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ABSTRACT

This paper establishes the roots of computers and automated teaching in the field of psychology and describes Dr. S. L. Pressey's presentation of the teaching machine; B. F. Skinner's teaching machine; Meyer's steps in composing a program for the automated teaching machine; IBM's beginning research on automated courses and the development of the 1500 instructional system; Programmed Logic for Automatic Teaching Operation (PLATO); the 1970s, the era of the microchip, the microcomputer, computer assisted instruction, interactive video programs, computer simulations, and tool software; and the 1980s and 1990s refinement of the software and the development of CD-ROM. The development of two software companies, Sunburst Communications and Tom Snyder Productions, is used to explain the maturation process of simulation software. Several future trends are identified: (1) the use of multimedia will expand rapidly; (2) the use of telecommunications will explode; (3) preservice teacher education programs will change to supply new teachers with the capabilities to make effective use of available technology; (4) the collapse of educational software publishers into fewer companies will continue; and (5) students will benefit from the infusion of technology into the educational process. (Contains 11 references.) (ALF)

The Historical Evolution of Educational Software

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Running head: EVOLUTION OF SOFTWARE

The Historical Evolution of Educational Software

Introduction: Early Usage

The search for acceptable educational software began long before the current proliferation of microcomputers into the K - 12 educational setting. The concept of computers and automated teaching finds its roots in the field of psychology. Dr. S. L. Pressey exhibited and discussed an early version of a teaching machine at the meetings of American Psychological Association in 1924 and 1925. The concept took the form of a simple machine which gave and scored tests as well as teaching. Pressey felt that "rather than stultifying education, such mechanical aids should free the teacher from unnecessary burdens and leave her free for those inspirational and thought-stimulating activities which are, presumably, the real function of the teacher"(Glaser, 1960, p. 24). The machine would present a multiple choice question through a window; the student would press an answer key. Only when the correct key was pressed did the user receive a new question. A student who provided the right answer to a certain question would be provided with one sequence of questions thereafter; a student who gave the wrong answer would indicate a lack of familiarity with the content and would be given a more augmented list of questions and answers (Glaser, 1960). This is the first glimpse of educational software is seen in the literature.

A generation later, B.F. Skinner discussed the concept of a teaching machine. Skinner's machine required that the student compose his response rather than select it from a set of alternatives. In acquiring the necessary behavior students were led through a series of small steps which moved the student closer to the desired end-product behavior. Skinner did not believe that the machine and its program or software actually taught. He simply viewed the combination as a laborsaving device because it could bring one competent programmer in contact with an indefinite number of students. Skinner viewed the machine as a private tutor for students. He pointedly emphasized that the success of the machine depended on the quality of the program or software.[1]

From Skinner, the evolution of educational software progresses to Meyer, who in 1959 described three major steps involved in composing a program for an automated teaching machine. From a curriculum specialist's point of view, the first step was to delineate the field or subject to be taught. This meant the terms, theories, facts, concepts, and principles of the subject needed to be collected. These would serve as the answers for questions developed for the program. The second step was to determine the learner's entry level skills in that subject. The third step was to arrange the subject matter into a logical order which would promote rapid learning and long term retention. Skinnerian psychologists, behaviorists, and psychologists with a behaviorist orientation view this same three step process in the terms of various forms of stimulus-response connections (Carr, 1960).

IBM research was also being done in 1959 to develop an automated courses which would teach stenotyping, statistics, and German. The program for the stenotyping course was characterized by the following operations:

1. The word to be coded is presented to the student.
2. The student keys the response into the keyboard.
3. The computer checks the answer and indicates where the student is correct or incorrect.
4. If the answer is correct a new item is presented to the student or if the answer is incorrect the same item appears, as decided by the branching logic in the program.[2]
5. After a lesson is completed the student is asked if he wishes to continue. During the query, a new lesson is developed by the computer combining questions from a set of new items and a set of items the student has missed.

