

RESOURCES

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Introduction

Educational technology is the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and *resources*.

THE TERM *RESOURCES* IS understood to include the tools, materials, devices, settings, and people that learners interact with to facilitate learning and improve performance. Both the types of resources (specifically, *technological* resources) and how these resources are used (*appropriately*) serve to differentiate what is done by educational technologists from similar efforts in other fields. The chapter begins with these defining characteristics, and then, it surveys the evolution of the various types of resources and surveys how emerging technologies have affected the field. The second half of the chapter differentiates analog and digital media, examining in greater depth how digital tools have changed the landscape of educational technology. It also discusses how settings and people are used as resources. The chapter concludes with a consideration of ethical issues in the use of resources.

Technological Resources

In the context of the current definition, the term *technological*, as a modifier of *resources* indicates that the resources created and used in educational

technology are most often tools, materials, devices, settings, and people. Other resources, such as natural resources or political resources, are not considered to be primarily technological or educational and are therefore not central to the field. While educational technology professionals may indeed understand and account for natural, political, or other types of non-technological resources, including the term *technological* provides a focus on tools, materials, devices, settings, and people as the primary resources that are used to improve learning and performance.

There has recently been significant emphasis in the literature on the use of newer, *digital* resources, almost to the exclusion of historically traditional *analog* resources. Yet in terms of actual practice, analog resources such as textbooks, the overhead projector, and the videocassette recorder (VCR) are still used extensively in both corporate and educational settings. Molenda and Bichelmeyer (2005) illustrate the continuing use of the VCR in schools: “The predominant media formats in the collections of members of the National Association of Media & Technology Centers (NAMTC) continue to be analog, particularly videocassettes. Their collections include (from greatest to least) videocassettes, multimedia, curriculum materials, professional books, digital video disks and CD-ROMs” (p. 27). In corporate training, Dolezalek (2004) reports that manuals and workbooks are used in over three fourths of all training programs and video recordings are used in over one half (p. 34). Analog media are also still in widespread use in higher education. Chalkboards, whiteboards, and overhead projectors serve a valuable function in enabling instructors to generate verbal and visual cues spontaneously to supplement lectures. Photographic slides continue to be used for subjects where high-definition images are critical, such as biology, veterinary medicine, optometry, and the visual arts.

It can be safely concluded that, while current trends do indeed point toward an increased use of digital resources, instructors will continue to use and demand support for a number of the traditional audiovisual (AV) media.

Appropriate Resources

The term *appropriate* is used to modify resources to indicate that the hardware and software used in education should be selected with consideration of their suitability for and compatibility with educational goals. The first criterion of suitability is that they should be selected through a process that meets professional standards. The Association for Educational Communications and Technology (AECT) code of ethics provides many guidelines to professional expectations, as discussed in chapter 11. One of the most fundamen-

tal is observance of the relevant law. Section 3 (Association for Educational Communications and Technology, n.d.) requires that members observe copyright laws and other legal protections of intellectual property rights *and* that they inform users of these laws and they encourage compliance. This is not necessarily an easy requirement to meet. Media librarians, technology coordinators, and instructional designers frequently face challenges in these areas; for example

- To have ready access to needed teaching materials, a teacher would like to duplicate a videocassette outside the boundaries of “fair use”
- To enable all the students in his large but poor school district to use current computer applications, a school superintendent would like to use unlicensed software
- To convey important ideas in a distance education course a professor would like to incorporate some visuals downloaded from a website without inquiring about permission

A second professional standard (Section 1.5) is that members follow “sound professional procedures for evaluation and selection of materials and equipment” (Association for Educational Communications and Technology, n.d.). Again, this may seem obvious, but practitioners may find themselves tempted to accept or use resources that have been donated with some expectation of private gain, that may be commercially exploitative, or that are simply easily accessible but would not stand up to close scrutiny.

Other criteria come from political, social, and cultural expectations, such as avoiding content that promotes gender, ethnic, racial, or religious stereotypes (Section 1.8) and, on the positive side, encouraging the use of “media that emphasize the diversity of our society as a multicultural community.” Along the same line, Section 3 calls for providing “opportunities for culturally and intellectually diverse points of view.”

These meanings of *appropriate* pertain to educational use in general, for example, the selection of materials for a school media-center collection or a corporate resource-center collection. When the resources are being considered for use as part of an *instructional* lesson or program, other issues come to the fore. The criteria of effectiveness and efficiency now must be included. Effectiveness refers to the suitability and compatibility of a given resource with regard to particular instructional objectives—likelihood of yielding positive results—and sustainability in the local setting. For example, social studies teachers might select a particular social-simulation game if their past experience indicated that it stimulated the sort of topical discussion that they wanted to evoke. It was suitable for their purpose.

Efficiency refers to the wise use of time and resources, including the effort of educational technologists themselves. Since everyone's budget is finite, purchasers have to consider which hardware and software will provide the greatest benefits for the most learners or the greatest benefits to the success of the organization. Especially in the private sector, productivity considerations must be given high priority. For example, a training planner might have to decide whether to choose between face-to-face instruction or Web delivery for a course on copy-machine maintenance. They might first estimate the delivery costs of each option (e.g., travel and per diem costs for the live classroom vs. software and hardware costs for the Web course), then compare those with the benefits in terms of employee performance and meeting company goals. The choice might be a combination of the two modes: two days of Web-based instruction for the general principles and two days of instructor-led workshops for hands-on practice. The point is that efficiency, too, is a critical element of appropriateness.

