

Costs, Benefits, Effectiveness: Challenge to Educational Technology

Problems and perspectives on analyses of costs, benefits, and effectiveness are discussed.

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Technology can and is affecting education. Today, applications of technology are primarily in the form of in-school television, computers for administrative processing, multimedia presentations, and the use of audiovisual aids by the classroom teacher. By the end of this decade, the range of applications and the pervasiveness of technology in education will be greatly increased (1), primarily for two reasons. First, there is the growing demand for change in the present educational system, because of its high and still increasing costs, its low productivity, and its inability to be fully responsive to identified national needs. The second reason is the recent advances and growth in the number of cable systems, the potential expansion of Instructional Television Fixed Service for both video and nonvideo services, the appearance of new and specialized microwave common carrier systems, the development of domestic satellite communications, advances in film and tape cartridges, the emergence of minicomputers and computer time-sharing, and the growing acceptance of microforms.

The term educational technology is relatively new and, like all new terms, is often used to describe old practices. It is important, therefore, to define educational technology as it is used in this discussion. Educational technology is not hardware, although it incorporates hardware. Neither is educational technology the same as media. Media are the means by which contacts are made between a learner and the instructional materials. Thus, computer-assisted instruction (CAI) is a medium distinguishable from the medium of instructional television which is different from the medium of face-to-face instruction. A medium does not deal with the

process of instruction, but rather it is concerned with the method of contact or of communication to the receiver (2).

Educational technology, in contrast, is a systems approach to instruction, incorporating specific measurable instructional objectives, diagnostic testing, criteria for student performance (such as, 90 percent of the students will attain 90 percent of the objectives), and the repeated redesign of the curriculum materials until the criteria are achieved (3). By the very nature of its iterative design, educational technology assures a high standard of student performance in terms of the objectives which have been set. As defined, educational technology involves the application of scientifically tested principles of learning to an instructional environment in a consistent and coherent manner. It incorporates the media and may involve hardware, materials, and methods of instruction.

If the full potential of technology in education is to be realized, well-prepared cost-benefit and cost-effectiveness analyses are necessary. The technological developments mentioned earlier have been expressed in terms of equipment which can accept, store, manipulate, transmit, and display information. If this equipment is considered along with the cost of new and higher-quality materials and programs, the development of new teaching approaches and strategies, such as individualized instruction, and the necessary teacher training, the total cost of educational technology is high. Thus, even though technology is capable of delivering instructional services which may be flexible, powerful, productive, and personalized, it can be expensive if not properly planned.

Framing the Question

At this time when there is growing demand for rendering education more personalized and more responsive to the needs of students, accurate determinations of costs, benefits, and effectiveness are becoming of increased importance to educational decision-makers. The individualization of instruction, long a goal of American education, is one approach being investigated to meet that demand. For the first time in our history means are being developed through technology to make instruction responsive to the needs and abilities of the individual student.

Individualized instruction does not necessarily imply a Mark Hopkins situation or one-to-one tutoring, but instead patterns instruction to meet, within limits, the goals, aspirations, abilities, and especially the needs of each student. Each student is treated as a unique person having certain desires and competencies which make him different from other students. The individualization of instruction may involve lecturing, small group discussions, laboratory experiences, one-to-one counseling, or self-paced learning, with these approaches being used in concert or singularly.

In the past, schools moved toward this goal by reducing the student-teacher ratio. Over the past 10 years, the number of pupils per teacher in the public elementary schools has decreased by almost 4, from 28.4 in 1960 to a projected 24.5 in 1970. Future projections suggest that by 1979 this figure will drop by less than 1 to 23.6 (4, p. 59). Yet, during the decade beginning in 1960 public school expenditures (in adjusted 1969-70 dollars) increased from \$482 per pupil in 1959-60 to \$783 per pupil in 1969-70. In 1979-80 the estimated amount per pupil will be \$986 (4, p. 93). The cost of additional teachers' salaries and additional facilities to reduce the ratio is enormous. Studies have shown, however, that even with traditional approaches the amount a student learns as measured by standardized tests is relatively independent of the student-teacher ratio.

