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Computer, Teacher, and Learner: Some Technological Implications

The purpose of this paper is to suggest some of the implications for teachers' roles that might result from the growth of computer technology in education. In the past, technological innovations in education have affected the roles of teachers as much as those of students. An important historical example is the invention of mechanical printing, which created new and more readily available opportunities for individual learning. It also allowed the teacher to move away from such tasks as reading aloud to mature audiences.

The term "technology," unfortunately, has two different levels of meaning when applied to education. The most familiar one refers to machinery — for example, audiovisual apparatus — and specific instructions for its use and repair. The technologist, in this sense, supplies and services equipment and is a resource on its operation. In the jargon of computers, this application of the term is to *hardware*. There is another level of meaning, much closer to the experience and tasks of most teachers, which could also require some systematic understanding of the hardware but which emphasizes what to do with it. This is the *process* of creating, developing, and evaluating learning situations, environments, or systems. It includes preparing the content or subject matter of instruction and deciding on the learners' activities which most suitably accompany it. This view of educational technology emphasizes *software*. Teachers engage in this process every time they plan a lesson.

There are increasingly frequent occasions when technology as a process of designing instruction is constrained by tech-

nology as a mechanical aid for the teacher. Few teachers have not experienced arranging to show a film and having something wrong with the projector. The opposite effect also occurs. Schools often seem to invest in equipment which rarely gets used because it is inappropriate to what is being taught (for whatever reason). Sometimes these constraints are the result of more than a lack of mechanical skills. For example, making a good videotape or film involves the art of a director as well as the skill of a cameraman. The problem can be described as one of literacy, the ability to use the language of the medium. The usual meaning of literacy, the ability to read and write, has its parallel meanings in media other than print. In common to all such uses of the term is the ability to put a message into the medium and to understand (or at least decode) one that comes out.

In the following discussion, the idea of literacy is presented as people communicating with computers, both in terms of demands of the computer as a machine and contributions of the computer to the process of education.

problems of literacy

One of the most promising features of much innovative educational equipment is that it can be used (but not serviced!) with little technical sophistication. Young children can successfully use films, tapes, recordings, and videotapes. The inner workings of the machines themselves might be mysterious, but an intelligible message can be put into or received from them relatively easily. Of course, very sophisticated uses are also possible, but society does not require sophisticated use of even reading and writing in judging ordinary literacy. In short, the content of such media as films, radio, and television is at least as accessible to the conventionally literate individual as the content of books, and sometimes more accessible. These media do not hide the information they contain from the average citizen. Computers often do, and in this important way they differ from other educational hardware. It is frequently necessary to learn special programming languages in order to tell the computer what to do. This mostly affects the teacher or programmer, since the interaction of a learner with a running program is usually in a fairly simple language.

It is quite possible that this lack of direct control over the computer by educators is one reason for most school uses of computers to be less than imaginative. By way of contrast, schools often use portable videotape units to explore new kinds of learning experiences, whereas much of the literature on computers in education emphasizes new ways to do old jobs, from testing, scoring, record-keeping, and writing report cards, to drill and practice, presentation of text (sometimes "programmed") material, mathematical calculating, and even simulation gaming and serious attempts at individualization of instruction.[1] However, the result has too often been unsatisfactory inflexibility of material, limited applicability to certain disciplines, and costs and equipment beyond the resources of most schools. Computers do add to memory in quantity, speed, and reliability, but even their contribution to the individualization of instruction is not technologically unique. Neither is their potential for reaching large numbers of learners: radio and television, among others, can already do this. The above functions can, in many cases, be accomplished with machines already known to educators, or perhaps even without machines.

The question arises then, with what teaching functions can computers assist that other machines cannot? Computers can communicate with humans and even with other machines. They are also capable — under proper instructions — of intelligent behavior.[2] These two qualities are extremely important in defining what computers can contribute to educational technology. Their artificial intelligence is illustrated by programs which allow a computer to create general solutions for problems following trial-and-error learning to learn.[3] Their ability to interact, or converse, is easily observed at virtually any computer terminal.[4]

Interacting with students and making intelligent decisions about them are critical functions of the teacher. The advantages of having mechanical assistance with these functions could be tremendous. It is not the present purpose to offer this possibility as an educational utopia but rather, to discuss first some obstacles to its happening, and second, some of the adjustments that might reduce the objections.

To begin with, costs are not the major problem. They are declining rapidly on a per-pupil basis. The main issue is again reduced accessibility of contents.[5] Western societies have achieved levels of literacy that render nearly everything in

print comprehensible to a large number of ordinary citizens. However, the conventionally literate person is totally illiterate with respect to computers, though he knows there is more in the "black box" than is apparent.

The new technology is revealed as much through the new class or caste of scribes as by the new equipment, and perhaps more so. The key point is that computer technology is still very primitive. Computer programming and control are still extremely dependent on highly abstract written codes. When it becomes as easy to operate a computer as it is to operate a tape recorder, the literacy problem will be solved. This will not likely be achieved by a great dissemination of computer literacy, but rather by removing the need for such literacy. This is already happening, to some degree, as far as the learner is concerned, with the availability of conversational programs in which the only crucial skill is pushing a button at the end of each message. Meanwhile, terminals (like typewriters) which respond to spoken instructions are the focus of considerable research. The effects of this reduced dependency on literacy have been described by McLuhan:

> Nobody knows the language inherent in the new technological culture; we are all blind-deaf mutes in terms of the new situation. Our most impressive words and thoughts betray us by referring to the previously existent, not to the present. We are back in acoustic space. We begin to structure the primordial feelings and emotions from which 3000 years of literacy have divorced us.[6]

computer and teacher

"Will computers make teachers obsolete?" The answer to this question is probably, "No, but . . . ." Computers are quite likely to force a change in the role of the teacher. When a teacher adopts or rejects any technological innovation, he is making a decision about his role. The process also occurs when a technology is imposed. When a teacher employs a text written by someone else, a film he did not make, or a television program he did not produce, he is largely taking the role of *guide* rather than *model* for student learning.