Resources by Design Versus Resources by Utilization

To explain the types of resources available to help facilitate learning, the authors of the 1972 definition statement (AECT) made a useful distinction between *resources by design* and *resources by utilization*:

Some resources can be used to facilitate learning because they are specifically designed for learning purposes. These are usually called "instructional materials or resources." Other resources exist as part of the normal, everyday world, but can be discovered, applied, and used for learning purposes. These are sometimes called "real-world resources." Thus, some resources become learning resources by design and others become learning resources by utilization. This distinction is important because it makes clear the position of "noninstructional, real-world" resources as well as designed resources as an area of concern for educational technology. (p. 38)

Without this inclusive definition, those "real-world resources" not necessarily intended for instructional use might not be considered to be resources. This notion was stated clearly in the 1994 definition: "Resources are sources of support for learning, including support systems and instructional materials and environments. . . . Resources can include whatever is available to help individuals learn and perform competently" (Seels & Richey, 1994, p. 12). It is important to include "resources by utilization" in the current definition, especially with the significant increase in the use of this type of resource in information-rich learning environments. Explorations in public television programs such

as *Kitchen Chemistry* and *Backyard Geology*, for example, depend on resources not originally intended to be educational, such as baking soda and vinegar.

Whether they are analog or digital, used by design or by utilization, resources play an integral role in facilitating learning and improving performance.

Technological Resources and Early Identity Formation

Prior to the 20th century, education was generally characterized by the organization of teachers, textbooks, chalkboards, and students. This early model of education is typically perceived to have preceded the field of educational technology and is often referred to as *traditional* education. The modern field of educational technology is most often considered to have formed in the early 1900s as a loosely formed group of practitioners with a common interest in using new technological resources as an alternative to traditional education. Throughout the 20th century, new technological resources emerged and faded away, yet even today the differentiation between “traditional education” and technology-supported education has persisted. This differentiation is accepted by Reiser (2007), who defined *instructional media* as “the physical means, other than the teacher, chalkboard, and textbook, via which instruction is presented to learners” (p. 18). While many, even in educational technology, view the textbook and chalkboard as examples of instructional media, it is useful to adopt Reiser’s distinction. The emergence of educational resources *after* the chalkboard and textbook—and the corresponding evolution of a field of study concerned with the application of these emerging technologies to instruction—can then be viewed as the catalysts for the establishment of educational technology as a distinct field. In retrospect, it provided a clear identity for the group of people who would evolve into AECT, and who would ultimately attempt to define the concept of *educational technology* that has emerged over the past century.

Early Origins

The use of hand-drawn illustrations in textbooks is among the oldest examples of the use of educational resources and is considered by some to mark the early origins of the field of educational technology. Early, exemplary use of instructional illustrations can be found in the work of Johannes Amos Comenius in the mid-1600s (also discussed in chapter 5). Comenius’ *Orbis Sensualium Pictus* (The Visible World Pictured) was a primary school textbook that included illustrations of common concepts to complement the words (Saettler, 1990, pp. 31–32). There is, however, doubt about whether Comenius’ work should be regarded as the origin of the field, as he was arguably not con-

sciously working as an educational technologist, and there is little evidence that his work directly influenced the modern founders of the field.

The Visual Instruction Movement

Slides. There is little disagreement that the origins of the modern field of educational technology can be traced to the expanding efforts of practitioners in the late 1800s and early 1900s to use visual images to improve education. The first of the visual media was slide projection, which evolved from 17th century hand-painted slides illuminated by oil lamps. The “magic lantern” provided entertainment for paying audiences throughout the 19th century (Petroski, 2006, pp. 18–19). By the end of the 19th century, lantern slides, which came to be standardized at $3\frac{1}{4} \times 4$ inches, were in common use in education (p. 19). The slide format was later standardized at the two-by-two-inch frame size, using 35mm film, which was also used for the filmstrip, the most popular format for commercially produced AV materials. After World War II, overhead transparencies became popular for local production of visuals, and overhead projectors were ubiquitous in classrooms at all levels.

Commonly cited as the *visual instruction* movement, this movement was characterized by the emergence and use of still picture and motion picture technology as teaching resources. Initial efforts to make these resources widely available throughout school districts included the collection and organization of visual materials into educational museums. The first in the United States was established in St. Louis in 1905, based on exhibits saved from the World’s Fair held in that city in 1904. Circulation of collection materials (e.g., charts, pictures, maps, photographs, stereoscopic pictures, and lantern slides) to schools was carried out by a horse-drawn wagon (Saettler, 1990, p. 129).

Silent Films. The direct ancestors of educational films were the nontheatrical short films that began to emerge around 1910. British and French cinematographers exhibited films showing amazing sights such as microscopic creatures, insects in flight, and underwater seascapes. Films of news events and travel adventures played to rapt audiences. In the United States, Thomas Edison was quick to see the potential of film for classroom instruction. In 1911 and the years after, he released a series of films depicting historical events, natural phenomena, and principles of physics (Saettler, 1990, p. 96). By the 1920s, educators could find many types of films to use—theatrical films edited (often badly) for special purposes, industrial films (often providing biased depictions of their subjects), government films, and a smaller number of films produced specifically for the classroom.

Silent films began to be used in schools as early as 1910 (Saettler, 1990, pp. 98–99). The 1910s and 1920s were times of considerable ferment regarding educational films. Many different individuals, companies (e.g., Ford Motor Company), nonprofit organizations, and government agencies attempted to supplement the existing supply of theatrical films and newsreels. Schools with a progressive image of themselves wanted to be viewed as being current with the new technologies and rushed to establish collections and catalogs of films. Unfortunately, many of the available films were of marginal educational value and teachers often chose to show films for reasons other than their curricular relevance. Nevertheless, interest and usage continued to grow throughout the 1910s and 1920s. By the end of the decade, over half of the state education agencies had units devoted to film or visual education and thick catalogs documented the thousands of films available to educators.

A Professional Association: DVI. Those concerned with using images to improve instruction grouped together into a variety of organizations. In 1923, one of these organizations, the National Education Association's Department of Visual Instruction (DVI), emerged and became the preeminent organization of professionals concerned with the use of still and motion pictures to improve instruction.

Audiovisual Instruction

Sound Recording. The phonograph record, beginning in 1910, was the first widely available format for recorded sound, used almost exclusively for music. Although magnetic tape displaced the phonograph for recording purposes in the 1950s, vinyl records remain in use into the 21st century. As soon as the phonograph was invented, film producers tried various methods of using this new technology to add sound to motion pictures.