Since the only valid question that can be asked about schools is "What do the students learn?," reducing the number of pupils per teacher while retaining the same technique of teaching is questionable from a cost-effectiveness standpoint. The question should

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be not whether student achievement will increase if class size is lowered, but whether the achievement will increase more if the same amount of money is spent on other alternatives, such as technology-assisted or technology-presented instruction.

Although analyses of both cost benefit and cost effectiveness must be applied to education, a distinction should be drawn between them, or the analyses may be misapplied or applied at the wrong stage in the evolution of a specific technology application.

Effectiveness assesses the results of how well a program is doing, while benefits specify what the program ought to be doing. Cost-benefit analysis, therefore, is a means for comparing the resources (costs) to be employed on a specific project with the societal results (benefits) likely to be obtained from it. Cost-effectiveness analysis follows cost-benefit analysis, and is a means for measuring the extent to which resources allocated to an accepted specific objective under each of several alternatives actually contribute to accomplishing that objective, so that different ways of achieving the objective may be compared (5).

As an illustration of the difference between the two, consider the goal of raising pupil achievement in mathematics. Several options are at hand: (i) reducing the student-teacher ratio; (ii) adding more mathematics to the curriculum; (iii) hiring better teachers by raising salaries; (iv) hiring teacher's aides to release teachers from non-teaching duties; and (v) extending the use of the best teachers through television. Each of these approaches is an alternative to reach the same goal, and each can be evaluated in terms of its effectiveness in accomplishing the goal.

From a benefit point of view, however, none of them can be used in making the original decision that student performance in mathematics should be improved, particularly if the effort to achieve that improvement has a detrimental effect on performance in another subject, such as social studies. This decision must be based on benefits, that is, upon the values that the school administrator holds, not on the means.

Cost-effectiveness analysis provides a standard against which to judge alternative actions. Cost-effectiveness analysis, while useful, is not, however, the sole basis upon which many decisions are made. Funds, disproportionate in

amount to the number of people, are now being directed at the problems of the disadvantaged and the handicapped, and toward equalizing educational opportunity. With these priorities, large amounts of money are being spent to bring about small returns as measured by many indices, such as average increase in intellectual achievement and increase in gross national product. The Head Start Program for culturally deprived children, for example, has estimated the average cost per child to be \$1056 in 1970. This figure is about one and a half times the national average spent in 1969-70 per public school pupil at the elementary and secondary levels. In this case, decisions based on moral and social judgments have taken precedence over strict cost effectiveness.

Often in our nation social considerations become dominant. As a democratic society we are committed to the principle of equal opportunity for all, whether in jobs, housing, or education. Even though one may argue that a higher national average gain may occur by applying certain funds to the more advantaged elements of society, the funds may be committed to assist the less advantaged because of our belief in human rights.

Every analysis should begin by deciding what benefits should be gained, as determined by needs and values. For the most part, the basic goals of education are rooted in the values of society. Once the benefits are identified and goals determined, then ways to achieve those goals can be compared by an analysis of cost effectiveness. The more the goals can be transformed into objectives stated in nonconflicting, measurable terms, the more rational will be that analysis. Thus, the goal of analysis is not to maximize or minimize certain variables, but rather to provide the decision-maker with information so that he can select an alternative to meet such constraints as budget, manpower, or time.

Preschool education for culturally disadvantaged children, for example, has been deemed important. With the decision made to provide the needed education, alternatives could be explored. One resultant approach to reaching the children was the development of the television series *Sesame Street*.

Increased attention is being directed to the needs of the people of Alaska, although they represent only one-eighth of 1 percent of the U.S. population. The money that will have to be spent to equalize the condition of these people

within the norms found in the continental United States in health care, housing, basic services, and education will not appear to be cost effective from a national point of view when compared with other U.S. averages. As the goal is accepted, however, alternative methods for providing the needed services must be judged by cost effectiveness.