The programs for the statistics and German courses follow much the same pattern. Conclusions from this research led to the decision that computer teaching was feasible, branching logic must be included, automatic error analysis would allow for immediate updating of the curriculum, and the superb motivational properties of the computer should not be minimized (Uttal, 1962).

The growth of teaching machines and programmed teaching continues throughout this time period. Evidence can be seen in the Education Index, which first used these two terms in the July, 1959-June, 1961 volume. Here the number of articles about teaching machines is more than those indexed on programmed teaching. However, that is the only biennium which illustrates that trend. In the 1963-1965 volume, the number of articles on programmed teaching rose to 313 while the number indexed on teaching machines was at 29. This pattern points to a trend: there is an increase in the amount of research and writing on software (Corey, 1967). Discussions and work on teaching machines continued. However, around the middle to late 1960's the term changed to computer-assisted instruction or CAI.

In 1966, IBM announced the development of the first computer system designed with education in mind, the 1500 instructional system. This machine contained an audio system, a cathode ray tube (CRT) display with light pen, a picture projector, and a typewriter keyboard. These machines were used in a research project conducted at the Brentwood Elementary School in East Palo Alto, California. Here instruction in mathematics and reading was done with 100 first grade students. During this study the concepts of individualized drill-and-practice systems as well as tutorial systems were studied. In addition, a third level of interaction, dialogue systems, was also used. Issues raised by the study were (1) computer technology would impose a rigid, impersonalized curriculum on students, (2) widespread use of computer technology would lead to excessive standardization of education, and (3) the place of individuality and human freedom would be threatened by the use of technology in education (Suppes, 1968).

Another aspect of computer-assisted instruction evolving during this era was PLATO (Programmed Logic for Automatic Teaching Operation). Invented at the University of Illinois and debuted in the summer of 1960, this technology is thought of by most current technology educators as the beginning of educational computer software. Thirty courses for elementary school, high school, and college students as well as college instructors were available. Working on PLATO the student saw only a small television screen and a keyboard. The student did not see the computer, slide selector, and storage device needed to make the PLATO system operate. The system had the ability to provide tutorial instruction, inquiry logic, and research. One illustration has the PLATO system show a film on a chemical concept and then guide the student through a series of 32 questions on the film's content. The student may progress at his own rate, ask for additional help, and branch through the questions in a variety of ways (Trippon, 1968).

Recent Uses

The jump into the 1970's and the era of microchips and microcomputers has brought computer-assisted instruction to yet another level. The early 1970's still had programmed learning taking place on expensive minicomputers. With the invention of the Apple computer in 1978 and the Apple IIe in the early 1980's, schools could begin to afford microcomputers. Now the rush for educational software began. Educational software was rapidly divided into six categories. Drill and practice programs used the computer much as a flash card. These programs were built on the premises used in the early teaching machines and the programmed learning done throughout the 1960's. Tutorial programs were designed to teach a concept and provided comprehension questions. Again, this category of software found its origins in the days of teaching machines and programmed learning. The IBM experiments in the 1960's illustrated many of the ideas and concepts found in this category of software. Simulation programs were used to enable the students to interact with realistic situations as they were developing thinking skills. Here the jump in graphics capabilities and memory requirements of the microcomputer proved useful. Little simulation software is found in the 1950's and 1960's because of hardware constraints.

Interactive video programs were yet a fourth category of educational software. These programs used a computer to control a video source or sources as well as intersperse computer graphics and text. PLATO programs were the early forerunner of this type of educational software. Utility programs were classed as those programs which helped a teacher produce learning tools for students. Crossword puzzle makers, word searches, and the like fall into this category. These programs did not appear in the early days of teaching machines because of the cost factor of hardware. The sixth category was that of tool software, i.e. word processors, spreadsheets, databases, and the like. Here students and teachers used the tools to help them with daily work and assignments. The advent of lower priced computers and printers has made the use in this category increase astronomically (Troutner, 1983).

