

A Brief History of Educational Technology

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Since the early 1900s, education and training professionals have been intrigued with the potential of new technologies to advance human learning. The field of study and practice that evolved around this interest has borne many different labels over the years—visual education, audiovisual education, educational communications, instructional technology, and educational technology—as documented in the various “definition” statements issued by the Association for Educational Communications and Technology (AECT) and its predecessor, the Department of Audiovisual Instruction (DAVI): (McClusky, 1923) (Ely, 1963) (AECT Task Force on Definition and Terminology, 1977) (Seels & Richey, 1994) (Januszewski & Molenda, 2008). The common thread that ties these definition statements together is the quest to find ways to help people learn faster, better, more affordably, and more humanely through the application of contemporary technologies. For this concept we will use the label of *educational technology*, on the basis that it is the broadest and most popularly used term over the past century.

This quest for efficiency and effectiveness has been driven forward by a series of new psychological theories and new technological innovations, each of which appeared to offer dazzling new vistas for the enhancement of human learning. We can speak of these developments as new paradigms, that is, new frameworks or new ways of thinking about the complexities of human learning. Since educational technology is inherently an interdisciplinary field, many of the theories and innovations that have impacted the field have originated outside the field. In this chapter we focus on those external influences that made a lasting impression on educational technology. We propose that the history of educational technology can be viewed as a procession of contending paradigms, each looking at the problem a little—or a lot—differently, but all revolving around the notion of improving learning through the application of contemporary technologies. Note that *technology* can be viewed both as “hard” technology—the hardware and software employed to facilitate learning—or “soft” technology—the application of science or other organized knowledge to practical problems, exemplified by instructional design models, programmed instruction, and the other programmed technologies discussed below (see heading of “Programmed Instruction”). Specifically, we will discuss the paradigms of visual education, educational communications, audiovisual education, instructional technology, programmed technologies, instructional systems development, interactive multimedia, and several Information Age paradigms—democratization of media access, inclusion, distributed learning, and emerging technologies. Each paradigm will be given approximate beginning and ending dates; these dates are meant to be interpreted loosely, signifying the period of time when each paradigm held the center stage. Of course, none of the paradigms sprang fully formed on a specific date, nor did any cease to exist. To this day, each paradigm still lingers in the consciousness of the field and each still has applicability to a certain range of issues.

Any historical narrative of educational technology must make some reference to the broader social, economic, and cultural forces impacting institutions of education and training. While exploring these external forces in depth is beyond the scope of this chapter, we do offer brief descriptions of the most important factors. More extensive discussion can be found in Saettler’s authoritative history (1990) and in Bradshaw’s more recent analysis (2018).

The Visual Education Paradigm, 1905-1945

Early Technological Innovations

The invention of high-volume lithography in the late 19th century enabled the mass production of large-format color prints, known today as art prints or study prints. As they were expensive to produce, a school, university, or museum might possess only a few copies of a given artwork or scientific illustration. Caring for and promoting the use of such prints began to form the basis for a new professional specialization. The invention of photography and later the incandescent light bulb added lantern slides to the domain of that specialization, known as *visual education*. The beacons of the new movement were, first, the big-city museums, then museums within school systems, most prominently, that of St. Louis. Under the leadership of curator Amelia Meissner, the St. Louis Educational Museum housed and circulated some of the largest visual collections for educational purposes – from art prints to photographs to lantern slides and stereographs. By 1906, the St. Louis Museum made some 5,000 deliveries to classrooms every year (Saettler, 1990, p. 129).

Movies and their Sociocultural Setting

The innovation that drove the movement, though, was movies. Theatrical films (silent until 1927) had been popular since the 1910s; dramatic silent films such as *The Birth of a Nation* (1915), *Ben Hur* (1925), and *Wings* (1927), were viewed by millions nationwide. As with other mass media that were to arrive later—especially radio and television—commercial producers catered to the tastes of the dominant demographic, which was white and native born. Thus, indigenous, black, Latinx, immigrant, and LGBTQ(+) communities tended to be invisible or treated as stereotypes. Indeed, movies such as *The Birth of a Nation*, which glorified the rise of the Ku Klux Klan, contributed to the consolidation of racially discriminatory attitudes. Unfortunately, even films that were expressly made for school or college use tended to reflect these biases since producers were seeking acceptance by the majority culture to avoid limiting possible sales.

In any event, dramatic theatrical films convinced educators, civic leaders, and religious leaders that film had a singular power to inform and persuade. All were eager to harness the power of film for their own purposes. This created a market for entrepreneurs to create films for educational purposes and to adapt projectors for school and church showings. Between 1905 and 1923, sixteen large-city school districts had established bureaus of visual education (McClusky, 1923, p. 11). These agencies were building libraries of films and slides for loan to teachers within their district. By 1923, the highly flammable nitrate film (which required fireproof booths) had been replaced by cellulose acetate “safety” film, which initially was 35 millimeters in width. By 1930 the new film format of 16 millimeters had become standard for non-theatrical movies, so the smaller, lighter 16 mm projectors began replacing 35 mm projectors in schools, churches, and civic organizations. Shortly after, sound films began to replace silent films. All these technological innovations made film more accessible and more affordable for educational institutions. Ownership of slides, films, and projectors crept steadily upward.

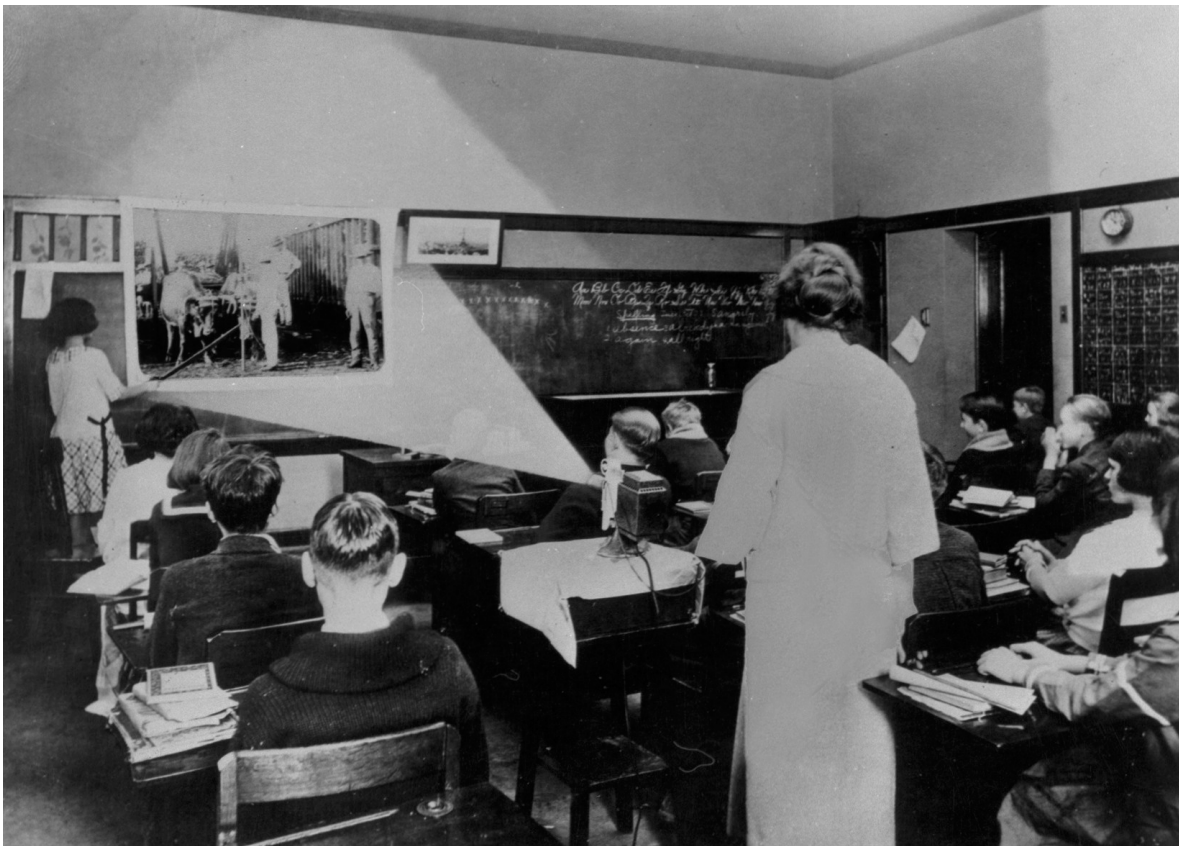


Figure 1. Early filmstrip projector

Pedagogy of Visual Education

The pedagogical principle underlying the visual education movement was that meaningful learning required rich and varied experiences, not just the rote memorization that characterized previous classroom practices. The shining goal of the movement was to surmount the limitations of “verbalism,” that is, reliance on the spoken and written word—lectures and textbooks (Hoban et al., 1937). Visual education advocates viewed learning experiences as falling along a continuum from concrete to abstract and then firsthand, concrete experience was not feasible, visual images could lend a measure of realism, giving concrete meaning to the ideas being studied. Edgar Dale’s “cone of experience” was the most popular reference for this principle (Dale, 1946). This concept became so misused over the following half-century that a comprehensive refutation of the corrupted uses was later issued (Subramony et al., 2014).