Cost-effectiveness analysis may be performed at the wrong point in the evolution of a technology application and, therefore, can give inappropriate results. An application evolves from a research stage to a developmental prototype stage to an operational stage. It is necessary to distinguish among these stages because criteria for making judgments about the appropriateness of the application may be different at each stage. As Seidel has pointed out (6), cost-effectiveness analysis is a valid measure but should be applied only in terms of operational systems after a prototype has been tested. The determination of effectiveness is important at all three stages. In the research and development stages, however, cost can be an issue, but cost effectiveness should not.

Problems in Assessing Benefits

There are many difficulties in trying to analyze costs, benefits, and effectiveness in education. Many elements are not quantifiable nor easily measurable, and thus they defy strict quantitative analysis. In our democratic society the goal of equality of educational opportunity is basic, since education is viewed as the key to a productive and satisfying life. But how does one provide equality of educational opportunity? Does the phrase mean equality of access to education, or equality of results, or equality of progress, or even equality of progress weighted by some socioeconomic factors?

There is no single definition. Federal programs, such as Right-to-Read (equality of results) and student loans (equality of access), are designed to provide equality of opportunity in different ways. Because a benefit cannot be quantified, however, does not mean that it should be ignored. In any analysis, a judgment will have to be made between the value of the expected results and the costs. There also is the question of criteria by which to judge benefits. For instance, in determining admission to a given college, should there be uniform

criteria which are applied to all students, or should different criteria be applied to students possessing different characteristics, such as socioeconomic background?

Clearly, benefits involve values. Every decision is a choice among alternatives, and by implication each decision states that one alternative is more important than the others. Each alternative, however, has a set of values attached to it by differing groups, such as students, parents, teachers, school boards, school administrators, and education officials at the local, state, and federal levels. These groups do not necessarily have the same values and may not agree on any decision which is made. A school district with limited resources, for example, may face the choice of extending its counseling program by hiring more counselors, or improving the quality of its reading program through in-service teacher training, or initiating a course in music by hiring music teachers. When the school board makes its choice of the alternative to be funded, it identifies that alternative as the most important, and the other alternatives as less important. The various community groups may not agree on the importance of the choice.

Problems in Analyzing Costs

Analyses of resources often attempt to reduce cost to a simple measure—the dollar. The costs to be considered, however, are often quite different and some may not be directly accountable or quantifiable. Analysis of them, therefore, is often fraught with difficulties, particularly in school budgeting where costs are varied with the expectation that the quality of learning in the school will increase—or at least not decrease. This assumption is often based on hope, since very little has been done to relate achievement in learning to the cost incurred. Education is replete with statistics on costs of capital outlays, teachers' salaries, and debt retirement, as well as the cost per pupil in average daily attendance at various levels of education. Every school district has determined the cost to educate a kindergartner, an elementary school student, and a vocational student, but very few know the cost of teaching a course in English, chemistry, or remedial reading. Almost nothing has been done to relate costs to specific achievements in learning, such as the ability to add a column of two-digit numbers, to dissect a frog and

point out its major organs, or to comprehend a specified list of words.

Effectiveness does not vary in a linear manner with cost. Doubling the number of teachers in a school will, by itself, not double the amount that a student learns. In general, increasing expenditures to do more of the same does not guarantee an improvement in student learning. The average cost of public school education in New York City in 1969 was \$1140 per pupil, almost twice the national average (7). Yet New York City schools have been characterized as "a static, internalized, isolated system which has been unable to respond to vastly changing needs and demands" (8).

Any attempt to reallocate resources based on an analysis of cost effectiveness must account for fixed expenditure patterns. Many costs cannot be adjusted to any great degree by an administrator. Teachers' salaries, for example, are often fixed by negotiation or by law. In 1970–71, salaries of classroom teachers were the largest item in school budgets, comprising, on a national average, 60.6 percent of the net current school expenditures, which is exclusive of debt service, capital outlay, and transportation charges. Costs for administration, operation, maintenance, and fixed charges (such as retirement funds) added up to an additional 23.1 percent of the total budget. Of the remaining 16.3 percent, over 10 percent was spent for salaries of teacher's aides, counselors, reading specialists, school nurses, and other support personnel. Nationwide, only 3.9 percent of school budgets was spent for textbooks and other teaching materials (9).

