifth, inaccurate responses result in either a repetition of the original stimulus or a modified (often simpler) version of it, and the cycle begins again.

During the last decade, many scientists and educational researchers have suggested that we are experiencing a “cognitive” revolution in learning theory (Bransford, Brown, & Cocking, 1999; Brown, Collins, & Duguid, 1989; Clark & Mayer, 2003; Jonassen, 1999; Papert, 1993; Schank & Cleary, 1995). Whether this movement is revolutionary or not, it confronts many obstacles, not the least of which is the dominant “instructivist” pedagogical paradigm that is used to justify the production of interactive learning systems that transmit a standardized curriculum to every student.

Constructivist learning theory has been proposed as an alternative to the traditional “instructivist” or “transmissionist” approach to education and training (Duffy & Jonassen, 1992). Constructivism is concerned with the cognitive processes whereby we construct meaning and knowledge in the world as well as with the results of the constructive process (Phillips & Early, 2000). How we construct knowledge depends upon what we already know, our previous experiences, how we have organized our experiences into knowledge structures such as schema and mental models, and the beliefs we use to interpret the objects and events we encounter. Fosnot (1996) offers a definition of constructivism:

Constructivism is a theory about knowledge and learning; it describes both what “knowing” is and how one “comes to know.” ... the theory describes knowledge as temporary, developmental, nonobjective, internally constructed, and socially and culturally mediated. Learning from this perspective is viewed as a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new in-
sight, constructing new representations and models of reality as a human meaning-making venture with culturally developed tools and symbols, and further negotiating such meaning through cooperative social activity, discourse, and debate. Although constructivism is not a theory of teaching, it suggests taking a radically different approach to instruction….a constructivist view of learning suggests an approach to teaching that gives learners the opportunity for concrete, contextually meaningful experience through which they can search for patterns, raise their own questions, and construct their own models, concepts, and strategies. The classroom in this model is seen as a minisociety, a community of learners engaged in activity, discourse, and reflection. The traditional hierarchy of teacher as the autocratic knower and learner as the unknowing, controlled subject studying to learn what the teacher knows begins to dissipate as teachers assume more of a facilitator’s role and learners take on more ownership of the ideas. Indeed, autonomy, mutual reciprocity of social relations, and empowerment become the goals. (p. ix)

Radical constructivists such as von Glaserfeld (1989) maintain that the ultimate nature of reality or whether it even exists does not matter as much as our unique and shared constructions of reality. According to constructivism, teachers are doomed to fail in attempts to map their own interpretations of the world onto learners because they do not share a set of common experiences and interpretations. Reality (or at least what we know and understand of it) resides in the mind of each knower, who interprets the external world according to his or her own experiences, beliefs, and knowledge. Learners are able to comprehend a variety of interpretations and to use them in arriving at their own unique interpretations of the world. The mind filters input from the world in making its interpretations, and therefore we each conceive of the external world somewhat differently. Fortunately, we are able to share our unique interpretations through language, art, and other communication channels, so that we are not completely isolated in our own special worlds. Constructivists regard multimedia as an especially powerful channel for self-expression and communication, as well as an appropriate vehicle for interactive learning (Jonassen, 1999).

In traditional instruction, “active” refers to stimulus, response, feedback, and reinforcement conditions that help students mirror accepted views of reality whereas in constructivist learning environments, “active” learners interact with the surrounding environment (including both the technology-mediated aspects and the support provided by other learners) to create their own interpretations of reality. While early computer-based tutorials utilized a transmissionist pedagogy grounded in behavioral psychology (Skinner, 1968), contemporary interactive learning environ-
ments are designed to implement constructivist pedagogy based upon cognitive learning theories (Wilson, 1996). Rather than working their way through problems and solutions that have been predefined by teachers and instructional designers, learners engaged in constructivist approaches to interactive learning define and refine the nature of a problem they have identified, reconstruct their knowledge to solve that problem, and represent their solution in multimedia formats (Lehrer, 1993).