Sound Films. By the late 1920s, the technique of adding an optical sound track to the film itself became the winning technology for “talkies.” However, there was considerable resistance to sound films in the education community. Some methodologists felt that the practice of having the classroom teacher add narration to silent films added a level of customization and personalization to film showings. Administrators worried about their “installed base,” the large investment they had made in silent film projectors. As late as 1936, a survey showed that schools owned ten times more silent film projectors than sound film projectors (Saettler, 1990, p. 234).

Radio. Meanwhile, another audio resource was developing. In the early 1920s, many American universities obtained licenses to operate radio stations, often as technical experiments in electrical engineering. A large proportion of these died out in competition with commercial stations, but some, like the University of Wisconsin's WHA and others in the midwest, put down roots. The operations that prospered were the ones in which radio played an integral part in the university's mission—bringing educational opportunities to the hinterlands in the case of Wisconsin (Wood & Wylie, 1977). “Schools of the air,” beaming programs to public schools, were formed in several states and cities in the 1930s. Programs were devoted to health, social studies, home economics, science, music, and many other subjects, including art.

Audiovisual Media. These audio resources were added to the growing base of visual resources. By the 1930s, schools maintained equipment pools that contained (in order of frequency) lantern slide projectors, radio receivers, 16mm silent film projectors, 35mm silent film projectors, filmstrip projectors, opaque projectors, microslide projectors, 16mm sound film projectors, and 35mm sound film projectors (Saettler, p. 234).

DVI to DAVI. The addition of an audio component to existing motion picture technology and the mushrooming of educational radio stations added a major new interest area to DVI, leading in 1947 to a change in the name to the Department of Audiovisual Instruction (DAVI; Saettler, 1990, p. 167). Thus, the first two names of the national organization that is now AECT both have in common a direct link to the emerging technological resources of the time.

Educational Communications and Technology

AV and the Baby Boom. In the post–World War II period, economic prosperity and the aging of “baby boom” children to school age led to a period of rapid expansion of schools and the educational media needed to support modern education. AV equipment and materials were at the heart of the field. In 1961, public schools in the United States owned approximately 7,000,000 filmstrips; 3,000,000 phonograph records; 1,000,000 slides; 700,000 films; and 400,000 tape recordings (Godfrey, 1967). In 1973, the heyday of the AV era, the dominant AV formats in terms of commercial sales were (in order) sound filmstrips, 16mm films, multimedia kits, audiocassettes, and silent filmstrips (Dean, 1975, p. 121).

Television. During the 1950s, dozens of noncommercial television licenses were granted and educational television programs began to be beamed to school audiences. Many of the same parties that had experimented with radio also did so with television, essentially replaying the radio scenario. As had the earlier radio licensees, the television licensees promised that “television will make it possible for the poorest and most isolated public schools to enjoy the benefits of the most modern teaching methods” (Levenson & Stasheff, 1952, p. 155).

Since this was a period of rapid school population growth, there was general shortage of qualified teachers. Television was seen by some as a way to reduce the need for teachers by replacing the presentation function with broadcast lessons. This prospect had special appeal in the southern states, attempting to operate “separate but equal” racially segregated schools. They would be able to offer quality instruction without having to staff two separate schooling systems, each with equally qualified teachers in each classroom. These were the first states to establish statewide educational TV networks. The same rationale was used in later years to justify the use of closed-circuit television in countries outside the United States that operated educational institutions segregated by gender.

In the late 1950s and through the 1960s, there were programs broadcast on a regional basis, such as the Eastern Educational Network and the Midwest Program of Airborne Television Instruction (MPATI), and a national basis, such as *Continental Classroom*. During this period, the Ford Foundation and the federal government were subsidizing the expansion of television in higher education, through grants for closed-circuit TV construction and program production. By the end of the decade of the 1960s, tens of millions of school and college students were receiving televised instruction on a daily basis.

DAVI to AECT. Although utilization of AV and broadcast materials was still the central concern of the profession, other conceptual innovations were making an impact during this period. Theories of communication arising in other academic disciplines were being absorbed; they were seen as providing powerful rationales for using sight and sound to supplement talk and reading as sources of information. The systems approach to instructional design was emerging from the military into the corporate and academic sectors. This approach merged in the 1960s with the behaviorist methods of programmed instruction and behavior management to yield a growing number of systematic models of instructional design, discussed in detail in chapter 4. The field was becoming more process oriented.

By the late 1960s, James D. Finn's promotion of the concept of *instructional technology* merged with B. F. Skinner's followers' popularization of the term *educational technology* to describe reinforcement-centered learning environments to lend momentum to the growing interest in shifting focus from a product-centered view to a process-centered view. This shift was signaled by the change of the name of the national organization in 1971 to the Association for Educational Communications and Technology (AECT), a name that persists today. The new name was adopted to reflect the organization's broader emphasis not only on traditional AV efforts, but also on the application of learning theories (cognitivist as well as behaviorist), communications theory, and systematic approaches to education (Seels & Richey, 1994, p. 13).

Computers. As described in chapters 2 and 4, computers began to be applied to educational uses as early as 1959. The PLATO and TICCIT projects in the 1960s and 1970s explored a broad range of pedagogical methods as well as a broad array of subjects. Computer-assisted instruction (CAI) was available first to college students, but programs for K–12 education emerged almost from the beginning. In the 1970s, one of the early explorers, Seymour Papert at MIT, developed a programming language called *Logo* that was specifically designed to help young children think mathematically. Children used Logo in interesting microworld environments to explore properties of music and physics. Papert later extended this approach to building virtual structures of Lego® blocks, instantiating a “constructionist” theory of learning.

The popularization of stand-alone personal computers in the 1980s released users from being connected to a wired network, creating a market for entertainment and educational products on floppy disks and later CD-ROMs and DVDs. Then the growth of the Internet, with its promise of e-mail and discussion forums, brought users back into the networking mode. In the late 1990s, when the World Wide Web provided a linkage among all the scattered networks and individual users, another level of interactivity was achieved. The Web allowed distance education to take off on a steady climb in popularity, with the promise of anytime, anywhere access. By the end of the 1990s, virtually every university and many school systems were offering menus of distance learning courses via the Web.