The guide generally operates as a classroom manager. A large part of his activities include keeping records of student progress, directing students to resources, and organizing learning sequences. Computers can do these jobs very well. Turning

over these tasks to a computerized system can free the teacher to spend a greater proportion of his time in personal contact with his students, without surrendering his responsibilities to the machine. He can use it as an important tool. In this manner, the use of computers can have a humanizing effect on education. However, any teacher who particularly enjoys his clerical tasks in management, or relies upon them for personal satisfaction, might very well be threatened by computer technology.

The teacher who sees his role primarily as that of a model for his students is less likely to have his role reduced by computers. While computers can be programmed to do some things in very human ways, this does not make them human. Perhaps teachers who prefer the role of model would be willing and happy to turn over clerical tasks to an automated partner. It is probably impossible for a teacher to operate exclusively in a role of either guide or model, partly because students surely retain some control over what they learn, regardless of what was intended to be taught. It is worth noting that present uses of computers in education tend to assume closely monitored management of student learning. One reason for this is that educational psychologists and others have some knowledge of learning under such a model. Considerably less is known about learning under less closely monitored conditions, though this body of knowledge is growing.

Research is currently in progress to assess the manner in which teachers make decisions about individual students.[7] One outcome of this series of studies will hopefully be alternative suggestions for the implementation of computer-aided individualized instruction which takes into account the preferred roles of particular teachers as well as characteristics of the students and the subject matter. Different teachers would appear to prefer help with different tasks. Among the alternatives at issue here are: first, the computer making instructional decisions, usually based on student performance, with the teacher responding with particular attention to the learner; second, the teacher making instructional decisions and having the computer do the specific teaching; and third, various combinations of both. It is almost a question of who serves whom. If the teacher can actually exercise this choice, it is an example of the more general meaning of educational

technology in practice. Potential roles for other personnel can also be seen under some of these alternatives.

computer and student

The possibilities of designing learning situations for which there can be reasonable expectations for success are increasing regularly. From the point of view of the students, and their relation to the rest of society, there are also major issues to be considered. For example, society is faced with the question of how much diversity among students it really wants to create intentionally, through highly individualized instruction, as well as how much it is willing to pay for it.[8] Such a view can also give the impression that the teacher is not personally necessary, since management is one of a teacher's most visible activities. As author, producer, or resource person, as well as general organizer, the need for a teacher's immediate presence might be reduced, but as a warm, sympathetic, concerned human being, it might not. The key point might well be whether or not teachers will have the option of making choices, not the content of the choice. Limited technology does not yet make the choice fully possible; noninvolvement in the broader technology by teachers may preclude it later. There are inherent challenges involving philosophical views of the value of man.[9]

Computers are the first technological innovation in education which can, to any large extent, take over the task of interacting with students. They provide not only question-and-answer sequences, but more general conversations as well. Before long, developments in computer technology will include the processing of natural language which will allow spoken discussions. In addition, the computer can be used to avoid the apparent passiveness that is possible with books, radio, or television. It can be programmed to wait for a reply before proceeding, and to provide cues and prompts which encourage that reply from the student. It can also remember the student on repeated visits, greet him appropriately, make polite comments and seem to behave in many ways like a human being.

Is this type of interaction sufficient for the student, not only for his specific learning, but for more general social needs? What is the essential component of this interaction: student participation, contingencies provided by the teacher

or computer, or the presence of a real human being? What matters more, the teacher or the teaching, good teachers or good teaching? The answers to these questions will contribute to an understanding of the contribution computers can make in education and their effects on traditionally human roles.

footnotes

1. Several examples are given by Patrick Suppes, "The Uses of Computers in Education," *Scientific American*, CCXV, No. 3 (September, 1966) 206-220.
2. Marvin L. Minsky, "Artificial Intelligence," *Scientific American*, CCXC, No. 3 (September, 1966), 246-260.
3. For example: Allen Newell, J. C. Shaw, and Herbert A. Simon, "Elements of a Theory of Human Problem Solving," *The Psychological Review*, DXV (1958), 151-166.
4. Further examples are found in Edward A. Feigenbaum and Julian Feldman (eds.), *Computers and Thought*, New York: McGraw-Hill, 1963.
5. Lord Ritchie-Calder, "Science and Human Rights," Second Beatty Lecture of 1971, McGill University, November 16, 1971. Excerpts available in "Hostages of the Computer," *The Montreal Star*, November 20, 1971, p. C-6. See also, *Privacy and Computers: A Report of a Task Force Established Jointly by Department of Communications/ Department of Justice*, Ottawa: Information Canada, 1972.
6. Marshall McLuhan, "Five Sovereign Fingers Taxed the Breath," in *Explorations in Communications*, Edmund Carpenter and Marshall McLuhan (eds.), Boston: Beacon, 1960, p. 208.
7. Bruce M. Shore, "Teachers' Decision-Making in Individualized Instruction." Paper presented to the Annual Meeting of the National Society for Programmed Instruction, San Francisco, April 1973.
8. Suppes, *op. cit.*, p. 20.
9. Extensive discussion of this topic is provided by Herbert J. Muller, *The Children of Frankenstein: A Primer on Modern Technology and Human Values*, Bloomington: Indiana University Press, 1970.