The value of any technology in education depends upon our ability to direct its capabilities with purpose.

Let's Challenge Technology

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American educators now talk a great deal about the innovative hardware of education, about computer-assisted instruction, 8 mm cartridge-loading projectors, microtransparencies, and other devices. In the not too distant future they may well be talking about enzyme-assisted instruction, protein memory consolidators, anti-biotic memory repellers, and the chemistry of the brain.[1]

MR. KRECH is correct in his assessment of "now" and his prediction is probably equally valid. Therein is the basis for the theme for this article: some considerable body of educators should stop talking about the devices and start thinking about educational programs for students. Such thought should then be referred to the potential opened by technology.

Thus, for example, an acquaintance recently attempted to arrange for the use of a closed circuit television system in a school. So little use was being made of the system that neither the cameras nor the display units were in good repair; this in a school where closed circuit television has been discussed and demonstrated, and thousands of dollars worth of coaxial cable installed. The teachers apparently have no vision or have not been motivated to consider how they, individually, could use the system to the advantage of either themselves or their students. By way of contrast, Postlethwait at Purdue has developed a multi-media learning laboratory for individualized instruction in biology.[2]

I propose to suggest the nature of in-service education which may prove beneficial in promoting greater understanding of how or if technology can serve better. Turning to a consideration of computer technology, I suggest that we cannot ignore it. Finally, I propose that we consider the computer as a concept in order to loosen our imaginations.

In-Service Education

What has been learned about in-service education that might be used in preparing teachers to use new technologies?

[1] David Krech. "The Chemistry of Learning." *Saturday Review*, January 20, 1968. p. 48.

[2] S. N. Postlethwait. J. Novak, and H. Murray. *An Integrated Experience Approach to Learning*. Minneapolis: Burgess Publishing Company, 1964.

David Levine speaks as though he were transferring a generalization from the experience of national curriculum study groups. Mr. Levine's concern is how in-service work can contribute to saving inner-city schools. He says: "It must also be kept in mind that 'freeing' the teacher to teach includes equipping her with appropriate skills in organizing and conducting instruction."[3] Thus an apparent reason for in-service work, "'freeing' the teacher to teach," is appropriately replaced by a "hidden agenda" reason, "equipping (the teacher). . . ." My suggestion is that we recognize beforehand the futility of offering in-service work on the technical aspects of new technology and attempt to provide in-service work on a utilitarian level. Hidden agenda items may still appear, but we will be much closer to confronting them than if we had started at the more abstract level of the technology.

In the case of technology, it is likely that a majority of the time allotted to in-service education would more profitably be spent getting the ideas and hopes of teachers stated. Once stated these can be developed and molded so they can be operationalized using new or old technology, or no technology at all if this is the clear case. Certainly such training cannot, for a vast majority of teachers in a variety of educational institutions, realistically be focused on specialized procedures such as creating aesthetically pleasing and technically accurate drawings, translating instructional procedures into strange languages for use in computers, learning how to repair slide projectors, or studying Boolean algebra.

Rather, it seems to me, technology, and particularly the computer, generates a reason for thinking harder about what one might like to provide for students: more certain understanding of music or poetry through the provision of ten examples for individual consideration where you now have time for one or two in class; an opportunity to have a student's spelling and punctuation improved before he submits an essay to the teacher; a chance to manipulate a simulated environment and perhaps to develop some notion of which variables may or may not be independent of other variables in biology or ecology; a highly structured procedure to be followed rigorously where such is important to safety, or to the success of the effort, perhaps in chemistry.

Finally, new technology sometimes requires further study in the content area in which the technology is to be exploited. Clearly, I believe, some films on Fluid Mechanics, which I recently saw in production at the Educational Development Corporation, will require such study on the part of many teachers wishing to use them. Similarly, new methodology developed for use with updated materials in biology, physics, chemistry, and mathematics has resulted in the necessity for upgrading teachers' acquaintance with the content fields.

In-service work suggested by new technology, then, probably should be focused on almost everything about instruction except the technology itself. My comments from here on will be focused on the high-speed electronic computer, the newest and potentially most

[3] David Levine. "Can In-Service Training Save the Inner-City Schools?" *Journal of Secondary Education* 43 (1): 7; January 1968.

useful of all the technology available to education.

Educators and Computer Technology

Lest one think that we have the same range of choice about computers as we seem to have had with past technological devices, let me put a few facts and opinions before you. John H. Martin has been quoted as telling a Congressional committee that "the center of gravity for educational change is moving from the teachers' college and the superintendent's office to the corporation executive suite."[4] Anyone who reads daily papers with some thoroughness realizes that many business combines are being constructed around electronics companies, combines with great potential for influencing educational method, content, and perhaps even purpose.