The Great Depression and World War II

During the Great Depression of the 1930s and continuing through World War II, schools, colleges, and community organizations were unable to continue the momentum of increasing availability of visual hardware and software; in fact, the federal government conducted an aggressive program of acquiring projectors from educational institutions in order to carry out their own agenda of massive, accelerated military training. During the war, great strides were made within the military regarding the production and utilization of training films, guided by a crash program of research on film production and utilization. Schools and colleges came to reap the benefits of the advancements made during the war, but only after demobilization brought the experts home and economic recovery allowed educational institutions to flourish again.

The Educational Communication Paradigm, 1930-1990

With the advent of broadcast radio, educators began to envision a new prospect: sending educational content out into the ether, where it could be received by listeners no matter how distant they were from educational institutions. The focus of the educational communication paradigm was on the components of the delivery system: the source, the message, the channel, and the receiver (Berlo, 1960). It was based on the newly emerging field of information theory (Shannon & Weaver, 1949). Thus, the educational communication paradigm represented another way of looking at the process of learning from visual and auditory media. It accepted the claim that auditory and (in the case of television) visual enrichment enhanced concept formation and retention, and it added the claim of logistical efficiency—being able to learn without bearing the cost of teachers or schools. This is the claim that underlies not only educational radio and television but also distance education over the internet.

Educational Communication via Radio

Radio, the new medium of the 1920s, like movies, inspired a wave of enthusiasm regarding its potential to bring the blessings of education directly into the home. Although radio carried only words, music, and sound effects, it had the ability to paint word pictures that evoked vivid visual images in the listener's mind. If used to create dramatic portrayals, it could bring history and social studies to life. Basically, though, the rationale for considering radio was that it promised to free education from the limitation of physical location. Anyone, anywhere, could potentially receive broadcast signals. The voice of the teacher could reach thousands of people simultaneously, even those located far away from the origination site.



Figure 2. Boys listening to the radio

In many countries, including Canada and most European countries, radio was quickly put under the control of the national government, with the primary goal of informing and educating the populace. In the United States, the Radio Act of 1927 put the national government in charge of granting broadcast licenses, allocating most of the spectrum to commercial stations. Licenses were also granted to educational institutions, and many universities and school districts undertook experimental operations in the 1910s and 1920s. However, most withered over time as it became clear that money was required to attract and retain skilled engineers, writers, producers, and on-air talent. One state, Ohio, made a serious effort to incorporate radio programming into the K-12 curriculum. The Ohio School of the Air began broadcasting school programs in 1930. The weekly schedule addressed both elementary and secondary school subjects (Saettler, 1990, pp. 198-199). Although Ohio was considered a leader in using radio in the schools, a 1941 survey found that, even in Ohio, only 46% of schools possessed even one radio set. The national average was only 14% (Reid, 1942a).

The nature of broadcast signals entailed another barrier—without recording devices, schools had to receive the program at the time it was broadcast, meaning school schedules would have to be standardized around the broadcast schedule, which is simply unworkable in a schooling system as locally controlled as that of the U.S. That lack of standardization pertains to curricular content as well; even with today's stricter state standards, the variation in curriculum content from place to place is substantial. These problematic issues were well understood from the very beginning; they were discussed in detail by Dent (1937, pp. 125-126).

Educational Communication via Television

As with movies and radio, television inspired an outpouring of public speculation about its educational potential: "Television will be the instrument which will create as complete a revolution in the education of the future as the discovery of movable type..." (Stewart, 1941), presaging the uncritical techno-enthusiasm reflected in the "emerging technologies" paradigm, discussed below. Coming out of World War II, with rapidly expanding school and college populations, television was viewed as a potential solution. It could enable a single master teacher to reach multiple classes of students simultaneously. For adult education, it could enable interested adults to gain new knowledge and skills without leaving the comfort of home and without having the trouble and expense of matriculating at a college. However, as with radio, the United States federal policy allocated television channels mainly to commercial operators. Later, as the result of lobbying by the Joint Council on Educational Television (JCET) and the determined efforts of commissioner Frieda Hennock, the Federal Communications Commission (FCC) in 1952 reserved 242 channels for non-commercial stations. A variety of operators emerged, including community groups, universities, public school boards, vocational education boards, and state departments of education. Their missions varied widely, from cultural programming for the community to direct instruction for schools. The community stations eventually prospered after passage of the Public Broadcasting Act of 1967, which supported the operation of non-profit stations that came to be sustained by the contributions of viewers and philanthropic foundations.



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Figure 3. Freida Hennock

However, the adaptation of broadcast television to instructional use encountered the same obstacles as broadcast radio: how to craft program content to fit varying school district curricula and how to schedule programs to fit varying school schedules. On top of these difficulties was the ever-present issue of funding. Philanthropic foundations, such as the Ford Foundation's Fund for the Advancement of Education, supported some educational experiments. Federal programs, such as the Educational Television Facilities Act of 1962, sprinkled several tens of millions of dollars over a decade into the support of school and college television, but never enough to create real momentum to the effort. A business model that made sense for production and distribution of K-12 televised instruction was developed by the Agency for Instructional Television (AIT) in 1970. Its consortium plan allowed the cost-effective development of successful series in many different subject areas, such as math skills, writing, and early childhood and adolescent emotional development. U.S. state (and Canadian provincial) departments of education could "buy in" to a potential project that suited their needs, sharing the costs of production and distribution (Middleton, 1979). Thus, mass-distributed televised instruction—broadcast through community, school district, and university stations and distributed through closed-circuit systems—reached millions of students from the 1950s through the 1970s (Wood & Wylie, 1977; Zigerell, 1991).

Morphing from a Broadcasting Model to an Audiovisual Resource Model

It was only after the introduction of the videocassette recorder in the 1970s that educators were able to break through the timing and scheduling barriers of the broadcasting model. If one teacher in one school wanted to use a particular series, they could borrow or purchase one or a full set of videocassettes. As users began to prefer videocassettes to film, the business model of educational film libraries began to crumble. Films that could be borrowed "for preview" might be locally converted to videocassette, depriving the film library of a sale. By the late 1970s, many of these film libraries stopped purchasing new films and switched to videocassettes, duplicating films and new video titles as requested by customers. In this form, instructional television resources continued to be widely used until the onset of Web-based resources in the 1990s.

Correspondence Study to Distance Education

University-based programs of correspondence study, later to be known as *distance education*, took root at the University of Chicago and Columbia University late in the nineteenth century. These programs involved mailing printed lessons to which students mailed back written responses, which were graded by monitors who returned feedback to the student with the next lesson. This mode of operation was rendered obsolete in the 1970s when Britain's Open University (OU) inaugurated programs based on broadcast radio and television, supplemented with print and cassette tape materials mailed to students. Another key element of the program was interaction with tutors—at local learning centers or by telephone (Molenda & Subramony, 2021). This model was based on the educational communication paradigm—expanding educational opportunities by transmitting lessons through broadcast media to reach potential learners wherever they were.

The Audiovisual Education Paradigm, 1946-1983

What began as the *visual* education paradigm gradually evolved into the *audiovisual* education paradigm, referred to by Davies (1978, pp. 20-21) as "the audio-visual archetype." The shift in focus came as sound film and sound filmstrips replaced the earlier silent versions. As this was happening, sound recording and playback became more accessible, thanks to magnetic audio tape recording. In the visual education era, the only source of recorded sound was the phonograph record, which was the most frequently used technology tool in schools (Dent, 1937, pp. 120-121). The audio tape recorder allowed teachers and students to create their own audio products. Thenceforth, the movement advanced under the flag of *audiovisual* education. It carried forward the perspective of the visual education paradigm: that auditory and visual enrichment aroused the interest of learners and enabled them to grasp abstract concepts more clearly and retain them more permanently.

The Post-World War II Sociocultural Environment

The end of the war brought an end to rationing and shortages of critical materials. In the U.S., it also brought the homecoming of millions of military personnel. During the war, women stepped in to replace men who departed for military service. The

resulting percentage of women in the work force rose from 26 to 36 percent. After the war, most of those women wished to remain in their jobs, but jobs shrank as industrial output turned from wartime to peacetime production. Though industrial employment for women decreased the expanding service and education sectors provided new work opportunities. At the time, these new work opportunities were still mainly identified as “women’s work” (this included elementary school teaching and school library services, which were beginning to merge with audiovisual services) (Department of Labor, Women’s Bureau, 1946).

Up to this point, women were not a particularly visible part of the educational technology profession. The job of school or university “audiovisual director” typically went to men—returning veterans who had participated in film and audiovisual work during the war, science teachers who were the heaviest media users, or simply men who had the physical strength to handle the bulky audiovisual equipment of the day. Women often served behind the scenes—ordering, cataloging, reviewing, storing, and distributing audiovisual materials—but seldom appeared in leadership positions. In fact, during the first half-century of AECT’s existence (known then as DAVI), only four women served as president of the association. Anna L. Hyer, who served as executive secretary from 1958 to 1969, was viewed as somewhat of an anomaly—a successful woman leader in a “man’s field.” In the second half-century, after the nature of the profession had changed, fourteen women served as president.