The late 1980's and the early 1990's have seen the refinement of the software in the six categories. Drill and practice software has become much more sophisticated. The spelling and content errors which were accepted in the late 1970's simply because the software existed are no longer tolerated today. In fact, today often drill and practice software is scorned as an inappropriate use of computer time. The issue of screen design has become much more important in this group of software as well as the reward system and the branching component of the help screens (Bork, 1985). Also a feature called scaffolding is being seen. This coaching feature provides help for the students in the form of hints, suggestions, and performance evaluations (Lieberman, 1991).

Tutorial programs are still used in some instances; but, the distinction between tutorial and tool software seems to be blurring. With the increased memory, graphics, and sound capabilities of today's microcomputers, teachers have come to expect a very polished product. One example is the Money, Time, and Measurement series available from IBM. These programs have a digitized speech component which allows for kindergarten and first grade students to use the program with ease. The same program guides the students through learning about measuring by units, inches, and half-inches. And, the same program contains a graph making utility, which allows students to develop and print bar, pie, and line graphs of their own information.

Simply tracing the history of an educational software firm such as Sunburst Communications or Tom Snyder Productions provides the best explanation of the maturation process of simulation software. Sunburst Communications started publishing simulations in 1981 with The Factory. In the ensuing ten years, Sunburst Communications has become one of the primary developers of simulations. In 1990, the company split into three divisions--Sunburst Elementary and Middle School, Sunburst High School, and WINGS for Learning. The reason for the split was that the complement of software available was too large for one group of employees to be able to adequately support.[3] Tom Snyder Productions began with the publication of four simulations currently used with the Macmillan social studies textbooks and has grown into a company publishing seventeen simulation programs in the space of less than seven years.

Interactive video programs have taken a new name in the 1990's: they are called multimedia programs. This type of software is in its infancy. The advent of Hypercard and Linkway have reopened the use of interactive video programs. These two authoring programs allow for the student and teacher creation of interactive programs without a great deal of programming knowledge. The entrance of companies such as National Geographic, CNN, and ABC News into the field of multimedia has provided educators with some excellent examples of what can be accomplished with this type of software.

The category of utility programs has seen some new additions such as Timeliner by Tom Snyder Productions. But, most of this category has simply seen improvements on the original versions. One example is The Print Shop by Broderbund. Current versions are out for the Apple IIGS, the Macintosh, and IBM machines which include a number of new features and make use of the upgraded graphics capabilities of all three machines. The advent of laser printers priced so that schools can afford them has also provided an avenue for upgrading a number of older utility programs.

Tool software has progressed into the arena of integrated programs such as Microsoft Works and Appleworks. Students and teachers have come to expect a spelling checker and a thesaurus in any word processor as well as the ability to paste into a word processing file a chart created from information in a spreadsheet. In the 1990's tool software has also come to mean telecommunications software which allows teachers and students to connect with a modem to the outside world. Networks such National Geographic's Kidsnet, IBM/Sears Prodigy, and the Indiana STEPS network allow students to communicate with people around the world, get encyclopedia information easily at home during the weekend, as well as allowing pre-service teachers at Indiana University to critique high school English papers from McCutcheon students in Lafayette, Indiana without ever leaving campus.

The 1990's have also seen another category of educational software develop, CD ROM material. Here the compact disc is used to store text, computer graphics, still pictures, small portions of motion video, and computer programs. One example is the Compton's Multimedia Encyclopedia which contains the full text of the encyclopedia along with a number of programs to help students learn to narrow a research topic, find additional information, and take notes. CD ROM versions of Grolier's encyclopedia and World Book are also available. National Geographic has published an encyclopedia of mammals which not only includes information, but also provides a game where students must find and photograph a specific mammal to win.

Conclusions

A look into the world of teaching machines as described by Pressey and Skinner raise three issues. First is the quality of the programming material. Second is the issue of defining the field. In the early era with the precision available in the teaching machines, specific knowledge goals are needed if the programming is to achieve the behavioral objective. Third is the area of feedback on the effectiveness of the program. Teaching machine programs were capable of providing detailed analysis of student learning behavior. As one ponders the world of educational software in 1991, these same three issues are still relevant.