These combines cannot be ignored for two substantial reasons. First, they have engulfed the entire set of enterprises which make decisions about and produce educational materials. Second, each combine is built around or includes as a substantial unit a company which builds computers. It has been estimated that "within a decade we will have a national capacity of approximately 2 billion computations per hour for every man, woman, and child in the United States."[5] The educational combines plan to use this potential, and educators who choose to ignore this certainty might plan to be disoriented by the form, procedures, and substance of schooling in the last quarter of this century.

Let me not be understood as suggesting that the appearance of business and industry in education through ownership of the technology is *per se* evil or even unfortunate. Educators are not yet the largest users of electronic computers. The largest users demand that certain capabilities be guaranteed on delivery of the computer. Fortunately some of these capabilities, or the underlying logic required for them, can serve educational purposes, even instruction, very well. If we have good ideas, i.e., sound in terms of producing desired learnings, we can take advantage of capabilities already extant, and we can significantly influence the future capabilities if current ones are found inadequate.

My acquaintance with several men working on the development of instructional materials and procedures for use in an environment served by a computer suggests that within some large corporations there is an awareness that the mere transfer of linear teaching-machine programs to the new computer technology is simply unacceptable. The men I know realize that: (a) the view of mind implied by what I have called errorless programs is a limited view which may serve some restricted purposes in education; (b) such direct transfer of paper and pencil materials would be a waste of money and an unbelievably myopic view of the potential of the computer; (c) the simulation potential is probably the most versatile characteristic of the computer and as such should be exploited to its fullest in the service of education. This situation

[4] From: Charles E. Silberman. "Technology Is Knocking at the Schoolhouse Door." *Fortune*, August 1966. p. 120.

[5] Arthur L. Aden. "Challenges for Display." *Information Display*. November/December 1967. p. 33.

is very heartening, for a year or two ago the educational application of computer technology seemed to be in the hands of men not disposed to examine alternative approaches to learning or instruction.

A combination of circumstances thus leads me to believe that attempting to ignore the potential of computer technology for instruction would be unrealistic.

Computer as a Concept

As I have suggested elsewhere,[6] it may be very useful to consider the computer as a concept rather than as a piece of hardware. People have a tendency to broadcast instances of the fallibility of machines. We also apparently have a natural tendency for hyperbole which results in our assignment of magical qualities to computers. These tendencies probably have already resulted in the development of stereotypes which most of us use when thinking or talking about computers. If one could be persuaded to set aside the stereotype he now has and consider the computer as a concept, perhaps more creative and more useful ideas challenging the potential of computers in the educational process would be forthcoming.

It is not my purpose here to develop the concept theme but merely to suggest that if you can drop your stereotypes for a little while you might be able to conceive of uses for the computer which are not immediately apparent to you. The basis for the uses you wish to make, however, still rests on a consideration of what it is you would like to do to improve the educational environment for your students. Desire to improve this environment may issue from such a simple, honest, and straightforward motive as reducing your own burden. Let me relate some ideas which have been conceived and, in some instances, subsequently made the basis for using computer technology in new and startling ways. Perhaps these examples will serve to stir your own imagination.

In a recent article, Entwisle and Huggins report several computer-based simulations used in higher education. One of the most interesting is presented as follows:

> Another computer-based simulation, the Homewood Job Shop, is much more elaborate, and we have studied its use with engineering students fairly extensively. It models a completely equipped electronic Job Shop filled with transistors, vacuum tubes, and other parts. It is "staffed" by a technician who never makes mistakes in calculations or in wiring things together.[7]

What was it that the faculty was trying to do that led them to the development of this interesting simulation? They thought that learning to design required experience by the students. They knew that such experience was difficult to arrange, and that when one did arrange practical design situations it was almost impossible to get feedback to the students after the designs had been evaluated. This made the experience perhaps less than worthless.

The problem then was to arrange for some kind of experience in the design of electrical circuitry or complex elec-

[6] John R. Ginther. "Computers in the Elementary School." *Illinois Elementary Principal*, May 1967. p. 3-6.