Figure 4. DAVI Board



Figure 5. Anna Hyer

The return of peacetime conditions led to the “baby boom.” As families grew and moved to the newly built, expanding suburbs, educators scrambled to build schools and supply them with qualified teachers. Meanwhile, the “G.I. Bill” (officially, the Servicemen’s Readjustment Act of 1944) offered subsidized college education for nearly eight million veterans over the next decade. The surge of new students at all levels prompted renewed interest in finding ways to use technology to help professors cope with overflowing classes of new students. The audiovisual education profession, then populated by thousands of veterans who had participated in “rapid mass training” programs during the war, explored methods of using audiovisual media in a systematic way to serve more students per instructor.

Technological Innovations

At the top of the hierarchy of audiovisual media was the film. As one observer noted, “the educational motion picture, in the parlance of the golf course, can be likened to the driver. A well-outfitted golf bag, however, contains a varying assortment of other types of clubs—each in its own way peculiarly adapted to a different type of shot” (Flory, 1957, p. 458). Films were then in color and with sound; they were shown on smaller, portable projectors, built rugged and reliable to military specifications. The other “clubs in the golf bag” included: 35 mm slides and filmstrips; overhead projectors that were developed during the war; record players—the most popular media device since the 1920s, now transistorized; and the magnetic tape recorder, invented in Germany and brought home by veterans. The other “clubs in the golf bag” included: (a) 35 mm slides and filmstrips; (b) overhead projectors (developed during the war); (c) record players, popular since the 1920s and now transistorized; and (d) the magnetic tape recorder, invented in Germany and brought home by veterans.



Figure 6. Overhead projector at an elementary school

The highest hopes of visual education advocates were lavished on television, which was beginning its explosive trajectory to become the dominant mass medium of the nation. It appeared to be the ideal solution to the problem of covering the shortfall of qualified teachers and professors. Broadcast and closed-circuit systems gained a foothold in the 1950s, supported by state and national government subsidies and philanthropic foundations—especially the Ford Foundation. By 1960, around 50,000 television receivers were being used in K-12 classrooms (Finn et al., 1962, p. 54). However, as discussed above, the issues of curricular diversity and non-uniform classroom schedules were never solved. Nor was a solution found to the high cost of acquiring and maintaining equipment and of producing high-quality programs. Hard experience also proved that teachers were leery of embracing a tool that had the potential to replace them. Video software ultimately found a good measure of acceptance when it was translated into videocassettes and added to library shelves alongside films as another audiovisual resource, useful for supplementing teachers' class presentations.

Sputnik and the National Defense Education Act of 1958

Historically, in the U.S., the fear of a government mandated national curriculum impelled both major political parties to oppose national funding of any level for education. That fear was superseded by a larger threat—the resurgence of the Soviet Union,

symbolized by the launching of the first space satellite, Sputnik 1, in 1957. Less than a year later, Congress passed the National Defense Education Act (NDEA), which authorized expenditures of around \$200 million per year over a four-year period. Its major purpose was to upgrade science education, but one particular provision—Title VII—supported research and information dissemination on the utilization of radio, television, film, and other media. Further support came in the form of the Higher Education Facilities Act of 1963, the Elementary and Secondary Education Act (ESEA) of 1965, and the Higher Education Act (HEA) of 1965. These laws were meant to address the needs of the “baby boom” generation, who were now of college age and whose children were approaching elementary school age. Thousands of new schools, vocational-technical institutes, and college buildings were constructed and equipped with the latest technology. After 1969, the Nixon administration began to cut back on these initiatives, but many popular programs survived and continued to be funded for decades.

The most notable beneficiary of NDEA was the innovation known as the *language laboratory*—a room equipped with audio listening, recording, and playback equipment for foreign language practice. Although typical language labs cost around \$10,000, they were snapped up by secondary schools and higher education institutions at a rapid rate. Finn, Perrin, and Campion estimated the expenditure of over \$100 million in the six years after the implementation of NDEA (1962, p. 49).



Figure 7. Tape recorder language lab

The Civil Rights Movement and Educational Change

Throughout the late 1950s and early 1960s, protest marches and political pressure mounted, urging action to resolve the issues of poverty and racial inequalities. In response, President Lyndon Johnson, under his “War on Poverty” campaign, pushed through the Civil Rights Act of 1964 and the Elementary and Secondary Education Act of 1965. The former was intended as a mechanism for supporting school integration (which had supposedly been mandated since 1957); the latter was meant to bolster schools that served low-income children. These funds gave needed impetus to the audiovisual education enterprise by

providing audiovisual equipment and materials to low-income and bilingual schools, by encouraging the use of educational television on a statewide basis to enrich the curricula of schools undergoing desegregation, and by supporting the development of stronger state education agencies, including audiovisual and school library departments.



Figure 8. Girl operating film projector

During the 1960s AECT grew to its largest membership, reaching almost 10,000 in 1970, and its greatest national prominence. A group plurality of members served as audiovisual coordinators at the school building and district level. It remained an overwhelmingly white profession until after the passage of the Equal Employment Opportunity Act of 1972, which prohibited job discrimination based on race, religion, national origin, or sex. Following the passing of this act, the numbers and visibility of women and people of color increased within AECT membership; two women served consecutively as president in 1978 and 1979, and the first non-white president, Wes McJulien, was elected in 1980.

Demise of the Audiovisual Coordinator

Over the next thirty years, as “library media specialists” took over most of the school-level AV duties and as computer technologies replaced many audiovisual technologies, “AV coordinator” positions decreased dramatically. By 1999, AECT membership dropped to about 1,000—of whom only ten percent worked in K-12 education. By 2020 the percentage of members in the K-12 category fell to about one percent, with university faculty and graduate students comprising most of the remainder.



Figure 9. Media Specialists in a library

The Media vs. Methods Debate, 1983 to 1991

The audiovisual paradigm implies that audiovisual media themselves exert a direct impact on the quality of instruction. This assumption had been questioned since the 1970s, but the issue erupted into widespread discussion with the publication of a major research review challenging the proposition that media have direct causative influence on learning (Clark, 1983). Later, in a review of research on computer-based instruction, Clark reached a conclusion that shook the foundations of research on audiovisual media. He demonstrated that in experiments that compared an audiovisual treatment with conventional instruction, the more successful treatment was usually not the audiovisual treatment but rather the treatment that employed a more powerful *pedagogical method* (Clark, 1985). He concluded that what mattered in improving instruction was not “using more media” but “using better methods.” This became known as the “media-methods debate.” Discussion of this critical issue was marked by a number of exchanges between Clark and various critics, especially Robert Kozma (Kozma, 1991). All parties to the debate conceded that audiovisual media offer a wide range of logistical advantages (e.g., reaching more learners at lower cost) and pedagogical potentials (e.g., making abstract concepts more concrete), but their potential for improving learning outcomes depends on whether the lessons in which they are incorporated employ powerful instructional methods.



Figure 10. Richard Clark

Evolution of “AV Education” Paradigm toward “Instructional Technology” Paradigm

The audiovisual education movement championed the notion of making learning richer, more permanent, and more meaningful by supplementing or replacing verbal presentations with audiovisual ones. This ideal is captured in an ad for DeVry film projectors in *Educational Screen*, December 1929: “Motion pictures turn words into reality. To the sometimes dull routine

of school work—motion pictures bring a dramatization of study subjects that turn words into reality—leave impressions that never fade.” But one of the great visionaries of the field had an even more expansive vision. Based on his experience in officer training at the General Staff School during World War II, James D. Finn developed a vision of revolutionizing education by creating comprehensive *systems* of instruction that combined audiovisual media with diverse instructional strategies—large-group, small-group, and individualized. The instructional technology paradigm accepted the rationales of the audiovisual education paradigm and added the claims of increased efficiency and effectiveness—which were achieved by putting lessons into a more highly structured, repeatable framework and adding feedback loops in the form of testing and revision. As a professor at University of Southern California and president of the Department of Audiovisual Instruction (predecessor of AECT) in 1960, he shared his vision of *instructional technology* in over 100 books, articles, and published speeches. This promotional campaign was exemplified by his series of articles on “Automation and Education” (Finn, 1957a) (Finn, 1957b) (Finn, 1960). The acceptance of this new paradigm was signaled when the association adopted its new name in 1970—Association for Educational Communications and Technology.



Figure 11. James Finn

Finn's 1950s vision of *instructional technology* would not be fulfilled until the next paradigm—programmed technologies, including computer-based developments—came to fruition in the next three decades.

Programmed Technologies Paradigm, 1954-1989

The paradigm represented by programmed technologies had a completely different origin and evolution than the visual/audiovisual paradigm. It was not based on the visualization of concepts or enrichment of the learning experience. It aimed to replace the highly inefficient method of lecture-and-testing with a tightly controlled, reproducible product that maximized efficient use of learner time by emphasizing practice with feedback. By doing this, the paradigm dispensed and deleting contents or was activities that were not directly pertinent to the mastery of the specified objectives. This paradigm, which Davies refers to as the “engineering archetype” (1978, p. 22), was first manifested in the form of programmed instruction, but it morphed into other formats over the years of its prominence.

Programmed Instruction

In the early 1950s, American psychologist B. F. Skinner demonstrated that laboratory animals could be trained to perform quite complex behaviors by applying the principles of reinforcement theory, manipulating the consequences that followed responses (Ferster & Skinner, 1957). By 1954, Skinner had become interested in the possibility of applying reinforcement theory to human learning (Skinner, 1954). He developed a mechanical device, which others called a “teaching machine,” in which the content was arranged in small steps, or frames, of information to which the user responded through writing or selecting an answer. The machine judged the answer and provided a reinforcer (“knowledge of correct response”) if correct. The device presented the next frame only after a correct answer was given. The format became known as *programmed instruction* (PI) and the development of the software took place at Harvard University between 1954 and 1960 by a team of doctoral fellows—the most influential of whom was Susan Meyer (later Markle). She “established many of its conventions—prompting, fading, and so on” (Watters, 2021, p. 137). Markle went on to author or co-author the first “how-to” books on creating PI software (Markle et al., 1961; Markle 1964).