Impact on AECT. The changes in modes and delivery systems wrought by the computer revolution have had a deep impact on professional life in the fields related to educational technology. In the case of AECT, it has changed the dialog within the association, with the vast majority of publications and conference sessions being devoted to considerations of instructional comput-

ing. And it has brought the challenge of another association, the International Society for Technology in Education (ISTE), which appeals primarily to teachers who play leading roles in computer use in their schools. In many instances, this person, the school technology coordinator, has displaced the AV specialist or the school media specialist as the most visible representative of technology in the building.

It is clear that the early identity and the ongoing identity crises of the field of educational technology are inextricably connected with the emerging technologies of the day. If history is any indicator, educational technology will continue to maintain a central focus on the use of emerging technological resources to improve learning.

Alternative Views of Educational Technology as Resource-Driven

As the field has evolved, some people and organizations—especially those in related fields that are also concerned with using resources for teaching and training—have maintained a narrower focus on resources as hardware driven (rather than theory or processes) as they have outlined and defined their own conception of educational technology. This approach is exemplified by the International Technology Education Association's (ITEA) definition of educational technology: “The use of technological developments, such as computers, audio-visual equipment, and mass media, as tools to enhance and optimize the teaching and learning environment in all school subjects, including technology education” (ITEA, 2003, p. 17). Although the distinction between educational technology as hardware and software and educational technology as AECT has more broadly defined it is important to the AECT community and those it serves, it is equally important to understand other interpretations. In fact, it is somewhat likely that newcomers to the field very recently conceived educational technology to be something similar to the concept outlined by ITEA. The ITEA conception is in fact not only common but also understandable. However, it can be problematic to an organization seeking to promote a broader view of educational technology. The current AECT definition itself can be seen as part of an ongoing effort of the organization to continue to emphasize this broader, more encompassing view.

Emerging Technologies and the “End of Education as We Know It.” Maintaining a narrow focus on the technological tools themselves—rather than on the broader and more sophisticated educational systems in which they exist—can lead to a misreading of the potential influence that technological tools can have on education. For example, there have been many educational

futurists (often not educators themselves) who have greatly overestimated the potential impact of emerging technologies on education. A good example is Thomas Edison, who in 1922 predicted, “The motion picture is destined to revolutionize our educational system and that in a few years it will supplant largely, if not entirely, the use of textbooks” (Edison, as cited in Wise, 1939, p. 1).

More recently, renowned management consultant Peter Drucker predicted,

Thirty years from now the big university campuses will be relics . . . Already we are beginning to deliver more lectures and classes off-campus via satellite or two-way video at a fraction of the cost. The college won’t survive as a residential institution. (Drucker, as quoted in Lenzer & Johnson, 1997)

Drucker made this prediction before the Web had accelerated the pace of adoption of distance education, so it may be that he would have doubled his bet 10 years later. Or would he? Had residential colleges shown signs of going out of business in that decade?

Predictions of this sort have consistently been made as new technologies have emerged. Understanding the broader systems in which resources are deployed and used (discussed in chapter 3), along with the factors that influence change in these systems (discussed in chapter 5), would help to “soften” these types of overstatements. It is likely that we have not yet, unfortunately, seen the last of the “end of education as we know it” prophecies. When considering these historical overstatements, Reiser (2001) wisely predicted, “In light of the history of media and its impact on instructional practices, I also think it reasonable to expect that . . . changes, both in schools and in other instructional settings, are likely to come about more slowly and be less extensive than most media enthusiasts currently predict” (p. 62). It is indeed possible that there might be some future technology that quickly revolutionizes instruction. Yet when educational technology is viewed through a historical lens, it is clear that we are more likely to continue to see slower, more incremental and evolutionary changes as new technologies emerge.

Tools, Materials, and Devices as Resources

As technologies have emerged and evolved, the terms *tools*, *materials*, and *devices* have been used in many ways. The specific example of the creation, storage, and use of a training video, which provides one way of conceptualizing the relationship among these terms, is illustrated in Fig. 8.1.

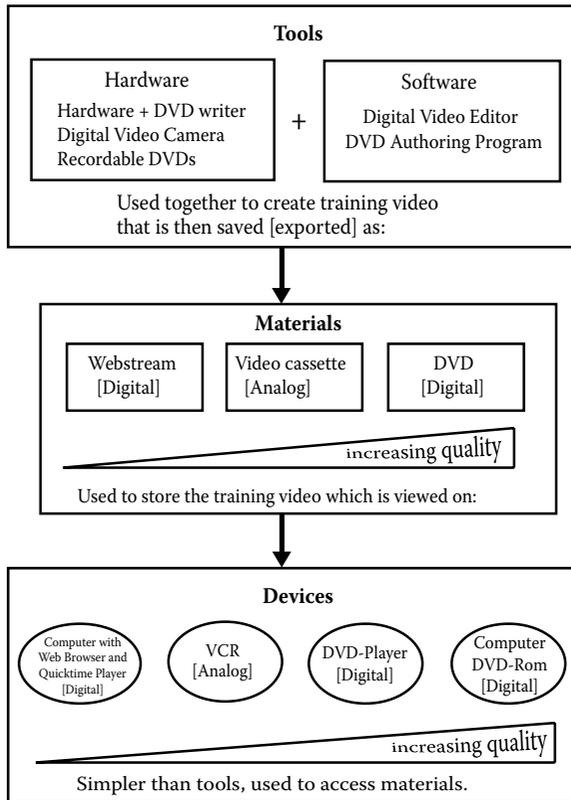


Figure 8.1. The relationship among tools, materials, and devices in creating, storing, and accessing a training video. © A. Betrus, 2006. Used with permission.