[7] Doris R. Entwisle and W. H. Huggins. "Simulated Environments in Higher Education." *The School Review* 75 (4): 379; Winter 1967.

trical jobs, experience which would provide the student with some information about whether his work was operative, inoperative, subject to certain kinds of failures, etc. They programmed a computer to simulate a broad class of circuits which were used by the student to "build" electrical devices and other configurations specified by the designer, or the teacher. The validity of the simulation not only of the configuration but of the individual components is reported in some detail, and it is indeed difficult to imagine. But to quote further:

> Without going into further detail, we can say that the student is furnished with a completely equipped "laboratory" for building and testing electrical and electronic devices. The physical realization of these devices is made unnecessary because the simulation correlates so well with performance of actual devices. Results are available in a very short time. A design created in the morning may be evaluated by afternoon, or several different designs may be tested simultaneously. Shortening the time between creating a design and witnessing its realization has obvious advantages.[8]

Stemming from recognition of the problems and difficulties of teaching electrical engineering the way they thought it should be taught, this group devised a simulation which has obvious advantages. Students no longer spend weeks or even months creating an actual physical design job which has then to be evaluated. Since one of their goals is to have the student engage in creative designing, it seems appropriate that the student does this rather than spend his time "in tedious computation or in shop procedures like soldering."[9] With this particular use of the computer "in the nine weeks session *fifteen different designs,* some of considerable sophistication, were built, modified, and tested."[10]

Information Retrieval

I turn now to quite a different field of content as well as to information retrieval as opposed to simulation. Several years ago Mr. A. M. Andersen, a member of the faculty in history at Bloom Township High School in Chicago Heights, Illinois, suggested that he would like to be able to bring the relevant thoughts of highly regarded Americans to the attention of students when the students were studying certain issues or current problems in American history. For example, he said he would like to have the students be able to hear the words of George Washington, Senator Arthur Vandenberg and others on the question of whether or not our foreign policy should permit or encourage entanglements in foreign wars.

This is a matter which could be arranged relatively easily with a computer either providing a hard copy of the relevant quotations from several Americans or serving as a librarian to provide reference points on a tape recording which could then be played. This is a very straightforward potential application of the computer as an aide in the instructional program. As in most instances there would need to be a great deal more work done by teachers in preparing the content or subject matter with which the computer is to deal than there is work to be done in studying the electronics or the logic or the language

[8] *Ibid.*, p. 382.

[9] *Ibid.*, p. 383.

[10] *Ibid.*, p. 384.

of the computer itself. Someone would have to dig out the various quotations which he might wish to use for the particular question or problem in American history and would probably have to provide some kind of cross-indexed reference system before the computer would be useful at all. But once the computer became relevant, it would indeed act swiftly and on short notice.

Another example is using the computer to do a series of troublesome tasks for the librarian. When books are received at a library the processing entails the assignment of numbers and the typing of book cards and file cards. If the volume of incoming books is large this becomes a never-ending routine. At one library in the midwest this routine is now completed by a computer system in which information is stored and collated and the desired cards printed once each week. This is an example of a highly organized routine which can be programmed for the computer. It is characteristic of a large class of routines for processing records, routines likely to be found at many levels of an educational system.

Games have become a procedure for instructing in some areas. Business management provides illustrations. Babb and Eisgruber [11] suggest that games can teach concepts such as planning and control and organization; can provide practice in managing, and teach the value of organization, among other things. Several games have been computerized, and they report some in use at Purdue University. Two of the titles are "The Purdue Supermarket Management Game" and "The Purdue Farm Management Game." As always, the need and the idea for a game were developed without any necessary technical knowledge of computers. Once the idea occurs it can often be molded to the capabilities of the technology, but knowledge of the technology alone seems to do little to inspire creative ideas about instruction, or record keeping.

Two or three years ago I observed a patient responding to questions from a computer program which helped diagnose some allergies. At Stanford, computerized instructional programs in reading and mathematics are in use. General purpose programs for analyzing language are well known. The potential and versatility of computer technology will be tested in education as we conceive for it tasks useful in the educative process. We are most likely to conceive a broad range of tasks if we think of the computer as a concept to be given meaning from our imaginations.

Our search for some way to confront technology leads, as always, to in-service work. One job for in-service work is to stimulate a large number of persons to generate ideas and develop them as a challenge to the potential of technology, particularly, at this time, the computer.

It seems likely that the most fruitful use of computer technology in instruction will be to create simulations. However, a second important category of use will be to provide short sequences of instruction about difficult topics or concepts. Clearly, the real value of any technology in the educational process depends upon our ability to direct its capabilities with purpose. Herein lies a clear goal for in-service work.

[11] E. M. Babb and L. M. Eisgruber. *Management Games for Teaching and Research.* Chicago: Educational Methods, Inc., 1966.