Figure 12. B.F. Skinner

Note. “B.F. Skinner” by Msanders nti is licensed under [CC BY-SA 4.0](https://creativecommons.org/licenses/by-sa/4.0/)



Figure 13. Girl using the teachig machine



Figure 14. Susan Meyer Markle

Alternative Format for Programmed Instruction

Not long after Skinner's format underwent developmental testing, Norman Crowder introduced a divergent format not based on learning theory but on a pragmatic concern for efficiency. Crowder's PI format presented frames of information but allowed users to jump ahead as long as they showed mastery; it provided remedial suggestions when incorrect answers were given. Its methodology came to be known as "branching programming." His device, the AutoTutor, which resembled what a desktop computer would later look like, offered individualization in terms of pacing and sequencing of frames, based on the learner's responses.

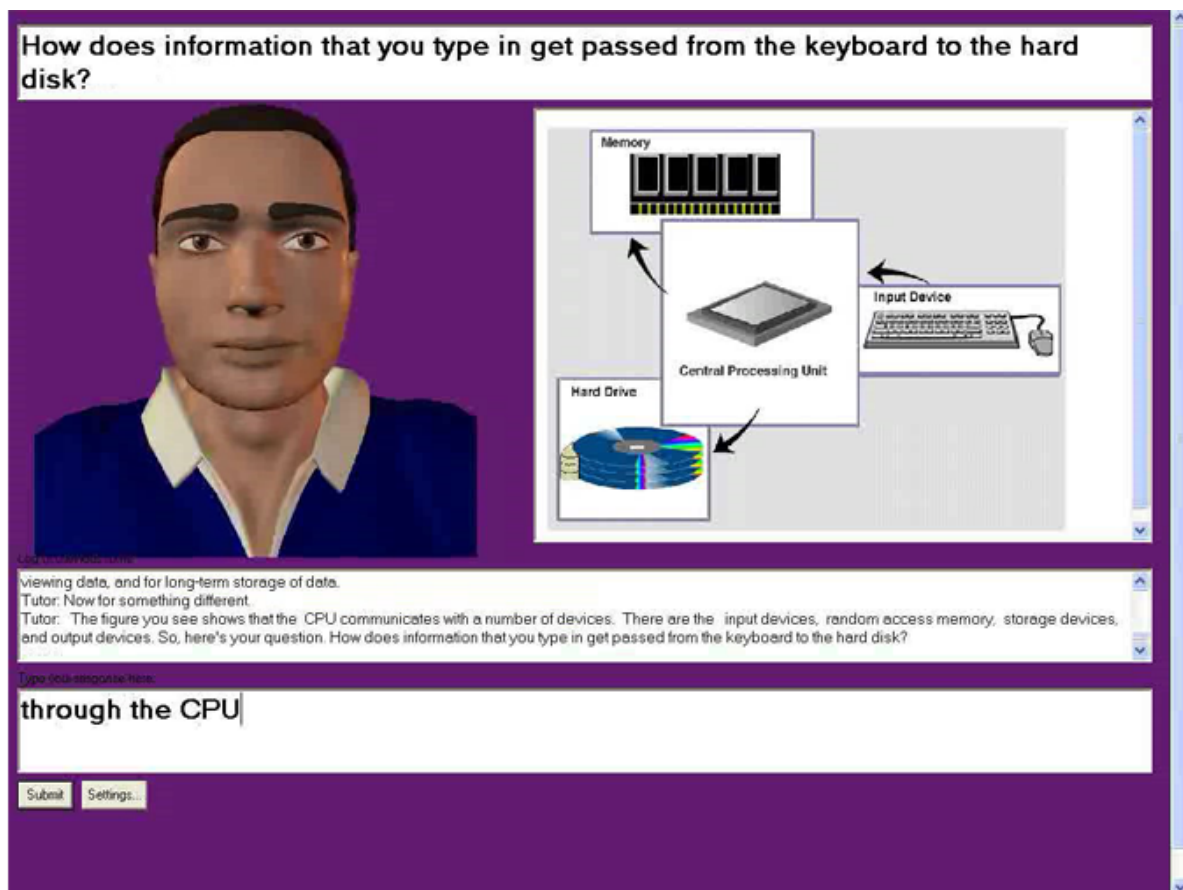


Figure 15. Autotutor

Note. "Screenshot of AutoTutor interface" by Sidney.dmello is licensed under [CC BY-SA 3.0](https://creativecommons.org/licenses/by-sa/3.0/)

In the early 1960s, PI devices based on both formats—linear and branching—were widely promoted by leading publishers. However, researchers quickly discovered that bulky and expensive machines were not required to respond to the simple sorts of responses allowed by these early programs—typically, just multiple choice or fill-in-the-blank answers. Programmed materials in print form proved to be just as effective, trusting users to write in their responses or turn to the page corresponding to their selected answer. Between 1960 and 1966, dozens of publishers released hundreds of new titles; the curve flattened after that. However, by 1976, there were still over a thousand titles of programmed books on the market. Indeed, in certain niche markets, such as reading instruction, vocational studies, and corporate training, programmed materials are still widely available.

Successor Programmed Technologies

The PI movement constituted a new paradigm for the application of technology to instruction. Unlike the audiovisual paradigm which focused on the richness of presentations, the basic claim of programmed instruction is that certain kinds of human learning can be mastered more efficiently and effectively (learn faster, retain longer) when the learner responds to the material presented and receives reinforcement for correct responses. Skinner referred to his methodology as a "technology of teaching" (1968), using *technology* in the sense of applying the science of learning theory to the practical task of instruction. Later innovators found other formulations for applying the same scientific theory to human learning; we will refer to the whole group of techniques as *programmed technologies*, the term coined by Lockee, Larson, Burton, and Moore (2008).

Programmed Tutoring

Douglas Ellson detected a weakness in programmed instruction, in that it applied only one type of reinforcer—"knowledge of correct results"—which was far from being a universal reinforcer. He developed a method of face-to-face tutorial instruction—known as programmed tutoring or structured tutoring—in which the tutor is guided by a structured set of rules for how to respond to different learner answers. Correct answers received a "social reinforcer" in the form of praise, encouragement, or a

smile; incorrect answers earned one or more hints to retreat to the learner's current level of mastery and nudge them forward (Ellson et al., 1965) (Ellson et al., 1968). Due to its track record of proven success, programmed tutoring became one of the first six innovations endorsed by the U.S. Office of Education for national dissemination (RMC Research Corporation, 1976, p. 2) and was adopted by schools in 35 or more states (Wickline, 1981). The value of social reinforcers in mediated learning has been rediscovered in the form of "emotional pedagogical agents" in the recent literature (Lang et al., 2022).

Precision Teaching

According to its originator, Ogden K. Lindsley, Precision Teaching (PT) consists of "basing educational decisions on changes in continuous self-monitored performance frequencies displayed on 'standard celeration charts'" (Lindsley, 1992). It is not a format, but a system for precisely defining learning objectives, encouraging practice of the desired behaviors, and continuously measuring and graphing the frequency of learners' responses. It was developed in the 1950s as another method of applying reinforcement theory, with Lindsley's PT choosing to focus on "free operants" while Skinner's PI focused on "controlled operants" (Lockee et al., 2008, p. 193). Like PI, PT requires major restructuring of classroom routine and teacher training, which inhibited widespread adoption. However, where implemented, PT has established an enviable track record of success (Binder & Watkins, 1990). By the 2000s, computer response-judging was replacing human teachers for offering adaptive reading and math programs based on continuous measurement of learner responses, similar to the PT process (Kiriakidis & Geer, 2014).

Personalized System of Instruction

Inspired by the principles of programmed instruction, Fred Keller applied the notion to the organization of a complete course. In the personalized system of instruction (PSI), all the content of a course is divided into sequential units (such as textbook chapters or specially created modules). These units are used independently by learners, progressing at their own pace. At the end of a unit, learners take a competency test. Immediately afterward, they receive feedback from a proctor, who provides any coaching needed to correct mistakes (Keller, 1968). During the period it was being tested—the 1960s and 1970s—PSI was found to be the most efficacious innovation evaluated up to that time (Kulik et al., 1979). Since then, the mastery-based, resource-centered, self-paced approach of PSI has been incorporated into many face-to-face courses in schools, universities, and corporate training centers. It serves as the basic pattern for many forms of distance education.

A similar method was developed by Sam Postlethwait, under the label of Audio-Tutorial System. From modest beginnings in 1961—making audio recordings of his botany lectures for students who missed class—the project evolved into an independent study system in which students worked in laboratory carrels, listening to recordings, viewing visual materials, and conducting hands-on experiments. They also interacted in discussion sessions and attended weekly large-group presentations (Postlethwait et al., 1964). This formula proved so successful that Postlethwait and fellow enthusiasts formed an organization in 1970, the International Audio-Tutorial Congress, which morphed over the years through several identities before arriving at its present name, International Society for Exploring Teaching and Learning (ISETL), while continuing to attract supporters.

