The concept of distance education is changing with time, places, and people. At its most basic level, distance education takes place when a teacher and students are separated temporally and spatially. Not too long ago, distance learners were also separated physically and temporally from educational resources, which resulted in delays in obtaining responses to their queries, accessing library resources, and communicating with peers. More recently, multimedia technology (such as voice, video, data, and print) carried over increasing network bandwidth have drastically changed the way distance learners communicate with their instructors and with each other. Technologies such as Web conferencing and videoconferencing virtually diminish the distances perceived by the learner. Accordingly, new distance education terminologies are emerging every day, such as flexible learning, online learning, Web-based education and training, virtual universities, and agent-mediated education. Distance education implementations and enrollments are increasing at a fast pace. Different surveys report that 1 million students are taking distance learning classes via the Internet and predict that the number of college students enrolled in online courses will reach 2.2 million by 2002. Distance learning is now one of the most interesting new directions for education, reducing instructional gaps still in distance education modes to a minimum.

Distance education delivery

We can break distance learning into two types: synchronous and asynchronous. Synchronous distance learning is basically same-time, different-place education. We can connect local classrooms to learners at a distance. To do so, we can use networked multimedia computers with video systems or TV over high-speed communication channels (such as satellite and fiber-optic media). Asynchronous distance learning students can learn at different times and places.

The styles of distance learning are varied and innumerable. Until recently, they ranged from sending out printed course materials and broadcasting courses using TV to one-way, Web-based content delivery—that is, making course materials, announcements, electronic libraries, and other information accessible through carefully designed Web pages. The lack of some form of interaction with the educator and fellow distant students was a serious drawback in all these styles. However, adding threaded bulletin boards, chat rooms, and email has helped bring online interactions to the distance learning environment. Educators use email questions and answers where Web conference facilities are absent and when the personal nature of communication requires a private dialogue.

The Internet has facilitated distance learning, resulting in experimentation with how we deliver education. Students can interact with the instructor and other students asynchronously. Collaborative technologies such as messaging, document conferencing, chat, and multipoint audio- and videoconferencing help create an interactive learning environment between students and teachers. Incorporating audio and video can enrich Web conferencing. With advances in media streaming, it’s now possible to send video clips (together with traditional text, graphics, sounds, and images) over the Internet and to store video clips on different media for access during online instruction. The Web lets students submit assignments online in multimedia formats and receive an evaluator’s review of their assignments online.

Multisensory learning environments maximize the learner’s ability to retain information. Researchers have shown that we can remember 20 percent of information by seeing it; 40 percent by seeing and hearing it; and 70 percent by seeing, hearing, and doing it. Any instruction that incorporates an active response from students will produce greater learning. Many researchers agree that interactive multimedia can help people learn more efficiently because of parallels between mul-
timedia and the natural, balanced way people learn. Multimedia’s multisensory capabilities (including text, graphics, colors, audio, and video) create a much stronger, lasting impression than single- or dual-sensory input through increased interactivity. The flexible, rich content of multimedia also supports better structured lessons. In addition, with interactive multimedia instruction, instructors can require active responses from each and every learner, which in most cases is difficult in a traditional classroom environment.

Multimedia technology, high-bandwidth data communication, and improvement in protocols to incorporating multimedia have each played a distinct role in making distance education one of the most interesting new directions of education.

**Flexibility in distance education**

Distance education provides additional value to the learner because it offers more flexibility compared to traditional learning environments. Specifically, consider the following:

- Distance education provides flexibility for those who are disadvantaged by limited time, distance, or physical disability. They can benefit from a more flexible environment that lets them learn on their own time, wherever they choose.
- Shy students can choose to observe and become an involved participant because other students can’t see them.
- Adults may take a second chance at a college education. Most adult learners have children and a job. They can’t spend several hours in a classroom because they have a home to manage and house payments to make. With distance learning programs they’re in control of what they do and how fast they cover the material within a range of time.
- After completing an undergraduate degree, learners may decide to enter the workforce and at the same time get an advanced, graduate-level degree. Distance education provides a good solution. In many cases, students can immediately put into practice what they learn.

**Technological challenges and opportunities**

Technological and human issues are the two major challenges related to planning, implementing, and successfully continuing a distance education program. However, we can find opportunities embedded in both issues.