The organization of the categories in Fig. 8.1 conveys *typical* conceptions of these terms. That is, *tools* are used to create (and later manipulate if needed) *materials*, which are then accessed by *devices*. Devices are typically somewhat simpler than tools, and they are most often used primarily to access materials—both through viewing and through interacting with them as appropriate.

In the previous example, the hardware and software tools, as well as the devices, are intentionally generic, as there are many ways in which a training video could be created and used. It could be created completely with analog tools instead of using computer hardware and software. The resulting video

could be converted into a digital format using yet another tool. Further, some devices needed to access the materials are not listed but are rather implied: The DVD player and VCR, for example, need another device, a television, in order to display the video, and a computer similarly needs a monitor. To complicate things further, a tool typically can double as a playback device. The video could be viewed in the DVD authoring software directly, rather than viewing it with a separate player. In other words, the relationship among these various terms is not always as clear-cut as the diagram would indicate. However, it can be useful as a general way of looking at the relationship among these terms.

In addition to the tools, materials, and devices, the term *media* is also used in the field, although with a number of very different meanings. In popular parlance, “media” refers to mass communication enterprises (e.g., radio, television, or newspaper businesses). In educational technology, the term has historically been used to designate the delivery system through which messages are conveyed to the user—printed matter, still-image projection, television, radio, sound film, and the like. Or it could refer to instructional materials themselves—overhead transparencies, slides, filmstrips, audio-cassettes, and the like. Nowadays the term is most often used to refer to the physical devices that store data (e.g., floppy disks, flash drives, CDs, video-cassettes, or DVD-ROMs). Thus, it tends to be a catchall term that could refer to a tool, a material, or a device.

The training video example is only one of literally thousands of examples of media that have helped to augment the teaching and learning process over the past century. While an attempt is made here to describe some of the tools, materials, and devices that are used at the time that this chapter is being written, perhaps a better place to ascertain more complete and current information can be by examining various surveys and yearbooks (e.g., *Educational Media and Technology Yearbook*) that compile this type of information or by examining the content of introductory technology courses taught to preservice teachers (or the textbooks used in these courses).

Analog Tools, Materials, and Devices

In everyday use, *analog* simply means something that resembles something else. Hence, an analogy is an object or idea that is used as a point of reference to explain some other idea. The term has a more technical meaning in engineering where an analog signal is one that is continuously variable in both time and amplitude—as opposed to digital signals, which are either off or on; they are not continuously variable. Analog sound recordings are made by translating the variations in air pressure striking the microphone into a corresponding variation in voltage amplitude. That is,

the voltage fluctuation “looks like” the air pressure fluctuation; it retains all of its dimension. Analog television pictures are similar to film projections in that the entire image is painted on the screen with each frame. So audiocassettes and videocassettes are analog recording media.

By extension, the term *analog* is used to refer to all of the AV media that are not digitized, such as slides, filmstrips, and films, as well as audiocassettes and videocassettes. Some would consider these historical artifacts, as they are largely being replaced by digital equivalents, mainly for greater compression of storage and for easier transmission through computer networks. However, analog media continue to be valued for their high fidelity of reproduction (e.g., slides that project a large image in high definition) and their usability without the intermediation of computers.

An extensive collection of historic analog tools, devices, and materials is currently housed at the University of Northern Illinois in the Blackwell History of Education Museum and can be accessed via the World Wide Web through the AECT Archive Equipment Virtual Tour (AECT, 1999). Along with the use of stand-alone resources, educational technology has a long tradition of combining the functions and features of multiple tools, materials, or devices into one, *integrated technology*. The online AECT Archive Equipment Collection has some historical examples of integrated technologies, including a combined 35mm camera and projector, a combined slide projector and recorder, and a combined phonograph and filmstrip projector, among others. In fact, the affinity of educational technologists for such new, cutting-edge devices (and their application to instruction) largely has traditionally defined our field.

Although current advances in the field are clearly centered on the use of digital resources, the legacy of the field is in the use of analog resources to improve education. Even in the midst of what many see as a digital revolution, analog resources—especially the overhead projector, the VCR, and locally compiled printed materials—remain an integral part of most instructional settings. Critical attributes of analog resources—including high definition, ease of creation, customizability, and lower knowledge barriers for use—will likely ensure that they will continue to be used in a variety of teaching and learning environments well into the future.

Digital Tools, Materials, and Devices

Digital media are those that are stored and transmitted by means of digital codes, usually binary codes—0 or 1, off or on. Unlike analog media, digital representations—a series of zeroes and ones—have no resemblance to the original image or sound, which was probably initially recorded through

analog means. The advantage of digital storage is that the data are generally easier to manipulate, more compact to store, and the resulting presentation can be transmitted or reproduced any number of times without loss of quality. For example, think of a photocopy of a photocopy of a photocopy of a newspaper clipping—as opposed to the replication of the same newspaper clipping from a digitally scanned image.

Currently, typical formats of digital media are computer displays, Web pages, compact discs (CD), digital video discs (DVD), video games, and e-books. It is difficult to predict which tools, materials, or devices will be prevalent in five, ten, or twenty years. Current trends and advances in the capabilities of digital tools and devices, along with innovative ways of using them, point to a commercial trend in society to combine functions and features together into one integrated technology. An example of this type of technology is the all-in-one television receiver/VCR/DVD; or the combination of television, telephone, and Internet services through one digital service provider, delivered via one digital cable into the home. Much like their earlier counterparts dealing with analog media, current educational technologists are often working with digital integrated technologies to better facilitate learning and to improve performance in a variety of settings. Currently, the most commonly used integrated technology, from a hardware perspective, is the personal computer.

The Computer. While useful, early versions of analog integrated technologies often had the drawback of being cumbersome and requiring a high level of technical expertise. The computer—especially the home computer—offered the potential of ease of use and convenience that other integrated technologies had lacked. These features, as well as a reduction in size and cost of the computer, led in the 1980s and 1990s to the proliferation of the computer in society at large as well as in education and training. The computer combined the functionality of many previous tools and devices, and delivered instruction in easy and convenient packages to instructors and trainers. Prepackaged instructional software (most often referred to as “computer-assisted instruction,” or CAI) largely replaced previous generations of programmed instruction delivered via analog teaching machines. In addition, the computer offered the ability for both instructors and learners to create their own materials.