Human Performance Technology

In the 1970s, corporate training consultants steeped in the behaviorist perspective brought the tools of programmed technologies—conducting task analysis, specifying behavioral objectives, selecting procedures for shaping behavior, implementing procedures, evaluating results, and making revisions as necessary—to bear on performance deficiencies in the workplace (Ainsworth, 1979; Brethower, 1999). This engendered a new field that came to be known as Human Performance Technology (HPT). Early on, practitioners such as Joe Harless discovered that not all performance deficiencies were attributable to ignorance, thus requiring training. Insufficient incentives, inadequate tools, or dysfunctional working conditions were often to blame (Harless, 1975). Wile (1996) ultimately identified six categories of interventions in addition to training—personnel selection, physical environment, tools, cognitive support, incentives, or organizational change—that could be part of a plan for performance improvement.

The field that eventually came to be known as HPT has been most authoritatively defined as "the study and ethical practice of improving productivity in organizations by designing and developing effective interventions that are results-oriented, comprehensive, and systemic" (Pershing, 2006, p. 6). HPT is a construct that lies largely outside the boundaries of educational technology but is connected to it in that both fields share an interest in instruction as a performance intervention. Molenda and Pershing (2004) developed the Strategic Impact Model to show how instructional and non-instructional interventions could be designed and developed in tandem to solve organizational performance problems.

Computer-Assisted Instruction

Many of the early attempts to apply computer technology to the control of instruction followed the formats of programmed instruction. Users typically interacted by inputting a verbal or numerical answer or choosing an answer from multiple alternatives; the machine program responded by confirming the correct answer and directing the user to another frame of information. The format differed from mechanical teaching machines mainly in that the software had a more sophisticated ability to judge responses and a more flexible menu of “next steps” in reaction to learners’ input.

During the 1970s, when “computer” generally meant mainframe computer, the computer-assisted instruction (CAI) stage was dominated by large-scale projects at a small number of universities, e.g., PLATO at University of Illinois, TICCIT at Brigham Young University, and Computer Curriculum Corporation at Stanford University (Saettler, 1990, pp. 308-309). Access to appropriate hardware and the development of software programs mushroomed in the 1980s with the advent of the “microcomputer.” Not all CAI applications were derived from programmed instruction. Even in the earliest period, some applications used a simulation or game format or offered problem-solving activities (Feldhusen & Szabo, 1969, p. 37).

The lasting legacy of the programmed technologies movement is seen in the design of all sorts of CAI programs and in the many corporate training manuals that require frequent user response.

The Instructional Systems Development Paradigm, 1967-1983

The idea of having a formulaic approach to the design of lessons that is based on current knowledge of human learning stretches back at least to Johann Heinrich Pestalozzi (1746-1827) and Johann Friedrich Herbart (1776-1841), both of whom had strong and lasting influence on teacher education programs in Europe and the U.S. (Saettler, 1990, pp. 36-47). But the approach that superseded earlier traditions—instructional systems development (ISD)—did not come from educational philosophy or curriculum studies. A detailed account of the historical evolution of ISD and of the theoretical perspectives that came to be incorporated in it can be found in Molenda’s historical account (2010). Here, we will briefly summarize three major sources of the concept of ISD: the systems approach, arising out of military training doctrine; academic research on integrating media into instruction; and the programmed instruction movement. These approaches were all aimed at constructing a roadmap for the process of lesson planning, making instructional planning more efficient and its outcomes more effective. This is the essence of the ISD paradigm, or what Seels refers to as the “instructional design movement” (1989) and Davies refers to as the “problem-solving archetype” (1978, pp. 22-23).

Inspired by the Systems Approach

During World War II, the U.S. Navy was pursuing its computing problems—such as submarine hunting—with an early IBM computer (Williams, 1999). Putting this computing power into practical application required the development of a new planning tool, systems analysis—a way of organizing thinking about “man-machine” problems. In the 1960s, the U.S. armed forces changed their bidding procedures for new weapons systems, requiring contractors to provide not only the hardware, but also the training needed by the operators (Dick, 1987). Weapons were now part of “weapons systems,” and training was part of that system. Training designers began to apply what they termed a *systems approach*. In 1973 a team at Florida State University were tasked with developing a systems-approach model for the design of U.S. Army training, a model that was later adapted for use by all the American military services, called the Interservice Procedures for Instructional Systems Development (IPISD) (Branson, et al., 1975). The IPISD model eventually had enormous influence in military and industrial training because its use was mandated not only in all the U.S. armed services but also among defense contractors. The many and varied ISD models that followed differed in details but typically adhered to a common conceptual framework: analyze, design, develop, implement, and evaluate. This conceptual framework came to be called by its acronym, ADDIE (Molenda, 2003).

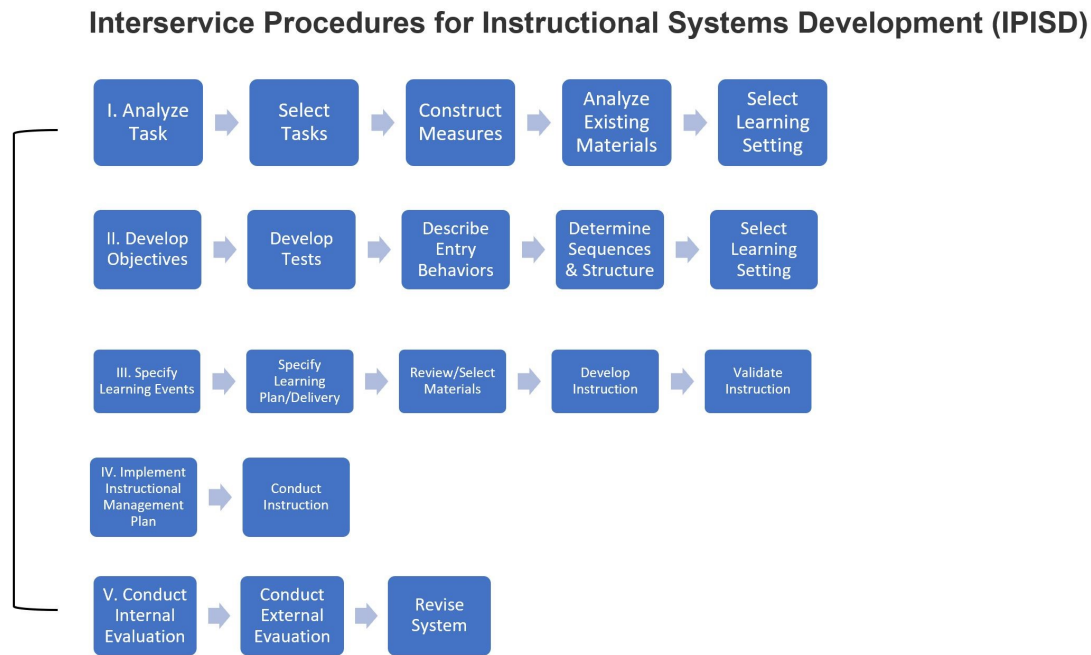


Figure 16. IPISD Model

Inspired by Academic Research on Media Integration

A team of leading researchers at the American Institutes for Research were at work in the 1960s, trying to systematize the process of developing lessons that would incorporate multiple types of audiovisual media (Briggs et al., 1967). The lead author, Leslie J. Briggs later used these ideas to generate an early textbook, *Handbook for the Design of Instruction* (1970). Separately, research and development funds from the Elementary and Secondary Education Act and the Higher Education Act of 1965 supported a large number of research projects based at university audiovisual centers, seeking models for more systematic integration of media into classroom lessons and into more advanced teaching-learning systems. The Instructional Systems Development project, based at Michigan State University in collaboration with three other universities (University of Colorado, Syracuse University, and San Francisco State College), produced an influential model and a set of heuristic guidelines for developers (Barson, 1967).

Inspired by the Programmed Instruction Movement

The procedures for creating PI materials specified: analyzing the task to be learned in order to break it down into a series of small steps, specifying the behavioral indicator of mastery for each step (performance objective), sequencing the behavioral responses in hierarchical order, creating prompts for the desired responses, observing the learner response, and administering appropriate consequences for each response. Further, since reinforcement theory called for practicing mostly correct responses, each frame of the program had to be tested for efficacy; hence, the development process entailed repeated rounds of testing and revision. Gradually, PI developers began to realize that it was the painstaking development process that made PI successful:

The uniqueness and strength of programed [sic] instruction lies mainly in its production process Programed [sic] instruction is developed through a process which has empirical and analytic qualities. (Lange, 1967, p. 57)

Or, as Susan Meyer Markle and her research partner, Phil Tiemann, succinctly proclaimed: “programming is a process” (Markle & Tiemann, 1967). That is, it is not the PI *format* that accounts for success, but rather the developmental *process*. Markle and Tiemann’s procedural flow chart for PI product development consisted of analyzing learners and learning tasks, specifying performance objectives, requiring active practice and feedback, and subjecting prototypes to testing and revision; it can be seen as a precursor to the analyze, design, develop, implement, evaluate (ADDIE) cycle proposed in later ISD models. By the

early 1980s, textbooks—such as Dick and Carey’s (1978) and Kemp’s (1971)—had codified the knowledge base of the instructional development paradigm, enabling new research to flesh out its articulation. By 1983 the Division of Instructional Development was the largest division of AECT, signaling the shift of the center-of-gravity of the field from audiovisual media to ISD.