Costs, particularly in technology, often represent capital investments and when converted to cost-per-student-hour are usually based on total utilization. The cost-per-student-hour usually increases rapidly with decreasing use. A CAI system, for instance, which supports 2000 terminals and is utilized 60 hours per week may yield an hourly cost of \$0.50 per student. If only 400 terminals are operated for 20 hours per week, however, the hourly cost can rise to \$5 to \$10 per student.

Many technology costs are derived from assumptions which often are not considered or are unknown to decision-makers. A CAI system, for example, designed for a 1-second response time presupposes, among other considerations, an average number of computer instructions executed per request, a certain file organization of the ma-

terial, an average volume of output data per request, and an expected terminal usage. It also assumes a certain form of entry of answers by the student, such as constructed or multiple choice, or it might presuppose off-line analysis or immediate entry of the answer. System response can be significantly affected and the performance of the system degraded when these "hidden" assumptions are violated by changing instructional strategies, modes of presentation, or requirements placed on the student in presenting his response. If an assumption is violated, the cost of operating the technology system can rise significantly.

In addition, a system involves many components and all costs must be accounted for. They may include the cost of materials, development, hardware, maintenance, supporting facilities, staff training and salaries, operation, and others. Other costs are often omitted or are not quantifiable, including the cost for research on the learning process, for the time spent in acquainting teachers, parents, and students with new approaches, the cost in human acceptance and effectiveness brought about by disruptions in organizational structure, and others.

When judging benefits from a national point of view, one must, in addition, consider the societal cost incurred by inadequately educating a segment of the population. This may be judged in terms of a national policy of equal opportunity, or by its effect on the national economy. It is possible, in the latter, to weigh the cost in dollars needed to educate a given segment of the population to a specified level against a projected increase in the gross national product because of the additional goods and services these people are able to produce.

Problems in

Determining Effectiveness

Even more difficult than determination of cost is the problem of evaluating effectiveness. Since the desired outcomes of education are rooted in societal values, it is difficult to define them precisely and often impossible to put them in measurable terms. The selection of appropriate instruments which can reliably measure the degree of attainment of program goals is a key problem in determining effectiveness. Setting tolerances on acceptance is also difficult. In teaching mathematics, for instance, if

the criterion is 1 month of growth for each month of schooling, is an average growth rate of 0.9 acceptable? Suppose the approach which produces the latter growth rate is cheaper and has more side benefits?

Another difficulty is that a widespread improvement in effectiveness does not immediately occur with change. Education requires long lead times to turn innovation into widespread practice. In the 1930's, it was estimated that 57 years would be required to diffuse an innovation throughout the school system, even after the materials and methods had been thoroughly developed. In a series of studies conducted in 1946 this estimate was revised to 25 years—a definite improvement, but still a long period (10).

To be effective, a change must be accepted and adopted by the people involved. Education, however, has been characterized by a strong resistance to change. Evans (11, p. 344) observed that this "problem of resistance is of so much importance that, without its solution, we are in danger of financing massive installations of educational technology hardware which will end up gathering dust in spite of some apparent acceptance here and there." Further, "indications are that whenever hardware is brought into the learning system resistance is likely to be encountered" (11, p. 351). Any appraisal of future effectiveness which does not consider man's resistance to change will undoubtedly give erroneous results.

