Category: Concepts, Trends, and Challenges

Evolution of Computer-Based Distance Learning

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INTRODUCTION

Distance learning (DL), distance education, remote education, online learning, e-learning, learning at a distance, and distributed learning are all synonyms for *electronic learning*, a phenomenon that over 80 years has evolved into the delivery of instruction via the Internet. The legacy of those years has provided a theoretical foundation and a history of best practices that can offer today's distance learning practitioners a sound basis for exploring new instructional models utilizing technologies of the 21st century. This article describes some of the major milestones and accomplishments upon which today's computer-based distance learning tools and practices are based.

BACKGROUND

The First Half of the 20th Century

The theoretical foundations of electronic learning are rooted in seminal works on self-instruction pioneered in the 1920s by Edward Lee Thorndike and later by Frederic Burk and Mary Ward (Foreman & Turner, 2000). The first manifestation of technology in instruction was the teaching machine invented in 1924 by Sydney L. Pressey used for rudimentary drill and practice (Pressey, 1926). In the 1950s, the behaviorist B. F. Skinner invented the *Skinner box*, a small chamber used to conduct research on operant conditioning with animals. With the introduction of programmed instruction (PI), Skinner extended his theories of operant conditioning to teaching and learning. Skinner's methodology was the basis for *linear PI*, first demonstrated in the format of paper-and-pencil self-instructional manuals. Skinnerian PI was characterized by clearly stated behavioral objectives, small frames of instruction, self-pacing, active learner responses to inserted questions, and immediate feedback regarding the correctness of a response (Clark, 2000).

The Turning Point

Despite Pressey's 1924 invention of the teaching machine and the 700 related patents taken out in the 1930s, Skinner, in the 1950s, introduced a "new" technology that he too called teaching machines; these were based on linear PI (Benjamin, 1988). Norman Crowder in 1958 extended Skinner's work and developed *branching PI*, which was characterized by, among other things, multiple-choice, response-directed instructional branches in PI manuals (Crowder, 1960), a technology that would later evolve into computer-assisted instruction (CAI). For more than 10 years, teaching-machine technologies and methodologies were prominent and controversial topics in both the academic and popular press.

Lumsdaine (1959) noted three distinguishing characteristics of the Skinner and Crowder teaching machines that were being marketed at that time. These were the following.

1. Continuous active student response was required, providing explicit practice and testing of each step of what was to be learned.
2. A basis was provided to inform the learner, with minimal delay, whether each response was correct, leading directly or indirectly to the correction of the learner's errors.
3. Learners proceeded on an individual basis at their own rates—faster ones completing an instructional sequence before slower ones—all machine tutored with patience customized to the learner's needs.

In 1962, at the height of the teaching-machine movement, Crowder, who like Skinner pursued entrepreneurial ventures related to teaching machines, predicted that by 1965 half of all American students would be using teaching machines for one or more courses (Gilmore, 1962). And while his time frame and technology forecast were wildly wrong, due mainly to IBM's introduction of the revolutionary IBM System 360, the "third generation" of digital computers in the 1960s (Campbell-Kelly & Aspray, 1996), Crowder's forecast would prove to be more or less accurate—but almost 40 years later!

Rooted in Instructional Theory

With teaching machines as a basis, in the 1950s through the 1960s the development of instructional theories and methodologies provided a foundation for future educational technology-based instructional and learning practices. Four of these are behaviorism, constructivism, cooperative learning, and individual learning. These can be described in terms of the theoreticians that have contributed to them, and the contribution of each to the technology that succeeded teaching machines: computer-assisted instruction. Appendix A provides a summary of these four theories and key theoreticians that have contributed to them. Appendix B provides a summary of contributions that each of the theories has made to the development of computer-assisted instruction (Scheepers, 2001).

These appendices clearly reflect a decades-long development of instructional theory based on technologies that are more than 50 years old, and a body of knowledge that provides a solid foundation of theory, research, and practice, one that remains valid even today.

Computer-Assisted Instruction

Beginning in the late 1950s, CAI was introduced as a mode of instructional delivery in which a learner accessed mainframe-computer-based lesson material (courseware) developed and programmed by teams of instructional designers and computer programmers. It is worth noting that over the years, there has been much debate concerning the appropriate label to assign to activities related to the delivery of instruction via the computer. Terms such as CBE (computer-based education), CBT (computer-based training), and CBI (computer-based instruction) are only a few that may be found in the literature, each focusing on different and sometimes only nuanced aspects of the technology. This article uses the term CAI to encompass all of these.

The first CAI system was the IBM 650 Inquiry Station interfaced to a text-based typewriter used to teach binary arithmetic. The IBM 650 was the first mass-produced digital computer and the very first computer acquired by many universities. Tannenbaum (1999) describes the next major instructional technology initiative and the context in which it was introduced:

During the early 1960s, IBM researchers had experimented with computer-based instruction, using earlier computers and an assembler-level language they called Coursewriter. The success of these experiments, together with the demand for better education fueled by the Russian Sputnik successes and the programmed learning research of such psychologists as B. F. Skinner, led IBM to develop the IBM 1500 system. The system was purchased by about a dozen other educational institutions (including school districts in Montgomery County, Maryland, and Kansas City, the Ohio State University and the University of Alberta in Canada).

The hardware cost more than $250,000 (the equivalent of more than $1.25 million today) for a system that could accommodate a maximum of 16...simultaneous users, about $16,000 ($80,000 today) per user. ... In the early days of developing routine courseware for the 1500 system, we estimated 100 to 300 hours of development time for each hour of learner time.

The IBM 1500 was unique. It delivered online, individualized instruction in a (proprietary local-area) networked environment, driven by a multiuser operating system. It allowed course authors to integrate (character) graphics, audio, and still images into their courseware (Buck & Hunka, 1995); it was the first computer-based, multimedia, distance learning platform.

Multimedia

The mid-1960s through late 1980s was characterized by the improvement of CAI and CBT with enhanced multimedia. During that time, debates raged regarding the definition of multimedia. A somewhat later publication offered a definition that reflected the eventual resolution of some of those debates:

The term multi-media [sic] originated with the audio-visual industry, to describe a computer-controlled, multiple-projector slide show with a sound track. In computer terms, multi-media [sic] is viewed as a blending of media types: text, audio, visual, and computer data in one convenient delivery system. (Philips International, Inc., 1988, p. 3)

Two of the dominant multimedia CAI systems of the 1960s were PLATO (Programmed Logic for Automatic Teaching Operations) and TICCIT (Time-Shared Interactive Computer Controlled Information Television).

PLATO was produced under a partnership of the University of Illinois' Computer Education Research Laboratory (CERL), the Control Data Corporation, and the National Science Foundation (NSF). PLATO courses were developed with the course-authoring (scripting) language TUTOR (later to evolve into Macromedia Authorware). Courses were run on a time-shared mainframe computer that serviced hundreds of concurrent users. In addition to the pioneering hardware development of the plasma display integrating graphical images into the courseware, PLATO system developers created user-to-user communications tools that were the predecessors to the synchro-