Hidden Bias of the “Technological” Paradigms

As Bradshaw (2018, p. 338) points out, certain paradigms of educational technology share a bias with the *social efficiency* movement, popularized by Franklin Bobbitt (1924). With their emphasis on helping students learn more efficiently and effectively, the paradigms of instructional technology, programmed technologies, and instructional systems development (ISD) implicitly accept the assumption that instructional objectives can be stated in clinically precise terms and that the sum of these instructional objectives statements equals the educational mission of the institution. The focus on efficiency, while meant to reduce time wasted on non-essential activities, obscures the role of other “inefficient” educative activities (such as play, discussion, mentoring, creative production, trial-and-error problem-solving, sports, and participation in student government). That, together with instruction, comprise the total educational experience. Indeed, *instructed learning* comprises only one of at least three distinct types of learning taking place in educational institutions, alongside *spontaneous learning* and *observational learning* (Molenda, 2021, pp. 7-9).

The Interactive Multimedia Paradigm, 1977-2000

During the 1960s and 1970s, the PI movement had championed the issue of learners’ active response, but so did the movement of the “cognitive revolution.” Behaviorist theory insisted that learner performance be as close as possible to the target objective, and so did cognitive theory, as exemplified by Reigeluth’s elaboration theory (Reigeluth, 1979). At the same time, audiovisual advocates were promoting the benefits of sensorily rich experiences. The technology of the time did not offer an affordable, easy-to-use platform for creating instructional materials that were as interactive, immersive, and sensorily rich as these theoretical imperatives were demanding. The technological advances of the coming era would allow educators to combine audiovisual media with the practice-with-feedback methodology of the programmed technologies. Thus, the interactive multimedia paradigm incorporated the claims of the audiovisual paradigm and the programmed technologies paradigm; it focused on creating environments in which learners were highly motivated to immerse themselves in a problem space (often in the form of a simulation or game) and to learn through persistent trial-and-error.

User-Controlled Videocassette and Videodisc

A minimal amount of user control became possible in the late 1970s with Betamax and VHS videocassette recorders; functions such as “pause,” “fast forward,” and “slow motion” enabled some adaptation to individual learning needs. These functions became even easier with the videodisc systems of the early 1980s. Videodiscs stored up to 30 minutes of motion video; user control of its laser beam allowed rapid random access to high-quality still or motion sequences, making them much more suitable for instructional applications (A.K. Betrus, personal communication, September 8, 2022). The educational potential of videodisc was demonstrated in the late 1980s, particularly by *The Adventures of Jasper Woodbury*, a 12-disc series of interactive problem-solving scenarios for the mathematics curriculum. Commercially produced videodiscs such as this had a control program permanently embedded in the audio track; typically, it offered the user a menu of responses—leading to different content—following a video episode.

Immersive Experiences in Video Games

In the 1970s, face-to-face fantasy role-playing games, such as *Dungeons and Dragons*, began to attract growing numbers of players, ultimately reaching tens of millions. At the same time, arcade video games, such as *Space Invaders* and *Pac-Man*, used computer technology to translate users’ physical manipulations into exciting on-screen gaming action. There were some false starts before gaming techniques were reflected in home, and later school, use. First came the conversion of arcade video games to special-purpose home video game consoles. A number of the console systems of the late 1970s included educational games, such as “Basic Math” and “Math Gran Prix” for Atari 2600 and others from Coleco and Intellivision (A.K. Betrus, personal communication, September 8, 2022). These video games incorporated minimal pedagogical strategy, but they

did encourage practice of target skills through the motivational structure of a game. After a quick burst of popularity in the early 1980s, the video game industry crashed in 1983. It had a rebirth in 1985, thanks to the Nintendo Entertainment System, but remained a niche product, not integrated into the home or office communication environment (Edd Schneider, personal communication, September 8, 2022).

It was in the mid-1980s that affordable microcomputer technology brought such immersive game and simulation activities into the home, the office, and later, the school. Apple's Macintosh and Apple II series demonstrated the advantages of a graphical user interface (GUI), making computer use and computer program development vastly easier. However, by 1987, the business-oriented DOS personal computer (PC) was becoming the dominant platform for computer games, replacing Apple and Commodore platforms environment (Ed Schneider, personal communication, September 8, 2022).

The new technologies of CD-ROM and DVD made storage, distribution, and playback of interactive multimedia programs easier and more affordable. First came multimedia encyclopedias, simply using the storage capacity of CD-ROMS for random access to banks of data. By the mid-1990s a flood of interactive educational games and simulations, such as *The Oregon Trail*, *Where in the World is Carmen Sandiego?* and *Clue Finders*, reached the market—a market eventually worth hundreds of millions of dollars.

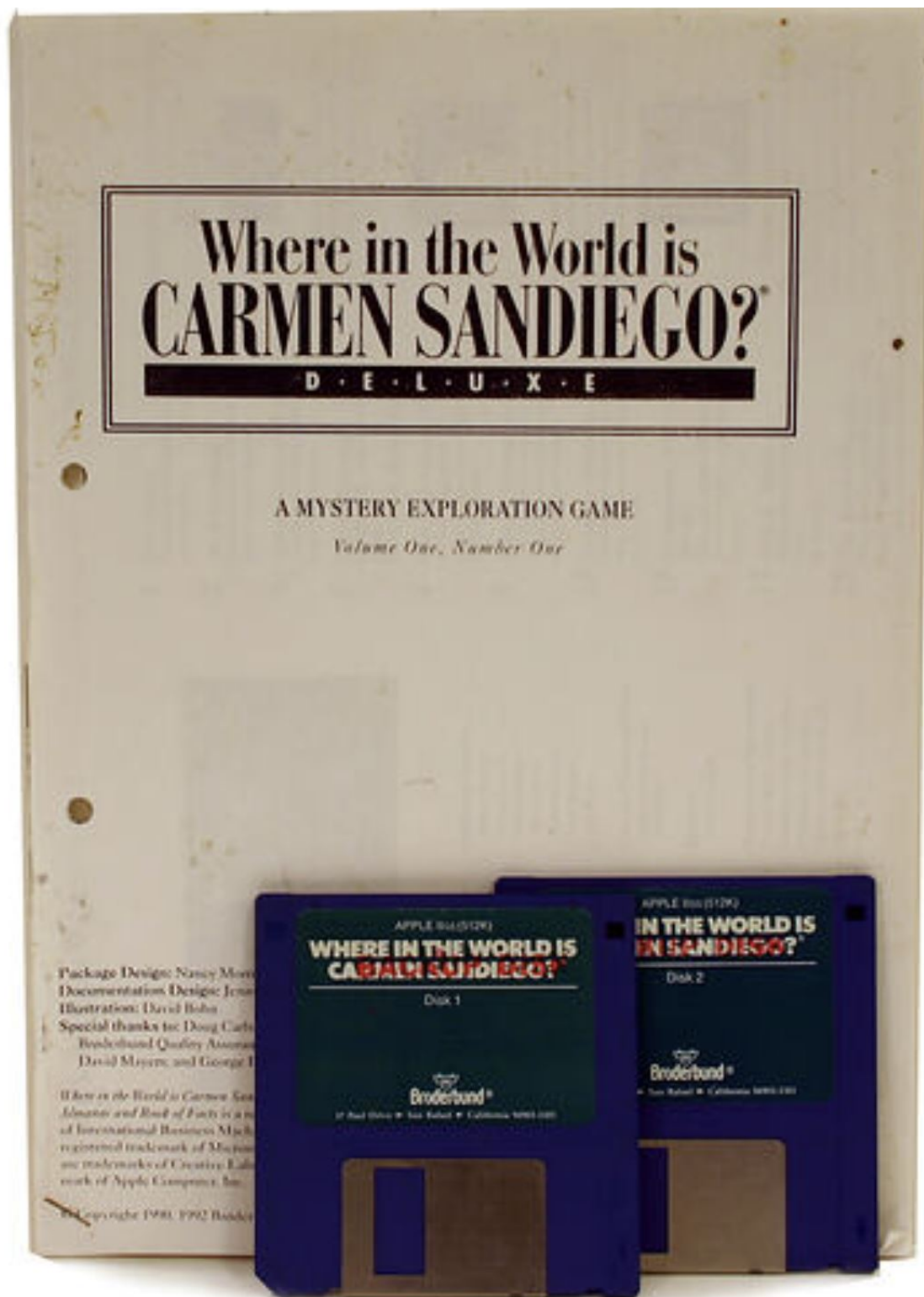


Figure 17. Carmen Sandiego

Information Age Paradigms, 1990 to Present

The final set of paradigms to be examined in this chapter sprout from a common source, the forces unleashed by the Information Age, by which we mean the historical epoch—beginning with computer proliferation and culminating with the internet, the web, and social media, in which information technology has come to represent, in Marxian terms, the primary “means of production.”

The Distributed Learning Paradigm, 1990 to Present

In the 1990s, advances in communication technology were beginning to shift the focus of interactive multimedia from media stored on disks to experiences shared through wired, later wireless, networks. During the 1990s, dial-up telephone modems were used to allow keyboard communications among users, with courses being offered through computer conferencing. Communication became easier and richer after the development of the World Wide Web in 1993, especially after the development of the web browser. Netscape Navigator, introduced in 1994, became the dominant browser for the next decade. By 2005, most homes linked to the internet via a broadband connection, typically through the wires that carried cable television. The higher speed of broadband allowed fast access to graphically complex materials, even streaming video. People could communicate with each other in writing, seeing, and hearing in real-time.

