We must decide the kind of education we want and then devise or utilize the technology needed to achieve it.

Introducing Technological Hardware in Education

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SCHOOLS have big jobs and small budgets. They are among the primary institutions for the transmission of social and cultural heritage. They are the principal consumers of educational technology and participants in its evolutionary development. They are sometimes initiators of innovations in technology, yet other supporting institutions such as universities and industry actually dominate this role.

Schools also strive for excellence in instruction. As such, they use techniques and devices to aid them in raising the quality and effectiveness of instruction. To a lesser extent, they consider technology as a means to an end—saving teachers time and energy. In the long-range view, there is an increasing interest in technology for its savings in the number of teachers employed. This cost of technology is added to the economic burden of the school and is justified on the grounds that it improves the quality of instruction, the motivation of students, and the prestige of the school, its administration, and the community.

In short, technology is visible evidence of progressive thinking and affluence. It reveals to the world that "nothing is too good for my child." It also serves to release parental tensions about the possibilities of a son or daughter getting into a "good" school. It allows the parents to feel that they have done everything possible to help their child in a highly competitive race for education.

On the other side, the educational innovator is interested in technology because he sees that it might improve the quality of education and more particularly instruction, to make better use of teachers' and students' time and energy. In brief, technology would appear to provide a way of making more humane use of human beings. It also has appeal to the more scientifically-oriented educational psychologist who sees in it a means of finding answers to old problems that have defied the precise and incisive analysis necessary to understanding and progress.

In the year 10 SA (Space Age) we are spending 45 billion dollars for education. As an industry, education is second only to national defense. An estimate of expenditures for instructional hardware is 120 million dollars. This cost includes language laboratories, tape recorders, projectors, television equipment, and computers. Expenditures such as these give heart to some and nightmares to others.

Some see the school's acquisition of hardware as analogous to an impoverished family spending money on silverware for the table when what it really needs is the food more than the utensils. Others perceive hardware as the necessary vehicle for moving students from low to high gear in their intellectual development. Still others see the purchase of hardware as a capital investment in the educational establishment that should be made now so as to make it possible to increase both quantity and quality of education in the future.

Instrument of Education

That we are making large expenditures for educational hardware is a fact. That we have a million classrooms to equip is another fact. That we have over 44 million students in school is still another fact. All of these numbers will increase each year, as will teachers' salaries. Nothing is going to disappear or get smaller—not the children, not the classrooms, not the cost of teachers and hardware. The problem is to manage the total enterprise in the best way to minimize these increased expenditures while at the same time maintaining quality and, if possible, improving it. We need to keep irrationality from reducing quality in the name of economy. Hopefully, this can be done between today's need and tomorrow's solution.

Technology is not the solution to today's educational problems nor will it help in tomorrow's solutions unless we make it an instrument of and for education. Technology has to be fashioned to aid education. Swords are not plowshares. They must be hammered and refashioned to be used to till the soil. Similarly, today's technology comes from business and entertainment. It has to be refashioned for education. A student console connected to a computer must meet special requirements—it cannot be just a teletype built for occasional use by a teletypist.

A film for teaching laboratory techniques to students of chemistry should not use the techniques of an Andy Warhol or Ingmar Bergman. The overlap of technology for education with that for business and entertainment is appreciable at the points where it is least needed. The great need in education is for technology to be used in instruction, not in simple communication. Instruction is much more than communication, in spite of the many statements to the contrary.

What is required in education is a conceptual framework that would determine the uses of technology. In sharp contrast with popular belief, theory is the most practical thing we can have. Behind every successful application of technology is a good theory. Technology implements theory, but the flow is not just in one direction. Technology has provided new data and thereby facilitated the development of better theory. Our task in education is to foster these processes with the

borrowed technology we are beginning to use and with which we hope to better understand our needs.

Assessing Results

The apparent importance and expense of scientific research in all fields naturally lead to efforts to assess its contributions to society and to optimize its planning. Behind these pressures is the conviction that we can and should make decisions about the support given to particular areas of scientific research based upon what we foresee as its tangible contributions. Unfortunately, there is good evidence that this realistic, hard-nosed and business-like attitude is often self-defeating. It eliminates from the decision process the cultural value of knowledge and measures scientific research only by its practical results today. While this is an appealing position to some, it is perhaps more relevant to physical than to behavioral science. Even realistic men would generally agree that we need to develop minds, to explore implications of ideas and observations, rather than train all to think alike.

There is abundant evidence that basic research develops many new ideas and new information from which technology is derived. This has led to the implication that we need to consider just what technology we want and then sponsor the basic research which will contribute to the needed background of information.

Clearly this is a valid approach for developed areas such as the physical sciences. Behavioral sciences, particularly as they relate to instructional technology, however, are not well developed; consequently, valid projections of the type of basic research that will pay off are less likely. This means that there is a greater need for fundamental research in the behavioral sciences relating to instruction than there is in these more developed areas. Unfortunately, both industry and government are stressing application ahead of basic and fundamental research in instruction. This clearly puts a flimsy cart before a powerful horse.

Results in Learning

Instructional technology has to evolve for education by its use in education. The hardware itself is clearly not sufficient to produce the desired learning effects; it has to be used with quality material and with discrimination. Therefore, the most efficient strategy for introducing hardware into education if we want it to fit into the mainstream and grow in a desirable way is to use a symbiotic plan for its entry and use. With this plan, the technology is used by students in schools so that it serves the immediate purpose of teaching them as best we can with what we now know. In addition, its use is a planned part of a research design that has as its purpose the determination of ways in which instructional technology eventually will be used and designed. With this plan both a short-range and a long-range purpose are served.

To make a symbiotic plan work in a substantial way throughout education, it cannot continue to be a hit-or-miss affair. A specially constituted and committed interdisciplinary group is needed to provide an interface between manu-

facturers and publishers, on the one hand, and schools, on the other hand. The program of this group is most analogous to that found in a proving ground, and should be distinguished from the evaluation of marketed educational materials.

Proving Ground

The program of a proving ground is designed to test the limits of technology before its design and the plan for its use are fixed. For instructional hardware and materials there is a need to determine acceptability and effectiveness and the patterns of use in a variety of schools and with a sample of different teachers. Efficient procedures for introducing hardware into schools, for training personnel to use and relate to hardware in their courses, for monitoring its use, for evaluating its effectiveness, for determining its limitations, and for employing it in fundamental research on instructional strategies are critical activities of an interface group.

The development of an efficient methodology for intervention could accelerate the evolutionary transitions in technology for both instruction and instructional research. Schools are not equipped to perform these functions, particularly since they do not involve established procedures, yet these processes have to be accomplished. Furthermore, the schools themselves are important objects of study when technological developments are introduced and used.

The sociological data are important in the overall evaluation of an intervention such as new hardware and software systems. The magnitude of the educational establishment, its economic dimensions, and the complexity and abundance of modern technology have magnified the problems of hardware intervention. The problems are clear but approaches to their solution need to be developed if education is to be helped by technology rather than just a market place for it.