Throughout this book, we present examples of interactive learning systems that we have evaluated in a variety of contexts. Some of these programs are decidedly “instructivist” in nature, and others are examples, at least in part, of constructivist learning theory. Although the particular type of interactive learning system you want to evaluate may not be represented exactly in these examples, the variety of systems we have included is such that we believe you can find adequate models for your specific needs.

Interactive learning: Systems for delivery and collaboration

In addition to examining the theoretical aspects of interactive learning, it is important to consider the array of options for linking learners to learning opportunities and resources. Imagine a simulation designed to help adults learn a second language by immersing them in a foreign scenario. There are a variety of technological options for this interactive learning environment, including CD-ROM, Digital Video Disc (DVD), and the World Wide Web. Although each of these delivery systems is different, the programs could have similar mixes of pedagogical strategies; for example, the learner could be interacting within the context of a real task (e.g., checking into a hotel), listening to a native speaker, selecting responses from a menu of choices, receiving feedback, and branching out to remedial instruction as indicated by his or her success or failure in the simulation. Using technologies such as the Web can also enable human-to-human levels of interaction (Kearsley, 2000). For example, whereas at a basic level the learner might interact with a prepared set of resources, if connectivity is provided, the learner can ask questions of an online tutor located anywhere in the world or seek feedback from peers.

The proliferation of delivery systems for interactive learning is sometimes overwhelming. From the early days of B. F. Skinner’s teaching machines, we have progressed to virtual reality immersion systems and teacher holograms. How long will it be before interactive learning systems regularly involve 3-D full-immersion video? To make matters
even more complicated, the many acronyms (e.g., CAI, CBI, CAL, CBE, DVD, IMM, WBLE, etc.) used to designate various technology options are used inconsistently in different parts of the world. We cannot provide a comprehensive list of all of them here, and anything we could produce would soon be out-of-date, as newer technologies are developed every few months.

In lieu of a comprehensive list of technology options for interactive learning, we have listed some of the primary technologies in use today (Figure 1.2). The list is presented in more or less chronological order to reflect the time when these various technologies were introduced. Some delivery systems with which you might be familiar may not appear in Figure 1.2 (e.g., digital video interactive or DVI) because these technologies either vanished from the interactive market soon after their appearance or because we consider them to be too similar to other technologies already on our list. Of course, we expect that there will be new delivery options by the time this book goes into print. For example, companies are already producing interactive multimedia courseware for personal digital assistants (PDAs) such as Palm Pilots, and it may be that the buzzword “m-learning” (m = mobile) will catch on (Gayeski, 2002). The challenge of keeping up with the delivery options for interactive learning involves reading journals and commercial magazines, attending conferences and trade shows, and surfing the Web on a regular basis.

From time to time, various authorities call for standardization of delivery systems for interactive learning, but we view these demands as unrealistic. Large computer and electronics corporations invest millions and millions of dollars in research and development for new technologies, and these types of investments are unlikely to stop. Calling for standardization of delivery systems is a lost cause because change is the name of the game. Indeed, the “chaos” that new technologies caused for big business from time to time in the 20th century (e.g., the widespread adoption of television in the 1950s or personal computers in the 1980s) is more likely to be the norm in what Hock (1999) calls the “chaordic age” of the 21st century.

You don’t have to look back very far within the history of interactive learning systems to see similar changes. Just as soon as corporate trainers thought that CD-ROM was the ideal delivery option for interactive education and training, along came the Web. As experienced developers of interactive learning systems, we recommend that you get used to living in an unpredictable world where the ultimate delivery system will never exist. Of course, as an evaluator of interactive learning and performance support systems, you must keep up with the latest technical developments in order to evaluate individual projects in an informed manner.
In the past, most interactive learning programs (such as computer-based training) were delivered on diskettes or loaded onto a hard-drive server and accessed over a local area network. Although many computers around the globe still lack modems and CD-ROM drives, the days when interactive learning is delivered via computer diskettes, central servers, or other magnetic media are coming to an end.

