Glenn F. Cartwright

Antecedents and Consequences of Educational Technology

Educational technology is not new. Between the years 1809 and 1936 the United States Patent Office issued over six hundred patents for machines which could teach. It would appear that many people felt that machines could do much of the routine job of instruction and it was this feeling which contributed much to the development of a systematic technology of education.

Emphasis in the evolution of educational technology has alternated between the hardware and software aspects of education. In the first decade of this century, software took the lead when the great American learning theorist E. L. Thorndike made an oblique reference to the establishment of a systematic technology of education to be brought about by the careful design and sequencing of instructional materials. His idea was given little attention and more than a decade was to pass before Sidney L. Pressey, the acknowledged "father" of the teaching machine, swung the emphasis in education technology back to one centered on hardware.

Pressey's device was one which gave and immediately scored multiple-choice questions, eliminating much routine marking for teachers. Although he found, almost incidentally, that his students learned from taking the tests and that many of Thorndike's Laws of Learning applied, Pressey chose to stress the hardware side of his invention rather than the educational program or software. For him, the machine was the answer! Unfortunately, the depression of 1929 contributed to the lack of support he found among teachers who, facing unemployment, could hardly be blamed for shunning a machine they thought might replace them. Three more decades were to pass before serious interest in programmed instruc-

tion was revived by B. F. Skinner. It was his task, in the late 1950's, to bring the emphasis in automated teaching back to the software side of the technology, and he stressed the importance of the educational program over the machine.

individual versus individualized instruction

It is often supposed that educational technology will bring about truly individualized instruction. However, a distinction must be drawn between "individual" and "individualized instruction." *Individual* instruction refers to any instruction which is presented individually but which is not necessarily geared to the assessed needs of the student. *Individualized instruction* refers to any instruction which is tailored to a student's assessed needs. Thus individualized instruction does not need to be presented individually as long the needs of each individual have been considered in the design. Theoretically, individualized instruction can be provided in a group setting.

One of the most significant claims made in the early days of teaching machines was that they provided individual instruction. In truth, a single machine could do little else, and little else was expected of it. The technology had not arrived at the point where a single machine could be used successfully to replace the teacher in instructing a large class. In fact, to allay the teachers' suspicions that they might one day fall victim to automation, the claim was made that, far from replacing teachers in the classrooms of the nation, teaching machines would "free" the teacher for other more creative teaching tasks.

Just what these "creative" tasks were was usually unspecified, and whether or not teachers using programmed instruction have in fact been freed from classroom drudgery remains to be verified. Nevertheless, the potential for "freeing" the teacher helped foster an attitude of acceptance towards mechanized teaching, at least among some members of the teaching profession and an even larger segment of the public. Here was the teaching machine's strength. Produced in large quantities, it could claim at least "individual" if not "individualized" instruction.

educational and historical precedent

Since those who espoused the cause of programmed instruc-

tion valued above all else the one-to-one tutorial method of instruction, as exemplified by Oxford, the fact that the teaching machine could teach only one person at a time was viewed as an asset rather than a liability. Thus the teaching machine's contribution to educational technology involved educational and historical precedent as well as technical feasibility.

The principle that technology is initially comprised of historical precedent as well as technical feasibility was well summed up in a recent television documentary which declared "Technology gives us what we had before technology." Marshall McLuhan pointed to this fact when he observed that the "new" technology of television was being used primarily to bring us images of the past. It was no coincidence that two of the most popular television shows for over a decade, "Gunsmoke" and "Bonanza," were both westerns and dealt exclusively with life the way it used to be.

The same is true of educational technology. If the teaching machine imitated the tutorial, it is true to say that computer-assisted instruction (CAI) imitated the teaching machine. Indeed, the first attempt at computer-assisted instruction (Rath, Anderson, and Brainerd, 1959) was intended as an imitation of a teaching machine. Little thought was given at that time to the possibility of a whole new computer-assisted instruction technology emerging from this simple attempt at mimicry.

technical feasibility

Technology can only incorporate what is technically possible at the time. Users of the teaching machine had insisted on a machine for every student. It was technically unrealistic to do otherwise. The first studies of computer-assisted instruction were made using a single computer and a single terminal in an attempt to duplicate the teaching machine. Time-sharing systems, where several users can use the same computer simultaneously, had not yet been invented.

When time-sharing became available in the mid-1960's, it seemed only logical to apply this advance to instruction and provide each student with his own computer terminal. Of course, the proliferation of computer terminals, like the mass production of teaching machines, seems to have contributed only to the expansion of "individual" instruction. The exciting potential of "individualized" instruction remains yet to be

realized. The point is that new advances in computer technology, such as time-sharing, were applied to educational technology, not because of the educational benefits they might bring, but because of the historical precedent of the one-to-one relationship between student and teaching machine.

It is now technically possible to have a computer teach an entire class in a manner similar to a lecturer but with the added advantage of student response and feedback. This is accomplished with video projection devices and giant screens but has never been implemented. Why? There is no technological precedent for this kind of instruction. Technology is comprised of historical precedent (some might call it educational inertia) and technical feasibility, but in most cases technical advances are used to serve historical precedent.

educational technology and change

Although technology incorporates some element of the past in its initial development, it also modifies that which it was designed to assist. Just as CAI began as an attempt to mimic the teaching machine but soon outgrew it and became a powerful force in its own right, so educational technology will modify many of the educational concepts we now hold.

When we began computer-assisted instruction here at McGill several years ago, instructional materials were programmed into units called lessons in a way similar to a teacher preparing lesson plans. However, the software technology associated with CAI has now grown so that it is possible for a student to sign-off the terminal in the middle of a lesson and return the next day to complete it. When he signs on again, the computer "remembers" exactly where he stopped, is aware of his past performance, and holds in its memory all of his student performance records. The student, greeted by name, continues his instruction where he left off. In other words, it is becoming increasingly possible for a student to define for himself what constitutes a "lesson" and it becomes increasingly unclear to the instructor what a lesson is. The concept of "lesson" becomes outdated since no two students ever take exactly the same material, neither do they begin nor end at the same points. The instructor, in asking the computer for a print-out of a student's performance can no longer specify the performance for a single lesson, since the student may not be finished that lesson yet. This process is responsible for course

authors changing their units of instruction to larger units and avoiding the term "lesson." One comes to view education as a more continuous, less disjointed entity, and to appreciate the arbitrariness of units called lessons. Lessons as we know them today are unnecessary and will not exist in the future, since the breaking up of material in that fashion serves no useful purpose when one has a computer as an instructor. This is one of the ways in which our basic concepts of education will change as educational technology modifies that which it was devised to serve.

Readers interested in instructional technology may be interested in subscribing to the **Newsletter** of the Associate Committee on Instructional Technology of the National Research Council of Canada. To put your name on the mailing list, contact:

Mr. J. W. BRAHAN,
Secretary,
Associate Committee on Instructional Technology,
National Research Council,
Montreal Road,
Ottawa, Canada K1A 0R8

The Newsletter is published at irregular intervals.