The quality of the programming material is what will make the success of the technology as a teaching tool. The best hardware available will do nothing for a student without software. The evolution of educational software has seen the quality the programming material improve. Today's software asks students to make complicated decisions, helps provide a structure for developing a topic for a research paper, tutors a student on concepts found in a physics class, provides situations where students must use concepts learned in social studies to solve a problem, and can force a student to learn reference skills in order to succeed at a game.

The issue of defining the field of knowledge to be covered is still one of concern in the evolution of software. As the educational trend toward interdisciplinary learning grows, the distinction between fields of study blurs. This means that programmers and software designers need to have a broad knowledge base or the ability to consult with content specialists. While this happens with the development of some software, such as The Voyage of the Mimi, the practice of having software developers and practicing teachers work together is still rare (Martin, 1987). Until this joint process develops further, the educational software produced will continue to be deficient in this area.

The area of feedback on the effectiveness of software still needs work in the 1990's. Too often teachers do not take the time to respond to the publishers about a specific program. The dialogue which takes place between educator and publisher is sparse at best. On a second level, the dialogue between student and teacher is equally sparse. Students are not often asked if the use of specific software helps or hinders their progress in a class. Finally, teachers are still not taking advantage of the feedback which computer software can provide on student learning progress and habits. Many teachers, overburdened with clerical tasks and other paperwork, do not avail themselves of the massive quantities of information and the analysis of this information which software programs can provide.

As educational software continues to evolve throughout this decade and into the year 2000, educators can look for several trends. First, the use of multimedia will expand rapidly. Library media centers and classrooms will have available the tools for students to develop multimedia term papers. In addition, expert systems operating with artificial intelligence will be available to students as they develop papers and projects. These systems will help guide students through the process of developing a coherent presentation (Young, 1990). The option to do a written paper or a multimedia one will become commonplace. Second, the use of telecommunications will explode. Students will come to expect that homework assignments will be waiting for them when they arrive at home. These assignments will be gotten by using a modem and a computer not by carrying home a piece of paper. Parents will come to expect that teachers will communicate at least weekly about happenings in the classroom. Principals will use electronic means to send home newsletters, memos, the weekly menu, and other parent communications. Third, preservice teacher education programs will change drastically to help supply new teachers with the capabilities to make effective use of the technology available. Fourth, the collapse of educational software publishers into fewer companies will continue. Software firms will find a specific niche in the market and develop almost a monopoly on that type of program. Fifth, the student will benefit from the infusion of technology into the educational process.[4] Students will be able to do research with greater ease and to make much more informed decisions about a wide range of topics as the evolution of educational software continues to provide them with better tools.

The evolution of educational software and infusion of technology into schools can have many benefits. Students can learn information handling skills and better communication skills. The use of higher level thinking skills can be advanced. The restructuring of education to truly include the parent can be accomplished. However, for this to happen teachers will need to change drastically as they adopt a role as learning facilitator of knowledge and drop the role of knowledge dispenser. In addition, staff development and pre-service education programs will need to adapt to this change. High quality hardware and educational software alone cannot make this change and will not result in better educated students: educators need to change for this transformation to begin.

Footnotes

[1]I am indebted to Kathy Hurley, former president of Mindscape Software and currently employed with the Educational Division of IBM, for taking time to discuss the evolution of software. During this discussion, Kathy made the same point. The value of educational computers is only as strong as the software available.

[2] This is one of the first discussions about the concept of branching logic in a computer program found in the educational literature.

[3] I am indebted to Claire Kubasik, the public relations director for Sunburst Elementary and Middle School, and Marge Cappo, President, Wings for Learning, for providing background on the division of the parent company during a recent phone conversation.

[4] As a software reviewer for Booklist, Technology & Learning, Elementary School Library Collection, Emergency Librarian, and a judge for the Critic's Choice Award from the Software Publishing Association, I feel qualified to make such a statement without further documentation.

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