**Interactive Videodisc (IVD)**

IVD involves the integration of an optical disc storing video frames and a computer program providing interactive routines. Interactive videodiscs were popular because of the high quality of the video they provided, but IVD programs are rarely produced today, and soon will be museum artifacts.

**CD-I**

Compact Disc Interactive (CD-I) is an optical technology that integrates a variety of media on a single compact disc such as audio, images, and up to an hour of full-screen motion video. CD-I requires only a CD-I player (a self-contained disc player and microprocessor) and any video monitor or TV. CD-I players went out-of-production in 1999.

**Current Technologies**

**CD-ROM**

CD-ROM (compact disc-read only memory) became a standard peripheral on most microcomputers sold in the 1990s, and they are a major component of the installed base of computers available today. CD-ROM is an optical medium that can store 660 megabytes of media including text, graphics, sound, and video. Many popular interactive “edutainment” programs are delivered via CD-ROM. Today, CD-ROM drives are being replaced with DVD drives that play most of the available CD-ROMs as well as the new DVD programs. CD-ROM is also being used as a hybrid medium with the Web to reduce the bandwidth requirements of multimedia programs.

**World Wide Web (Web)**

The World Wide Web is a network of files on computers all over the world. The computers are accessed using modems and phone lines via “links” using software browsers available from companies such as Netscape or Microsoft. Publicly accessible Web-based interactive learning examples abound, and many corporations provide training and performance support to their employees via restricted sites called “intranets.” Larger Web “pipelines” (e.g., cable and digital satellite systems) are gaining popularity because of the faster access they provide to end-users. Increasingly, the need to have direct wired connections to the Web is becoming less necessary because wireless connections are becoming widely available. The Web as a communications technology is an interestingly different form of technology to the laser disk technologies in that it can be structured in multiple ways to link learners with each other as well as to dynamic resources.

**DVD**

Digital Video Disc (DVD) combines the data intensity of CD-ROM with the video quality of videodisc into a new interactive format that requires a special player that works with any video monitor or TV. It has more than seven times the capacity of a CD-ROM, and can show full-screen, full-speed video.

**Figure 1.2.** Popular delivery systems for interactive learning.
Although delivery modes for interactive learning may never be standardized, there are efforts to establish technical standards for the courseware that will be delivered via present and future technologies. Whether you are developing or simply using various e-learning formats such as Web-based training (WBT) or Web-based learning environments (WBLE), you should be aware of the Advanced Distributed Learning (ADL) initiative and other efforts to promote technical specifications for sharing instructional content and learning management systems (LMS) over the Internet or across various intranets. For example, the U.S. Department of Defense is promoting the Sharable Content Object Reference Model (SCORM) via the ADL initiative. Other entities developing their own set of standards for courseware include Microsoft Corporation, the Aviation Industry CBT Committee, and EDUCAUSE.

Aside from the technology options discussed above, there are two terms used in reference to interactive learning today that deserve additional clarification. The first term is multimedia. (An earlier draft of this book was titled Evaluating Interactive Multimedia, but we ultimately decided to broaden the focus of this volume to all forms of interactive learning systems.) Multimedia at its simplest is the integration of visual, aural, textual, and data displays within one learning environment. The second term is distance learning, a poorly understood phenomenon with implications for all levels of education and training. Nowadays, distance learning and related terms (e.g., online learning or e-learning) focus on options for breaking or modifying the physical links between instructor and student, either by place or time, and also on ways in which learning can be facilitated by the instructor and through supportive technologies. Both multimedia and distance learning have captured the interests of the public around the globe, and as such are given special attention throughout this volume.