Either the measurement of effectiveness is very elusive or the effectiveness of education is virtually independent of the teaching techniques—at least the "traditional" techniques—and the medium used. Dubin and Taveggio have reported the results of a reanalysis of the data from 91 comparative studies of college teaching technologies conducted between 1924 and 1965. These data "demonstrate clearly and unequivocally that there is no measurable difference among truly distinctive methods of college instruction when evaluated by student performance on final examinations" (12). While these studies compared teaching approaches such as the lecture, discussion, tutorial, and independent study, the same "no difference" results have been found in media-delivered instruction. Chu and Schramm, in an analysis of over 100 studies on learning from television conducted in emerging as well as more developed countries on a variety of subject matters and content, at every age level from

preschool to adult, have demonstrated that there is no significant difference in student performance whether the instruction is delivered by television or through personal contact (13). Similar results have also been obtained in several studies of the effectiveness of computer-assisted instruction (14).

These findings of "no difference" have several implications for cost-effectiveness analysis. First, if there is no difference in the effectiveness of various teaching alternatives, then cost should become the major factor in the selection of an approach. Second, the fact that media-delivered instruction can do no better, and does no worse, than conventional classroom teaching should not be counted as a mark against it. For instance, for children of migrant workers or those living in ghettos or rural areas, where qualified teachers are lacking or where inadequate materials and facilities exist, education on a par with conventional urban instruction can be a great improvement over existing techniques.

The "no difference" findings have been based on media-delivered instruction, not educational technology. Educational technology, properly implemented, must assure a high level of student performance. By establishing specific instructional objectives and setting a level of expected performance, then using an iterative procedure of curriculum design, test, evaluation, feedback, and revision until the performance level is met, educational technology must be an improvement over traditional approaches, when judged on the basis of student achievement of the established objectives.

Another shortcoming of many studies of effectiveness is that they base their evaluation solely on incremental improvements in current practice. They do not account for new understanding that may result or the addition of new services which were not available under traditional approaches. Through computer simulations, for instance, a student may try various chemistry experiments which could not be allowed in a laboratory for safety reasons, or he may observe how jetties and man-made or natural features affect tide erosion of beaches, or he may study events in geological or atomic time. Used in these ways, computers can add a new dimension to student learning. In the information retrieval and library areas, computers and other technologies can provide new services which could not be implemented with traditional approaches

to information processing and handling. If these services are deemed to be important, then they should be accounted for in any study of effectiveness.

National Availability of Funds

The federal government currently is spending large sums of money on the support of instructional technology. Estimates indicate that in fiscal year (FY) 1967 alone, the U.S. Office of Education (USOE) spent \$865 million (including cost sharing) on instructional materials, media, and media-related activities, while in the 4-year period from FY 1966 to FY 1969 these expenditures totaled about \$2.5 billion (15, p. 52; 16). For printed and audio-visual materials, it has been reported that USOE has spent more than \$1 billion in the 3-year period FY 1967 to FY 1969 (17).

These large outlays are likely to continue. For one, the U.S. gross national product is rising about 4 percent a year, or on a compounded basis, about 50 percent a decade. The gross national product should rise from about \$944 billion in 1970 to about \$1200 billion by 1975. At the same time, federal expenditures should increase from \$189 billion in 1970 to \$206 billion in 1975 (18). The federal contribution to education has also been rising steadily. From 1920 to 1966 the federal contribution rose more than 7500 percent while in the 4-year period from FY 1965 to FY 1969 the federal contribution to all education rose by 200 percent (19).

In the field of educational technology, the federal presence is also likely to increase. Some perspective on this can be obtained by reviewing the level of current expenditures of USOE, from several major reports, current legislative proposals, and from a recent statement by President Nixon. In his "Message on Education Reform" of 3 March 1970 in which he proposed the creation of a National Institute of Education (NIE), the President stated:

Our goal must be to increase the use of the television medium and other technological advances to stimulate the desire to learn and to help teach. The technology is here, but we have not yet learned how to employ it to our full advantage. . . . How can television, audio-visual aids, the telephone, and the availabilities of computer libraries be combined to form a learning unit in the home, revolutionizing "homework" by turning a chore into an adventure in learning? The National Institute of Education would examine questions such

as these, especially in the vital area where out-of-school activities can combine with modern technology and public policy to enhance our children's education.