Major technological issues include leveraging further increases in bandwidth to enable smoother presentation as well as enabling both real-time and mobile communication. In addition, advances in technology will create additional tools that will enhance the learning experience for participants in distance education systems. Other technological issues include standardization, platform compatibility, and scaling hardware and software solutions to accommodate multimedia. Most technological issues seem to be a question of when to adopt new technology and how to manage and anticipate the resulting financial commitments.

These rapid advancements in technology and communication create increasing challenges to maintain the human aspect of education delivery. Educators are increasingly challenged to more completely and accurately present the course content and their personal philosophy of education at different levels. Increasingly, educators must collaborate in the selection, design, and implementation of effective content and tools to service their profession. Instructors are more often a member of a team of designers, content creators, technical support specialists, evaluators, and counselors, with no single person responsible for an entire course.

Major nontechnological issues exist that distance education has yet to answer:

- How do we prepare appropriate (adaptive) course content, incorporating technology to meet the varied requirements of student acceptability? Faculty members must partner with course developers, using a fundamentally new approach for conveying the message and ensuring that the requisite learning takes place.
- Who has control of the intellectual property, who has ownership of the intellectual property, and who has rights to the intellectual property?
- What are the effective student assessment and evaluation approaches to ensure that someone else isn’t doing a student’s work?

**Scanning this special issue**

This special issue aims to bring stimulating papers, thoughts, and discussions from the International Conference on Intelligent Multimedia and Distance Education (ICIMADE) 1999 to a wider audience. Accordingly, *IEEE MultiMedia* invited the authors, participants, and a few others to submit
expanded versions of their conference papers, which we then peer reviewed. We selected the included articles from 26 exceptional submissions. The seven articles here cover a wide range of concepts and case studies related to the three main aspects of distance education: multimedia, networking, and pedagogy.

As I discussed earlier, there’s widespread agreement that interactive learning is the most valuable aspect of multimedia-based education and that it can push students to be participants in the learning process rather than spectators. However, producing interactive multimedia content is expensive in terms of time and cost. Saddik, Fischer, and Steinmetz deal with this important issue and suggest ways to optimize reusable interactive multimedia to reduce cost and time in producing multimedia in Web-based learning environments.

Many researchers consider communications channels and bandwidth the most important technological parameters. Internet protocol version 6 (IPv6) and asynchronous transfer mode (ATM) are among the latest developments in this area. Fernández et al. summarize the experience they gained and the results they achieved by developing, testing, and evaluating multimedia distant education applications running over an IPv6- and ATM-based broadband access networks. They adapted a set of distant education applications, including a digital-video library, virtual workspace, and video and audio conferencing tools to work over IPv6. Their article reports the technical performance of the network and its applications.

Costantini and Toinard discuss a novel approach to promoting interactivity and collaborative learning for industrial training of designers using the Distributed Building Site Metaphor (DBSM) that provides distribution services for sharing a virtual world. The authors propose different collaboration styles such as tutoring of the design environment, case exploration, distributed explanation, mutual learning, distributed tutoring, real-time or offline learning, and so on. Moreover, the article shows how mobile learners automatically integrate their offline works to achieve a collaborative lesson.

Day, Liu, and Hsu look at using multimedia in a corporate training environment. The article presents an automated authoring method based on a formal specification for dynamically generating ISO DSSSL document styles. From the generated styles, we transform the existing storage-based product documents into large-scale presentation-based product training manuals.

Although multimedia applications as pedagogical tools in teaching are widely used, we must understand that these new technologies won’t solve every computer usability problem. Rodríguez et. al discuss the relevant parameters considered in the development of a physics video-based laboratory at the National Autonomous University of Mexico. Tokuda et. al detail the development of an efficient diagnostic system for an interactive intelligent language tutoring system.

The emerging MPEG-4 audio–visual representation standard will have potential impact on future videoconferencing systems. Sarris and Strintzis focus on the case study of their MPEG-4–based system Lip Telephone. Their videophone lets lip readers communicate over a standard telephone connection or the Internet.

Looking into the future

Distance learning is going through many technology-based changes occurring in education today. I expect that in the next century the technology and pedagogy will drive us to a historic change in the way people will access education and open up new educational possibilities. The attempt to merge wireless technology and handheld computers with online instruction will make online learning even more accessible.

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