**Multimedia**

The terminology used to describe multimedia and related software can be confusing. “Interactive multimedia,” “hypermedia,” and simply “multimedia” are used interchangeably by some and very distinctly by others. For example, Locatis, Letourneau, and Banvard (1989) prefer the term “hypermedia,” defining it as “a computer-based approach to information management in which data is stored in networks of nodes connected by links. Nodes can contain text, graphics, audio, video, source code, or other data...” (p. 65). The IBM Corporation (1991), on the other hand, proffers a more inclusive definition of multimedia: “The concept of multimedia makes accessible full-motion video, photographic still images, animation, stereo sound, and text and graphics – giving users the ability to weave a limitless number of stories for a universe of applications.”
Fischer and Mandl (1990) claim that hypermedia can be distinguished from multimedia by “the depth and richness of the information contained” and by the degree to which “the learner decides how much of this virtual database he or she wants to use.” They imply that hypermedia is a higher-order learning system than multimedia because of its complexity and accessibility. Gygi (1990) also makes a distinction between hypermedia and multimedia, and chastises those who “persist in believing that multimedia is inherently motivating” (p. 281). She maintains that the critical element in the dynamic power of hypermedia is the user’s ability to alter the medium, not the presence of multiple presentation formats (e.g., animation, graphics, sound, text, and video).

Despite the confusion, subtle distinctions have evolved in the use of the two terms. The commercial world and the general public definitely prefer the term multimedia. Apple Computer, Inc., the IBM Corporation, and the Microsoft Corporation each continue to make major investments in multimedia technologies. The online bookseller, Amazon.com, lists more than a thousand books with multimedia in the title (and fewer than a hundred with hypermedia). However, many in the academic world still prefer the term hypermedia. For example, recent books on hypermedia by academics include From Web to Workplace: Designing Open Hypermedia Systems (Gronbaek & Trigg, 1999) and Adaptive Hypermedia and Adaptive Web-Based Systems (Brusilovsky & Stock, 2000).

For those who specifically use the term hypermedia, the central tenet of the definition seems to be chiefly the concept of linked nodes. For those who use the term multimedia, the central tenet seems to rest mainly in the concept of a system consisting of a combination of text, graphics, still pictures, video, and sound. We prefer the term multimedia to describe the types of programs we most often design, implement, and evaluate. The term hypermedia seems less useful because the term “hyper” is often used in a negative sense in Western society to describe someone, especially a child, unable to control his or her behavior sufficiently to meet the expectations of structured environments such as a classroom. Further, we define multimedia as an interactive database that allows users to access information in multiple forms, including text, graphics, video, and audio. From an instructional viewpoint, we define interactive multimedia as any combination of media and pedagogical dimensions that support learning, commonly through simulated experience.

Classic examples of interactive multimedia for education include: Broderbund’s Just Grandma and Me, IBM’s Illuminated Books, Apple Computer’s The Visual Almanac, and the awarding winning Investigating Lake Iluka and Exploring the Nardoo simulations developed at the University of Wollongong in Australia. Notable interactive multimedia programs for training include Apple Computer’s Macintosh Funda-
One of the most promising uses of multimedia occurs when students are encouraged to construct their own representations of knowledge using multimedia construction programs such as HyperStudio, Toolbook, or Flash (Jonassen & Reeves, 1996). Based upon Perkins’s (1985) “knowledge as design” pedagogy, learners undertake a task or solve a problem, using multimedia as a cognitive tool to support their problem-solving processes and ultimately to present their solutions to others. Lehrer (1993) describes the results of a study involving eighth graders who used a multimedia construction tool called HyperAuthor to design their own lessons about the American Civil War. This study exemplifies the principle that: “Cognitive tools empower learners to design their own representations of knowledge rather than absorbing knowledge representations preconceived by others.” This is not only a highly motivating process, but there is also good evidence that authorship results in ownership of the ideas in the representations (Jonassen & Reeves, 1996).

Distance learning

Another important area of interactive mediated learning is more commonly referred to as distance learning or distance education (Moore & Kearsley, 1995). Traditionally, distance learning was delivered via media that were asynchronous and unidirectional, such as mailed print materials and radio and television broadcasts. However, new technologies and faster telecommunications capabilities are providing robust interactive tools for distance learning. Among the primary characteristics of these technologies are enhanced interactivity and both synchronous and asynchronous communications among teachers and learners.