Steps have already been taken in response to the President's statement. A bill was introduced in the Senate to establish a National Institute of Education (NIE) (20). A preliminary planning document for the NIE, prepared by the Rand Corporation, describes a series of program areas with which the institute should be concerned. Among the activities that NIE should support in order to increase the effective use of technology and media in education, the report recommends instructional uses of computers, cassette television and cable television, course productions for television, games and simulations, and instructional environments (21).

The Commission on Instructional Technology (CIT), appointed by the Secretary of Health, Education, and Welfare, went a step further. In a report of March 1970 to the President and the Congress, the CIT recommended that education could best be served through technology by establishing a National Institute for Instructional Technology (NIIT) within a National Institutes of Education. A NIIT would require a first-year allocation of \$565 million, including \$150 million to launch it and \$415 million for its first-year operating budget (22).

The "Educational Technology Act of 1969" (H.R. 8838) was introduced in the 91st Congress. If passed as introduced, the act would authorize continuing annual appropriations of \$300 million for the support of educational technology—\$200 million in elementary and secondary education, and \$100 million in higher education (23). If the present expenditures of the Office of Education, the CIT recommendations, and the authorization in H.R. 8838 are combined, a yearly cost of about \$1.5 billion for educational technology would result. Although all of these funds are not now available, the fact that Congress and a legislatively created commission have considered them is significant.

Federal Legislation

While federal expenditures are large, current support for instructional technology is dispersed among many sources. The Office of Education at present administers some 40 pieces of legislation which can fund technology projects

(24)—computers alone can be supported under 15 separate legislative authorities (25). Even with this plethora of legislation, there is insufficient authority to support certain activities. Funds may be available, for instance, for open-circuit television facilities but not for closed-circuit facilities, even though the latter may be cheaper and more effective in a particular application.

Many of the legislated Office of Education programs are designed to alleviate problems of specific population groups, such as the handicapped. Possibly none can currently act as a focus for the broad interests of the field, as did Title VII of the National Defense Education Act, to insure the continuing effort necessary to develop the full potential of educational technology. Although there are many excellent federal programs, attempts to solve total educational problems often involve splicing together grants under various legislative authorities such as one for equipment and another for curriculum development. All too often these attempts fail because support from one legislative authority does not materialize or because of differences in guidelines and procedures for administering the legislation. This fractionalized support precludes, in many cases, a systematic attack on total problems (15). Equipment is provided without materials, training without equipment. Research projects are funded, systems are not. It is necessary that legislative programs be coordinated and integrated to assure that the multiple services required for technological innovation can be provided.

Many pieces of legislation require that the appropriated funds be apportioned among the states by a formula. This apportionment is often divided among local school districts by federal or state requirements. The result is that what may have started as \$10 million to \$20 million is reduced to sums of \$1000 or less at the local level. While this approach insures an equity of distribution and may be satisfactory for small expenditures such as the purchase of books, it does not allow a school to make a commitment to educational technology systems, even when desired by the federal or state governments. Even seemingly large programs, such as Title I of the Elementary and Secondary Education Act (ESEA), with annual appropriations of about \$1 billion distributed among school districts based on their relative evidence of poverty and with the stipula-

tion that the funds are to be spent on educationally deprived children within the districts, cannot provide effective regulations or mechanisms to concentrate funds at the local level (26).

Too often, the availability of federal funds rather than need determines what is purchased at the local level. If federal legislation is available to support the purchase and installation of particular equipment and materials, such as language laboratories, schools will install that equipment regardless of whether it is needed and irrespective of more pressing needs. One result is that language laboratories are built and go unused, or that audiovisual equipment is purchased only to gather dust in storage areas. The need is not there; the planning is not done; the teacher training required to utilize the equipment as part of an instructional process and the backup support is not provided.