The computer is currently the primary means by which instructional materials are created. The word processor is perhaps the digital equivalent of the pencil and paper in that it is assumed to be ubiquitously available and a bare necessity for creating instructional materials. The most typical means of storing (saving) digital instructional materials are an internal hard drive, floppy disk, CD, DVD, USB flash drive, or Internet server. A typical scenario

might involve instruction being created locally on a computer (the computer is being used as a tool in this case) and saved as Web pages (the materials). Learners then access and interact with the materials from a remote location. In this case, the computer at the remote location is being used as a device to interact with the Web-based materials. Sometimes materials are printed, with the advantage that analog print materials do not require all learners to have access to a computer to use them. Interestingly, there is a tendency among some instructors or learners—even when digital access to materials is available—to print digital materials in order to interact with them.

The societal trend toward the increased use of the computer is very likely to continue into the foreseeable future; and as educational technology is inextricably tied to the technology of the day, it is likely that the educational resources of tomorrow will be increasingly digital and computer based. Currently, the personal computer—and increasingly the Internet—serve as the primary means by which educational technologists store, organize, retrieve, and interact with digital resources.

The Internet and World Wide Web. Perhaps the most significant added functionality of the computer was access to the Internet in the 1990s. The rapid increase in connections to the Internet in the early 1990s vastly expanded the potential for sharing information at a distance. The advent of graphical user interfaces allowed the World Wide Web to become the most popular Internet protocol. As the World Wide Web became the major service operating over the Internet around 1993, growth of users mushroomed, doubling every year until the end of the decade. Because of its ubiquity, it became the de facto standard platform for sharing resources. Being structured according to hypermedia principles—links and nodes—it largely displaced the earlier concept of hypermedia programs residing in a local computer system. Now the programs resided in the Web and could be tapped from any place in the world that could access the Internet.

In terms of integrated functionality, the Internet-ready computer has generally supplanted the majority of tools and devices that preceded it. While certainly most instructional materials are created with personal computers, and often word processors, current trends point toward an increased emphasis on creating instructional materials for the World Wide Web, with a variety of tools available for this purpose.

Computer-based World Wide Web browsers (e.g., Netscape's Navigator, Mozilla's Firefox, Apple's Safari, and Microsoft's Internet Explorer) are currently the primary means of accessing instructional materials on the Internet. The types of instructional materials available for use with a computer include educational software, educational games, instructional

simulations, edutainment software, instructional videos, reference materials, audio recordings, and movies. While much of this material is available via CD or DVD, current trends point toward accessing digital materials directly through the Internet.

Interactive environments. Educators had long appreciated the value of methods that involved learners deeply in realistic problem settings. Simulations and simulation games allow learners to explore complex dynamic situations, such as conflicts among individuals and groups. One of the barriers to development and widespread adoption of such interactive learning environments in the past was that of limited distribution potential. But with the Web as a delivery platform, it is now worthwhile to invest major resources in developing such simulations, simulation games, and other “microworlds” because of the prospect of widespread distribution, dispersing the cost of development. Immersive learning environments are also discussed in chapter 4.

WebQuests. Early on, educators saw the Web as an enormous database that could be used by students to generate their own answers to questions. Dodge (1995) created the WebQuest format for scaffolding information problem-solving experiences. A WebQuest consists of at least four components: an introduction that establishes a context for the student’s task, an inquiry task or quest, a set of preselected Web sites with information relevant to the quest, and a suggestion of how to process the information found on the Web, for example, what to look for. A WebQuest is more than a worksheet because it involves scaffolding to guide the learner; scaffolding includes the prior selection of sites that are most relevant and the provision of hints on for what to look. As a generative learning strategy, WebQuests aim for deep learning involving the construction of new knowledge through a critical thinking process (Dodge, 2001).

Web-based distance education. Distance education began in the 19th century using correspondence through the mail. It continued through most of the 20th century with radio, then television, added to the media mix. In the 1980s, as the Internet grew to encompass many home users as well as institutional computer centers it became feasible to offer distance lessons based on computer conferencing for communications among students and instructors.

During the late 1990s and early 2000s, hundreds of universities and businesses adopted the Web platform for their distance education and training, reaching millions of students, and Web-based distance education became the major growth area for educational technology. By 2006, the great majority of

all U.S. higher education institutions were offering distance education courses via Web delivery.

To some extent, “Web-based distance education” is a misnomer in that in the typical Web-based course only part of the course activities are based in the Web—perhaps only the information displays, such as the syllabus and list of assignments. Students typically communicate with one another and with instructors through other Internet services, including e-mail, bulletin boards, chats, and file-sharing via file transfer protocol (FTP), and they may use textbooks or online readings for much of the content presentation. However, the Web home page helps students navigate through the course, consistent with the instructor’s pedagogical intent and provides ready access to the interactive and communication elements of the course.

Course management systems. The software application that gave impetus to Web-based instruction was the *course management system* (CMS), developed in the late 1990s and gathering momentum in the early 2000s. The CMS is a suite of applications, tying together all the services previously mentioned, so that students can log in once and have all of their communication services available at a click, without jumping in and out of the Web. For example, once the instructor creates a course, a student can access a course syllabus, assignment materials related Web sites, and posted grades. The instructor and students can communicate with each other in discussion forums.

Blackboard.com introduced its first CMS, CourseInfo, in 1999. By 2006, Blackboard merged with its largest rival, WebCT, and dominated the field of college and university CMSs, although rival open-source software CMS systems were also being developed, such as Moodle and Sakai. On the corporate side, the term *learning management system* (LMS) is preferred, referring to systems that not only provide instruction but also keep records of users’ progress, documenting their accomplishments and certifications they may have acquired.