One long-established approach to delivering interactive learning at a distance is called audiographics. With audiographics, teaching and learning are achieved through two discrete telecommunications links. One link connects computers and another link provides audioconferencing through telephone communications (see Figure 1.3). Standard telephone connections are used to connect students and a teacher with two-way voice and graphic communication. The teacher and students view the same information on their computer screens. Any party can edit and change the displayed image under control of the teacher. The two-way audio communication provides a “classroom” environment for instruction and related activities, such as classroom management. A fax machine for transmitting teaching materials and student assignments
between sites is another piece of technology that may be included in an audiographics environment.

Audiographics (also called telematics) is used in Australian, Canadian, and South African schools as a means to cost-effectively increase the curriculum offerings to children in rural schools. It is especially popular as a medium for delivering LOTE (Languages Other Than English). Rural schools often have too few students and qualified staff to offer LOTE locally. Telematics link students from several remote schools in a virtual class of 15 to 20 students from several remote schools and a LOTE teacher who delivers a formal course. More than 170 rural schools in Western Australia use telematics to support subjects as diverse as Japanese and computer science (Oliver & Reeves, 1996).

Today, the Web is being promoted as the ultimate delivery system for distance learning, and many projects have integrated the Web into various types of education or training programs (Khan, 1997, 2001). Several other Internet tools are available to support interactive learning at a distance, such as chat rooms, MUDs, MOOs, and listservs. However, the slow speed of access to the Web over existing telephone modems limits the Web for delivery of interactive distance learning when high bandwidth is required. Several projects have used the hybrid system of CD-ROM and Web browsers to provide instant access to multimedia materials (immediacy) with online topicality (currency). As new, faster “pipelines” to the Web become more commonplace (e.g., digital cable and DSL), the proliferation of distance learning opportunities on the Web is expected to be enormous. Before long, wireless networks will improve access to the Web, thereby enabling widespread access to interactive learning environments. In developing countries, wireless

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**Figure 1.3.** Illustration of typical audiographics system.
systems such as mobile phones and access to the Internet are providing opportunities for connectivity at a much cheaper cost than traditional terrestrial networks. Buzz-words for these trends are e-learning and m-learning (Rosenberg, 2000). Many training departments are using the Web to provide updates and short courses to keep their employees up-to-date with new products and company directions. However, most e-learning solutions still provide a one-way experience whereby “content” is delivered to the learner. True interactivity in terms of collaboration and dialogue, while technically possible, is still largely ignored. With better evaluations of interactive learning technologies and appropriate authoring tools, this may change over the next few years.

One trend is clear: Distance learning is not just for remote learners anymore. Increasingly, people enrolling in distance learning programs may live or work near traditional educational institutions, but choose “distance” options because they value the flexibility and convenience these alternatives can provide over instruction that is offered at a fixed place and time. Students may be enrolled concurrently in distance and traditional courses. Interestingly, distance learning as a term appears to be declining in usage in favor of terms such as flexible delivery, flexible learning, e-learning, and blended learning, all of which reflect the convergence of various interactive learning technologies. If sufficient attention is given to the instructional design of these flexible learning systems, learners may eventually choose them for quality reasons as well as convenience. In the end, we expect that distinctions between place and time of learning will become less and less relevant. Interactive learning environments are evolving, and creative designers can combine new forms of technology with people, tasks, and tools to ensure that people collaborate and learn. But the importance of rigorously evaluating interactive learning systems should not be underestimated.
Summary

This chapter began by presenting a pragmatic, down-to-earth rationale for evaluation as a systematic process that should be focused on the decisions that must be made during the design and use of interactive learning systems. It also includes some important distinctions among types of interactive learning and vehicles for their delivery. In the next chapter, we present four major inquiry paradigms that influence evaluation practice today and describe several noteworthy evaluation models.

References


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