Local and Federal Support

The decision to purchase educational technology hardware and software is made at the local level by individual schools or school districts, or by individual professors within colleges and universities. Since none of these subunits is large enough to amortize the cost of a major effort in technology and since there is such a variety of decision-making structures, it is a high-risk venture for an industrial concern to expend the large amount of money necessary either to develop a major technological system or to produce high-quality, fully validated materials. To cope with this pattern of decentralized decision-making, Locke stated that the modern education company must provide expensive marketing coverage through "large and experienced staffs of school and college salesmen, who at the very least know where to find the decision-makers" (27). Many companies are unable or unwilling to provide the necessary coverage.

Although there is no single large organization which can make decisions about the purchase of educational technology, there is one organization which acts as a prime supplier of funds—the federal government. Much of the experimentation and demonstration that has taken place has been supported by the Office of Education, the National Science Foundation, the Office of Economic Opportunity, and other federal agencies. The purchase of equipment

and materials and the training of teachers and other professionals has been subsidized by the government. It is already a major financier of educational technology projects. The federal effort, however, has been fragmented and uncoordinated and thus has been inefficient and largely ineffective. It has not attracted industrial activity.

The key to the effectiveness of educational technology is the quality of the instructional materials. Molnar has made the analogy that the development of educational media without instructional materials of high quality is like the development of the automobile without a complementary highway system or a network of gas stations. The media cannot work without the complementary curriculum production and distribution systems (15, p. 8).

The production of high-quality materials requires large systematic investments. The only way to make these materials competitive with other materials, on a cost per student basis, is to use the same materials with large numbers of students. As this usage normally requires the participation of schools or school districts, it runs counter to a basic principle of American education—local autonomy. The slightly more than 18,000 school districts in this country form a unique non-system. They adhere rigidly to traditional organizations, structures, and teaching patterns, but maintain their independence in setting school goals, selecting content, and generally working with the students. In the words of one observer, the educational enterprise succeeds in combining the rigidity of a military service and the fragmentation of a small organization, without either the centralized authority that can ultimately make the military move, or the freedom of initiative and flexibility of response enjoyed by the innovation entrepreneur (28).

The resolution of this apparent dichotomy between the need for standardization and the autonomy of local school districts is basic to the successful implementation and use of educational technology. While not easy, it has been done. One children's television series, *Sesame Street*, expended \$6.5 million in FY 1970 to produce a 26-week, 130-program series. On a capital basis, this sum is extremely high for an educational activity. Since the show had a viewing audience of approximately 7 million children, however, the incremental cost was less than one cent per child per hour.

Effecting Change

There is a good deal of innovation in education, but unfortunately little of it leads to improvement in the educational process. Title III of ESEA, for example, has appropriated over \$400 million in each of the last 4 years "to stimulate and assist in the development and establishment of exemplary elementary and secondary school programs to serve as models for regular school programs" (29). Very few of these programs, it appears, have been continued after the grant period has expired, and few have had a significant effect on changing a regular school program. Among the reasons may be the normal resistance of the school systems to change, as well as the lack of prior commitment to make the new program a part of the regular school curriculum. Reluctance of students, parents, and the community at large to changes in the educational system is also a significant factor to be considered when planning for the implementation of any innovation.

Lecht has observed that the "extent to which Federal aid could be expected to yield a return in utilization of audiovisual aids, educational television, and computer based instruction is likely to be closely associated with the degree to which developments within education and in the larger society encourage State and local school systems to become more receptive to change" (30).

Educational decision-makers often presume that people who resist a change in an approach to education do not understand the advantages to be gained by that change. This is not necessarily so. It is precisely because parents, students, and others fully perceive the implications of an innovation that they may resist it. This is the case particularly when the innovation may affect established values of the student or impart new ones in a way which conflicts with the values established in his home or community or with those of his background or culture. Sex education, for example, has generated enormous controversy in many communities because the schools are attempting to instruct in an area which has been private to the family. The instruction given by the teacher may directly challenge the values set by the family. The introduction of television in the elementary school classroom is another change which has caused parental concern. Many parents have reserva-

tions about the use of television in schools, even though they may themselves use it at home as an electronic babysitter. While parents are aware that television can be used to enrich the curriculum, they also are aware that they have lost control over the selection of the programs their children watch and that the programs which the teacher selects may transmit values which conflict with those they wish to instill in their children. The introduction of any innovation without first taking account of the goals, values, and desires of all of the groups which are affected may cause those groups to resist the innovation.