Emerging applications. There is much educational promise in the emerging functions and features of new Internet and Web applications. Weblogs (blogs), for example, provide a high level of interactivity among users, who could be instructor and learners. Teachers can post online the most current course information for students, and both teachers and students have the ability to communicate in a highly interactive, up to the minute online space where they can place text, pictures, videos, and music to enhance their understanding of given content domain. Similar to Weblogs is the *wiki*, a type of Web site that allows users to freely and collaboratively add, modify, and otherwise manipulate online information towards a collective understanding of an idea or concept.

Mobile media. Additionally, while the majority of Internet access is achieved through the Internet-ready desktop computer, there has been a trend toward accessing the Internet through smaller, portable devices such as digital phones, watches, laptop computers, compact computers, handheld computers, and personal digital assistants (PDAs). These resources, along with other mobile technology such as game devices and MP3 players, are becoming more and more the norm and may someday supplant the desktop computer as the primary way in which information on the Internet (e.g., e-mail, discussion forums, blogs, wikis, and other applications) is accessed and interacted with.

Electronic Performance Support Systems (EPSS). Electronic Performance Support Systems (EPSS) might best be described as Web-accessible electronic databases that provide information in a just in time fashion to employees in an organization. An EPSS often takes the form of a “help” system to assist employees solve work-related problems. The EPSS usually stores organizationally specific expert knowledge for employees to reference as needed. Although such cognitive support systems are not designed as educational tools or resources, learning can happen. That is, as users summon the same chunk of information repeatedly they may come to remember and internalize the information. This sort of usage can somewhat blur the distinction between providing information and instructing.

Settings as Resources

Appropriately organizing the context in which problem-solving and performance-improving activities takes place is a critical component of good instructional design. This context includes both internal settings, such as classrooms or learning labs, and external settings, such as museums or zoos. Recently, as constructivist learning theories have become more popular and widespread, there has been an increase in efforts to organize authentic, complex, information-rich learning environments. Whether the setting in which learning and performance take place is internal or external, simple or complex, the ability to organize it appropriately is essential for educational technology professionals.

Community Resources

Community resources such as museums, libraries, zoos, hospitals, police stations, and fire departments can serve to expose learners to authentic examples of concepts and ideas they are studying in a classroom. The means

by which students interact with these community resources is typically by traveling to one of these locations, that is, by taking a field trip.

Field Trips. The field trip has maintained itself as a staple in schools. Heinich, Molenda, Russell, and Smaldino (2002) described it as “an excursion outside the classroom to study real processes, people, and objects, [which] often grows out of students’ need for firsthand experiences. It makes it possible for students to encounter phenomena that cannot be brought into the classroom for observation and study” (p. 90). The emphasis on unique experiences not available in the classroom (except through lesser, more abstract means) is often the primary criterion used to justify the time, effort, and expense associated with field trips.

Virtual Field Trips. While similar in purpose to conventional field trips, virtual field trips are enabled by technology and offer the possibility of exploring many locations that would otherwise be too expensive or even logistically impossible to visit. The technological resources for a successful virtual field trip include (but are not limited to) one-way video, two-way video conferencing, telephones, e-mail, instant messaging, and online discussion forums. Roblyer, Edwards, and Havriluk (1997) explain that virtual field trips “are designed to explore unique locations around the world and, by involving learners at those sites, to share the experience with other learners at remote locations” (p. 230). In practice, while virtual field trips do offer experiences with remote locations (most often via the Internet), they are more likely not to be live and not to involve interaction with peers. Virtual field trips without live interactions could also be classified as reusable learning objects. Regardless of the “flavor” of the virtual field trip, each type has in common the goal of providing students with access to locations that might otherwise be impossible to explore—especially such exotic locations as the ocean floor, outer space, and medieval castles.

Information-Rich Learning Environments. The Cognition and Technology Group at Vanderbilt University has conducted a great deal of research and development around the notion of engaging learners in realistic problematic situations. The group describes four roles for technology in creating and implementing “technology-rich instructional environments that support learning and understanding”:

1. Bringing interesting and complex problems into the classroom
2. Providing resources and scaffolds that support learning and problem solving

3. Providing opportunities for feedback, reflection, and revision.
4. Supporting communication and community building (Goldman, Williams, Sherwood, Hasselbring, & Cognition and Technology Group at Vanderbilt, 1999, p. 13).

These sorts of immersive settings are also known as rich environments for active learning (REAL) and are discussed in chapter 4.

People as Resources

Support staff and subject matter experts often serve as resources for instructors and learners. These people have advanced knowledge and experience dealing with specialized learning resources. They are often used when the knowledge and experience of the facilitator and/or learners needs to be augmented with the advanced knowledge and understanding that these specialists can provide. In some cases, these people might be *resources by design*, in other cases, *resources by utilization*.

Educational Technology Specialists

A clear example of a *resource by design*, the educational technology specialist serves to make sense of the sheer quantity of available resource options. Currently, as technology use has become more widespread, and more technical knowledge is required to use technology, the need for educational technology specialists (also known as “technology coordinators” and “instructional support specialists”) in K–12 schools, universities, and business and government organizations is even more pronounced than in the past. Additionally, educational technology specialists are often primarily responsible for addressing the ethical considerations that arise when using and managing resources.

In Schools. These technical experts often constitute the primary source of support for the increasingly diverse technological needs of school systems. Most are expected to support the teachers’, students’, and administrators’ use of technology to support learning. They often take on the additional role of maintaining the school technology infrastructure—including Web servers, e-mail servers, and the school data network. While some schools have the resources to support separate network specialists, often funds are limited. In these cases, the educational technology specialist takes on the roles of not only instructional support and technical support but also, increasingly, network support.

Some consider library science a “sister” field to educational technology, and there is a significant overlap in the training that professionals in each field receive. The library media specialist has many of the same skills as the educational technology specialist, as well as highly specialized knowledge of the organization of information and means for gaining access to information databases and other information sources. The library media specialist often receives formal training in instructional design and is charged by the library media profession with being “a primary leader in the school’s use of all kinds of technology . . . to enhance learning” (AASL & AECT, 1998, p. 54).