While homes and businesses—and most universities—became connected to the internet, schools fell behind. During his administration (1993–2001), Bill Clinton attempted several legislative initiatives to assist schools in connecting to “the information superhighway.” While the Clinton administration was unable to persuade a Republican Congress to pass a major bill, it did have some piecemeal successes, including reducing long-distance telephone charges for school computer systems—the so-called “e-rate” program added to the 1996 Telecommunications Act. In addition, it pushed to establish public-private partnerships among schools, businesses, and nonprofits to get schools wired for information technology through programs such as NetDay and One Laptop Per Child.

The wiring of campuses to connect to the internet also had a profound impact on distance education. Since its beginnings during the early twentieth century, distance education had progressed from correspondence study based on print materials to the use of broadcast radio and television to give greater numbers of learners access to richer resources. The paradigm—synchronous, group-based communication—was still that of the classroom, only with geographically dispersed students. However, advancements in communications technology in the 1990s—especially the explosive growth of internet-based learning, and later of social media and mobile media—made possible a different learning model. This model came to known as “distributed cognition”—knowledge shared across the members of a community (Dede, 1996). An early conceptualization of this paradigm was computer-supported collaborative learning (CSCL), in which small groups of students interact through computer applications to solve an unstructured problem or create a product of some sort. The concept was inspired by Vygotsky’s social learning theory, proposing that tasks too complex for an individual can be mastered with the assistance of knowledgeable others (Vygotsky, 1978). Thus, the distributed learning paradigm accepts the educational communications paradigm’s commitment to overcoming the boundaries of geography and economics and adds the claim that groups should be able to interact to solve problems and attain understandings that are shared as a learning community.

In the late 1990s there occurred a “gold rush” mentality as dozens of universities and hastily created for-profit ventures sought to capture the enormous audiences anticipated to flock to internet-based, collaborative distance education. Almost all these ventures perished when the “dot-com” bubble burst in 2000 (Molenda & Sullivan, 2003). Programs that survived the crash tended to be those that proceeded gradually, taking care to offer courses that incorporated “best practices” in instructional design. Such institutions and programs came to be a major employment source for educational technology practitioners in the 2000s.

The Democratization of Media Access Paradigm, 1990 to Present

Empowering Users

During the 1990s, as personal computers proliferated in the office and home, teachers gained experience and confidence with computers and ventured into the use of computers in school—and even the creation of instructional programs. Presentation software, such as PowerPoint, incorporated in Microsoft's Windows in 1992, enabled business and educational users to create attractive “slide sets”—at first, for overhead transparency masters and later for direct projection via computer projector—without the assistance of graphic artists or other media production specialists. New multimedia authoring software (e.g., Hypercard, Macromedia Director, and Authorware) also supported teachers and other users in becoming producers. While this was empowering for users, it spelled the death knell for one of the major services of audiovisual centers, further undermining what had been the dominant paradigm of educational technology.

These developments coincided with the “constructivist” movement in pedagogy, which put particular emphasis on authentic contexts, learner control, and problem-solving activities (Wilson, 1996). The learning model for the “constructivist learning environment” is analogical, case-based knowledge construction; learners immersed in a problem space try various strategies and learn by trial-and-error how to navigate toward a satisfactory conclusion. Often, students themselves were able to use authoring systems to create their own content. This pedagogical movement gave further support to the development of teacher and student designed software, with students often taking the lead.

Learning management systems (LMS), first introduced in 1991, tied together the many pedagogical and administrative processes needed to have a coherent online course. As with presentation software and multimedia authoring software, the LMS empowered teachers and trainers to undertake do-it-yourself construction of robust online lessons and courses. And like the other applications just discussed, it tended to undercut the expertise of instructional design specialists, diminishing their role to consultants rather than producers.

The democratization of the media access paradigm thus represents an expansion of control over media access and media production to people who previously had to rely on experts and gatekeepers—such as educational film, radio, and television producers; radio and television station administrators; computer programmers; instructional designers; and the like—to use Information Age tools.

The Digital Divide

On the other hand, despite the forces of democratization, access to these media tools has never been equitably distributed. Access to information and communications technologies (ICTs) has been linked to a number of characteristics, including socioeconomic status, race, gender, geographic location (urban-rural), age, and technological skills. The latter includes individuals who struggle to participate due to cognitive or physical limitations. The Universal Design for Learning (UDL) movement (Rose & Meyer, 2002) proposed that educational materials should incorporate multiple means of representation, expression, and engagement (Rose & Meyer, 2002, p. 75). Assistive technologies can help overcome physical handicaps in using information technology. Assistive technologies and other UDL practices have been incorporated into American law in the Assistive Technology Act of 1998, the Individuals with Disabilities Education Act, and the Higher Education Opportunity Act of 2008.

As Tapscott (2000) described, contemporary societies are divided into haves v. have-nots, knowers v. know-nots, and doers v. do-nots. This digital divide was harshly foregrounded globally during the emergency remote-education response to the COVID-19 pandemic (Sosa Diaz, 2021). Steps toward reducing the digital divide represent the distance that scholars, practitioners, and policymakers have traversed since Michael K. Powell—as chair of the powerful Federal Communications Commission—dismissed ICT access as a gratuitous caprice akin to luxury car ownership by likening the digital divide to a “Mercedes divide” back in 2001 (Irving, 2001).

Educational technologists working under this paradigm have implemented various innovative interventions to help bridge the digital divide. Open-source technologies, open educational resources (OER), 1:1 student computing, and mobile learning—which seeks to capitalize on the Information Age's media convergence trends to promote learning via personal electronic devices that are more physically and economically accessible to learners—are being explored as ways to bridge the digital divide's ‘access’ aspect; early age coding, logic, and computational thinking initiatives (e.g., Code.org and MIT Media Lab's Scratch) are being implemented to address the digital divide's knowledge/skills aspect, while mentoring/role-modeling programs are offered as ways to address its affective aspect. Activities within this paradigm recognize the importance of learner empowerment within the Information Age teaching-learning context. Educational technology professionals have therefore been striving to increase learner agency and control over the teaching-learning process via participatory web technologies to encourage active participation and content contribution over passive content consumption.

The Inclusion Paradigm, 1990 to present

Given the powerful impact that Information Age technologies have on national economies—and on the lives of the people contending with those social and economic forces—some education scholars and practitioners have turned their attention to the issue of historically underrepresented, underserved, and marginalized populations. The “War on Poverty” programs of the 1960s had run out of steam by the 1990s. Schools were slipping back into segregation by residential pattern and the gap between rich and poor was growing again. In educational technology, among the first scholar-practitioners to voice sociocultural concerns was Gary C. Powell (1997) in a pioneering *Educational Technology* special issue devoted to this topic. Later Thomas, Mitchell, & Joseph (2002) suggested innovative modifications to the field’s venerable ADDIE model to make the ISD process more socially and culturally cognizant. Subramony (2004) took the field’s temperature a couple years afterwards to discover a rather dire state of inattention to social and cultural issues within its mainstream discourse, and followed up more than a decade later (2017) to find that the changes taking place in the interim were more of a peripheral, piecemeal nature as opposed to a core, systemic one.

That said, some of these efforts do represent significant incremental steps towards making the field more socioculturally conscious and inclusive, viz., (a) an increasing number of scholarly conference presentations and journal articles—along with multiple journal special issues and full-length books—focusing on social, cultural, and power issues in educational technology, (b) the evolution of the AECT-affiliated ‘Minorities in Media’ (MIM) group into a full-fledged (Culture, Learning, and Technology) division of the organization—which, among other initiatives, is currently engaged in the valuable task of recording the oral histories of pioneering MIM members, and (c) AECT’s noteworthy incorporation of the terms “ethical” and “appropriate” into its revised 2008 definition (Januszewski & Moldena, 2008; Subramony, 2017). More recently, attention is also being drawn to the needs of the field’s LGBTQ+ stakeholders, as, for example, in Subramony 2018. In short, the inclusion paradigm aims to ensure that the fruits of Information Age learning are accessible to historically overlooked or excluded populations.

The Emerging Technologies Paradigm, 1998 to Present

Educational technology has been dealing with “emerging technologies” since its inception. Sound-on-film was a technological breakthrough in 1930, magnetic tape recording in 1946, video cassette recording in 1970, and so on. As these innovations entered the marketplace, educational technology professionals quickly attempted to figure out how the innovations could be exploited for educational use. However, over the course of the past five decades, thanks to the digital revolution, the pace of ICT evolution has only grown exponentially more rapid. This growth brings us to what we may call the emerging technologies paradigm, which centers around the question of how to appropriately respond to technological, theoretical, and philosophical “developments so diverse and fast-changing that they are best described not by their physical features but simply as being emergent” (Molenda & Subramony, 2021, p. 18). For instance, Martin Weller (2018) listed the following “emerging phenomena” that grabbed the attention of educational technologists, viewed in chronological order: Wikis in 1998, e-learning in 1999, learning objects in 2000, e-learning standards in 2001, open educational resources in 2002, blogs in 2003, learning management systems in 2004, streaming video in 2005, web 2.0 in 2006, online virtual worlds in 2007, e-portfolios in 2008, social media in 2009, connectivism in 2010, personal learning environments in 2011, massive open online courses in 2012, open textbooks in 2013, learning analytics in 2014, digital badges in 2015, artificial intelligence in 2016, and blockchain in 2017.