Prescriptions for Improvement

Technology holds great potential for the improvement of education and for the delivery of educational services throughout the nation. Telecommunications, computers, television, and audiovisual media can present new alternatives for providing equality of educational opportunity by storing, manipulating, and presenting information to students when and where desired. If not properly planned for, however, technology can also be highly expensive. To insure that costs do not become prohibitive and that the benefits desired can be met in a most effective manner, while expenses are kept within reasonable levels, several practices should be stressed.

First, specific goals and objectives must be established. These objectives, inasmuch as possible, should be stated in measurable terms. Determinations of program effectiveness must later be done in terms of these objectives. There is an old saying that if you don't know where you are going, then any road will get you there. If the objectives are too vague, then almost any results can be deemed to be satisfactory—or unsatisfactory.

Planning must be done from the point of view of overall program effectiveness. School administrators must be willing to change from making budgetary decisions on an incremental basis, in which a given year's budget resembles the previous year's with respect to the distribution of funds among budget categories, to program planning in which the budget is a reflection of the programs needed. This is necessary if the administrator is to have the flexibility to select the most cost-effective approach from a set of alternative pat-

terms of resource allocation, all of which can achieve the desired goal. It also may be necessary to reevaluate the way in which expenditures are accounted for. Traditional budget categories show how money is spent, but do not indicate what is received in terms of education for the investment. As Lessinger has pointed out, it would make sense to move from a per-pupil cost to a learning-unit cost in order to focus on the amount of learning, rather than on the maintenance of children in school (31).

If the full potential of technology is to be realized, technology must be viewed and implemented as part of a new system, and not as a supplement to conventional approaches. Elementary and secondary education in the United States is organized around the concept of teacher-directed, graded classes of 20 to 30 students per classroom. While such a concept was satisfactory when instituted in the 19th century and is still viewed as satisfactory to many people today, it can be a hindrance to the effective utilization of educational technology.

The concept of a teacher supervising 30 students, each of whom is seated at a computer terminal performing drill and practice exercises, is a costly use of the technology. This approach does not reduce the student-teacher ratio nor make instruction available to the student at his convenience or in different locations. The potential of technology for individualizing and personalizing instruction and for allowing more effective instructional patterns can only be realized with organizational change.

Any change, however, should account for and accommodate the concerns and values of the people affected. Montgomery County, Maryland, has proposed an interesting experiment in this regard. As a group, the parents of school-age children in the county have a wide span of desires for the ways in which their children should be educated. Some parents believe that schools should provide little more than a knowledge of the three R's, while others look to the schools to instruct their children about all modern social concerns. To accommodate these diverse views, Montgomery County proposes to establish a dual-school structure which includes one traditional and one innovative

school within each locality. Parents will then decide which of the two schools their children will attend.

Media-based instruction has been shown to be as effective as conventional approaches. This "no difference" in results should be capitalized on. Technology can reap its greatest benefits in those areas of education which have been neglected, as in ghetto and rural schools and among migrant groups. Technology is most promising in situations where teachers, materials, and facilities are lacking, or where traditional approaches have failed. Thus, satellites are being used to provide communications linkages for teachers and services for widely dispersed, culturally distinct groups, as in Alaska (32).

These suggestions are few in number and are not all-inclusive. However, they do present major changes from the ways that schools have operated in the past. Although reform can improve the educational system, change is costly both in dollars and in impact on people and organizations. It must be assured, therefore, that a given change is beneficial and that the benefits derived are worth the costs involved. Necessary changes must and will occur before the full potential of technology for education can be realized in a cost-effective, beneficial manner.

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