In Colleges and Universities. Colleges and universities typically have some version of a center for the support of faculty using technology. Beginning around 2000, there has been a trend toward creating new centers or reconfiguring old ones into the form of a teaching and learning technology center (TLTC). Hundreds of universities now support a one-stop shopping center where faculty can go to get help preparing technology-based instruction. Typically, according to Long (2001), these TLTCs combine the services of information technology support and faculty development, sometimes adding the library.

Educational technology specialists working in these units tend to specialize in instructional support, leaving the technical support, server maintenance, and data network support to a group of people in a different section or department. The typical model is that the TLTC is available to faculty who are seeking to improve their courses and who look to the expertise of these specialists for advice and help. Recently, activities in these centers have included assisting faculty as they place materials into online course management systems. Other activities include improving PowerPoint™ presentations, setting up and managing listservs, and creating Web pages. In many universities, this center has also assumed the responsibility of assisting instructors as they transform their courses to an online format, although in certain cases separate distance learning agencies take on this role.

In Corporations, Government, and Other Large Organizations. Businesses, corporations, and government organizations often maintain the rough equivalent of educational technology specialists on staff at central locations, satellite locations, or both (depending on the size and mission of the business). These personnel usually work in training departments and typically carry the title of trainer, training specialist, or the like. Like their counterparts in the university, these specialists directly support training and learning within their organizations. They often provide broad technology support, and they generally develop and deliver training to employees at the request of management.

In schools, in colleges and universities, and in commercial and government settings, educational technology specialists offer vital services and expertise. They serve as technological resources for students, teachers, employees, and members of organizations who attempt to enhance learning using technology. While historically they have been seen as important, the increased need for organizations to take full advantage of technological resources has made them essential.

Subject Matter Experts

A good example of a *resource by utilization*, the subject-matter expert (SME) is typically used as a resource for those involved in the design of instruction. SMEs are often used as checks in the creation of instructional processes and resources. Early in the instructional development process, SMEs provide input into the decisions about what content is appropriate to be taught. Later in the instructional development process, the design team will typically present instructional objectives, instructional materials, and assessment tools to SMEs for feedback. The SMEs draw upon their own significant professional and practical experience in the content areas to offer their opinions regarding the quality of the materials.

SMEs are sometimes used *during* instruction as a way to give students direct access to experts. Museum docents, who serve as expert tour guides and are available to answer questions, provide one example of such use. Book authors are another example, as they sometimes agree to communicate directly with students who are studying and analyzing their works. And while teachers in the conventional sense are most often not considered to be resources, expert teachers are often used as resources to deliver guest lectures, speeches, or seminars. In this sense, the expert teacher, serving as a consultant, would be considered an SME and an instructional resource. In each of these cases, the expert knowledge of the SME is used as a resource during instruction.

More recently, SMEs have been used as integral parts of creating and implementing learning environments. Experts in specific subject areas are available within these environments as resources for students to consult as they explore topics and issues. For example, the leader of a local acting troupe could be an SME for middle-school students to consult when putting on a school play. For an amateur violinist, a professional violinist could serve as an invaluable learning resource, at the appropriate time in the amateur's development. Interestingly, the use of SMEs in this manner approximates an apprenticeship model, albeit on a much smaller scale. Historically, apprenticeships have been, especially prior to the development of the printing press,

the most pervasive form of passing expert knowledge from generation to generation. While providing learners with access to people with expertise in a given area is often untenable for long periods, offering such access for short periods, or even electronically, can be very valuable in helping learners develop high-level skills in a given area.

Ethical Uses of Resources

Issues such as cost, accessibility, and equitable allocation of resources have become increasingly important in recent years. A central ethical concern for educational technology professionals is the effort to ensure equitable access to resources for all learners. The digital divide and the implementation of the Rehabilitation Act Amendments of 1998 are two areas of ethical concern.

The Digital Divide

As resources become more powerful, and often more expensive, the phenomenon of the *digital divide*, or the disparity between technology haves and have nots, has arisen as a problem for educational technology professionals, as well as for society as a whole. The digital divide is predominantly a socio-economic divide, and it is most visible in the disparity between wealthy and poor schools and communities. This divide is most obvious when comparing schools in wealthy nations to schools in poorer nations, although even within wealthy nations there remains a pronounced disparity of resources between rich and poor schools. As this is largely an economic problem, the solution is largely economic. By way of addressing this situation, grant money is often used to supplement technology resources in poorer settings, and an educational technology specialist will often serve as the primary grant writer and coordinator, especially for larger grants. Additionally, an educational technologist with proper training in using resources effectively and efficiently can serve as a valuable resource for those schools looking to make the most of the resources they have.

Accessibility and Universal Design

Equal access to information for all U.S. federal employees was addressed when the 1973 Rehabilitation Act was amended in 1998. Included in the amendment was a strengthening of section 508, which now requires that members of the public with disabilities have equal access to technology. This requirement applies not only to federal agencies but also to any school

or organization that receives federal funding. Fundamentally, it states that resources, especially electronic and information technology (e.g., Web pages), must be made accessible to people with disabilities. Accessibility can be provided either by proactively designing the resource to be accessible or by retrofitting existing resources using commercially available accessibility tools.

The concept of *universal design*, or the creation of resources that are as broadly useful to as many people as possible, has become increasingly popular as sensitivity to accessibility issues has become more and more widespread. While universal design does not necessarily address all accessibility issues, it does help to ensure that resources are created with the diverse needs of potential users in mind. Universal design of a product alleviates many of the accessibility issues that might otherwise arise.

Conclusion

Resources can take the form of the tools, materials, devices, people, and settings that learners interact with to improve learning and performance. Historically, the identity of the field is intertwined with the use of the emerging technologies of any given era. In the latter half of the 20th century, the field grew beyond the earlier, simpler, resource-driven conception of educational technology. Along with an emphasis on communication and learning theories, a shared focus of the field of educational technology remains on the *appropriate* use of emerging *technological resources* to facilitate learning and improve performance.

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