The emerging technologies paradigm proposes that whichever technological innovations are being promoted in the world at large at a given time will or should eventually impact education, however tenuous the connection might be. This situation has been effortlessly feeding into the field’s longstanding technocentric bias, with the end goal appearing to be persuading educators to adopt technologies irrespective of their relevance to a specific problem (Weller, 2018), or, as Cuban put it, “a solution in search of a problem” (Cuban, 1986).

The emerging technologies paradigm is marked by an increasing cognizance understanding of the tendency of technological interventions to over-promise and under-deliver (see Stoll, 2001, for more detail Clifford Stoll’s prescient lament about computers being uncritically embraced by the educational establishment as filmstrips were in a previous era). Instead of incurring the costs—and opportunity costs—of reflexively jumping onto the technological bandwagon of the year without

thinking things through, those operating within this paradigm are increasingly asking if said technological intervention is indeed the most appropriate solution to the educational problem(s) at hand.

Conclusions

One of the purposes of studying history is to look for lessons that can be gleaned from the experiences of those who have gone before us. In this spirit, we suggest a handful of generalizations that can be inferred through a century's experience with educational technology.

Boom and Bust Cycles

It is all too easy to fall into the trap of assuming that because a technology is new that it has great potential to quickly revolutionize education, leading educators down the path of “a solution in search of a problem.” The cycle begins with extravagant promises, followed by failure to live up to expectations, then speculations on where to assign blame, and finally criticism that the innovation itself is ineffective or costly. This “boom and bust” cycle was repeated with film, radio, television, teaching machines, desktop computers, and many other emerging technologies of the 21st century. Each of these innovations has some merit and has generated local successes, some of which have continued to yield benefits. However, the field of educational technology has suffered a serious credibility problem because of the tendency of its more hasty proponents to rush to embrace of the latest technology.

Dependence on New Money

The instructional budgets of educational institutions are largely consumed by personnel costs, so the adoption of instructional innovations is often contingent on finding new, outside sources of funding. For example, the explosive growth of the educational technology field in the U.S. occurred only because of the massive federal programs of the 1940s through 1960s—the GI Bill, NDEA, ESEA, HEA, Higher Education Facilities Act, and the like. During that period, support from foundations and nonprofits also played a large role in covering the added costs of purchasing and installing new technologies. Indeed, without The Rockefeller Foundation's huge support of educational film and the Ford Foundation's massive investment in school television, those technologies might never have achieved a significant presence in formal education. In later eras, it became more difficult to obtain federal financial assistance, so the U.S. and other governments turned to “public-private initiatives”—creating nonprofits such as NetDay and One Laptop Per Child—to encourage philanthropic support from the high-tech industry.

Resistance to Innovations that Threaten to Replace Instructors

It should not be surprising to learn that teachers, trainers, and professors are resistant to embracing innovations that take over the traditional roles of the teacher, especially major classroom activities such as presenting information. Radio and television programs, for example, clearly proclaimed their ability to perform the tasks of selecting and presenting lectures better than teachers could. Teaching machines were sold based on their ability to replace teachers altogether. Many of the early computer-assisted instruction programs were sold as complete, “teacher-proof” course packages. In response to all these claims, teachers chose to assign the innovation to a supplementary role—to show a film or video clip to supplement their lecture, to offer a computer game as an enrichment activity, or to assign a podcast as a homework activity. Consequently, none of these purportedly revolutionary technologies have ever had a chance to truly affect overall economic productivity—which would require replacing the most expensive category of cost: labor costs.

Difficulty of Curricular Integration

Technology advocates who are not themselves teachers tend to underestimate the difficulty of integrating innovative materials into the instructional plan. In the case of K-12 schools, teachers are concerned whether the audiovisual material addresses mandated curriculum standards. In the case of higher education, instructors wonder if the audiovisual material addresses their specific objectives. Since most instructors consider themselves subject-matter experts, they wonder if the material is as clear and authoritative as their own treatment. Often the answers to these questions has been “no,” so the proposed materials have been rejected.

Summary

The field we are labeling as *educational technology* has always had multiple nodes of theory and practice. Over the past century, different nodes have occupied center stage at different times. Shifts in attention have typically occurred in response to new technological developments or new discoveries in the psychology of learning. The earliest period (1905–1983) was dominated by the visual/audiovisual education paradigm, promoting auditory and visual media—especially film—as an alternative to the “verbalism” of traditional instruction. Running parallel in time (1930–1990) was the educational communication paradigm propounded by the educational radio and television community, which promised to deliver auditory (and later visual) programs at low cost to vast audiences, expanding the scope of education beyond the walls of schools and colleges. By the 1960s, visionaries were beginning to imagine combining audiovisual and broadcast media within a systematic framework, a framework in which instructional methods, grouping patterns, and assessment methods were chosen based on what would be most efficient and effective for attaining the specified learning objectives. They referred to this new paradigm as *instructional technology*.

A major contributor to this new way of thinking was programmed instruction and its successor technologies (1954–1989), developed in the field of experimental psychology. They offered concrete procedures for enabling individuals to master specific objectives without the presence of a teacher. It was embraced by audiovisualists as a new tool to help fulfill their vision of instructional technology: “a complex, integrated process...for analyzing problems, and devising, implementing, evaluating, and managing solutions to those problems” (AECT Task Force on Definition and Terminology, 1977, p. 3).

After World War II, new complex weapon *systems* required a new approach to training, which evolved into the instructional systems development (ISD) process, which represented a new paradigm for instructional planning in formal education. Between 1967 and 1983, attention was focused on devising more efficient and effective models for conducting ISD.

In the years that followed, the computer played an even greater role in determining what educational technology was about. For those coming from the audiovisual tradition or the educational communication tradition, the computer offered the opportunity to not only organize, present, and store a vast array of audiovisual programs but also provoke learner response, to which appropriate feedback could be given...thus the era of the interactive multimedia paradigm (1977–2000). The creativity unleashed by these new technological capabilities spawned an outpouring of instructional games, simulations, simulation games, and story-based problem-solving activities.

The most recent set of paradigms that have driven educational technology revolve around the forces unleashed by the Information Age: the internet, the web, social media, mobile media, and ubiquitous computing. We have organized these developments under four broad headings:

- The distributed learning paradigm (1990 to present): represented concretely by the explosive growth in distance learning programs based on the internet, represented more abstractly by a new learning paradigm—distributed cognition. A core tenet of distributed learning is that knowledge can be created and shared by groups operating as a learning community.
- The democratization of media access paradigm (1990 to present): first, computer technology enabled educators to create their own instructional materials, then it enabled “constructivist learning environments”—settings in which students are immersed in a problem space requiring them to construct their own solutions. Through authoring systems, students could even create their own content either alone or in collaboration with others.
 - Such possibilities are open only to those who have access to information and communications technology (ICT); those who do not are characterized as being on the other side of the Digital Divide. Since the early 2000s, educational technology professionals have joined with others to enact legal solutions, new computer protocols, such as Universal Design for Learning, and new initiatives in computer training and mentoring.
- The inclusion paradigm (1990 to present): the essence of this paradigm is to hear the voices of historically underrepresented, underserved, and marginalized populations. A growing number of educational technology professionals are seeking ways and means of making the field more socially and culturally conscious.
- The emerging technologies paradigm (1998 to present): the essence of this paradigm is to call attention to the uncritical embrace of the cascade of novel applications and platforms that emerge at an exponentially rapid pace.

Postscript on Historiography

Any attempt to create a narrative about a complex set of events and the people involved in them must necessarily be selective. Different observers are bound to choose different events to highlight, and each observer interprets those events through their own set of filters and lenses. A story such as educational technology's is especially susceptible to gendered interpretations given the different roles—with different power relationships—played by men and women over the century of historical evolution. The same can be said for the largely unrecorded perspectives of the many gender non-conforming individuals whose voices have traditionally been silenced. De Vaney and Butler (1996) examined the discourse of educational technology's founders—men and women—unveiling gendered perceptions through historical vignettes. Additionally, Butler and Lockee (2016) disclosed the voices of women pioneers in the field through vignettes revealed in oral histories.

Bradshaw (2018) and others raised the questions: what significant events have not been recorded and what contributions have gone unrecognized by the blinders imposed by traditional historiography? Young (2001) argues that African American contributions to educational technology have been largely overlooked for the post century, while Subramony (2018) asks a vital question: Where are LGBTQ(+) voices in the literature of the field? These questions remain largely unanswered, but they do open the door for future research and practice.

End of Chapter Resources

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Think About It!

1. In a group or independently, construct a timeline of the history of the field. Take note of important events, people, and innovations. Do you notice recurring trends along the timeline? What is unique on the timeline? What may be missing from the timeline/gaps?
2. Write a one-page argumentative reflection using historical evidence in response to the following question: Why is it important to recognize and study the field's history?
3. Re-create a historical broadcast with a leader in the field. Include significant biographical information and interesting contributions to the field. (Hint: while the broadcast media is your choice, think “podcast” style)

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