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A ten year experiment in educational technology sponsored under Title VII of the National Defense Education Act (NDEA) demonstrated the feasibility of large-scale educational systems which can extend education to all while permitting the individualization of instruction without significant increase in cost (through television, computer systems, microform techniques, and multi-media programming). Adoption of new technology has been slow, however, due to its high cost so small school districts, the loss of local autonomy involved in accepting regional systems, and unwillingness to invest in systems of unproven success in the field. The fragmented nature of education tends to restrict the spread of new technology, especially to small or remote districts and to minority groups, where its effect would be greatest in guaranteeing a minimum level of education. Quality materials must be developed for presentation, and larger cost accounting units are needed. Media use is ineffective unless the whole educational system is geared to take advantage of it: what is now needed are development projects to organize these research findings into effective systems. (RB)

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On June 30, 1968 a significant ten year, forty-one-and-a-half million dollar experiment in educational technology came to an end. Under Title VII of the National Defense Education Act (NDEA), the Congress sponsored a unique legislative experiment in education which provided for a decade of research in new educational media with the hope that educational technology could open the doors of quality education to all.

I. New Educational Media Research.

The promise of educational media rests upon the premise that technology can provide a mechanical or electronic advantage which will permit educators to teach more students for less while maintaining or even improving the quality of education. The objective has not been to replace the teacher with a machine but to free the teacher from the routine administrative functions, the monitoring of drill and practice and the simple presentation of factual information. Once free freed from these chores it was hoped that the teacher would have more time to interact with students on an individual basis and to devote more time to higher order conceptual and affective learning.

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1. The views expressed are those of the author and do not necessarily represent the views of the U.S. Office of Education.

The accomplishments of the decade have been many. The U.S. Office of Education (USOE) has supported research on a variety of media forms, for all levels of education using a wide-range of subjects and skills. The effectiveness of educational technology has been demonstrated in medicine, engineering, arts and humanities as well as mathematics and the sciences.

Television research has demonstrated that it is possible to overcome the restrictions of numbers and space. It is now possible for one teacher to reach many more students without limiting the quality of the presentation or the effectiveness of learning and without placing restrictions upon the time of presentation or the location of the students or the teacher. Chu and Schramm concluded after an intensive study of learning from television that its effectiveness has now been demonstrated in well over 100 experiments and several hundred comparisons, performed in many parts of the world, in developing as well as industrialized countries at every level, pre-school through adult education and with a great variety of subject matter and method.[1]

Research in programmed instruction, computer-assisted instruction (CAI) and computer-managed instruction (CMI) has lead to the development of one of the most significant educational concepts of the decade--individually prescribed instruction (IPI). IPI abolishes rigid time standards and assumes that a student can progress best when using materials which are tailored to his needs and which permit him to advance at his own pace. It has been said that before IPI, the teacher

taught and the student passed or failed. Now, the student learns and the school system passes of fails.

Multi-media research has attacked the assumption of human limits to learning. The multi-media approach makes the assumption that many materials are more effectively presented in certain modes and that the use of more than one mode tends to have beneficial effects upon learning and retention. Many times, traditional text materials are inadequate for transmitting information effectively. This may be especially true with the handicapped and disadvantaged who due to physical or cultural impairments may not learn as well from printed or text material as from other audiovisual modes. The significant contribution of the multi-media approach is to reject the concept of human limits of learning and instead focus upon increasing learning effectiveness by the redesign of materials and modes of presentation.

Microform techniques now allow us to store and have instantaneously access to all academic and administrative records. This opens the possibility of accomodating highly mobile student populations. Low-cost, rapid reproductive techniques also make it possible for all students to have their own individual learning materials whether it be a precious book or selected sections of a dozen books. Linked with computers, microform techniques make it economically possible for every school in the country to have direct access to the world's finest libraries.

While the evaluation of the ten year effort is just getting underway, it is safe to say that the research findings have been impressive. Instructional technology can improve learning effectiveness, change attitudes and provide new learning experiences economically and without restriction to time, location or frequency of use.

II. Potential and Practice.

In spite of all the impressive research findings, relatively few educational institutions have adopted instructional technology. Among those institutions who have adopted educational technology, it is difficult to find systems which have reached the potential demonstrated in research projects or pilot efforts. Characteristically, these new educational systems have not reduced the cost, improved the quality or extended education.

1) Factors affecting costs.

What are some of the reasons for the high costs of educational technology? Education strongly believes in local autonomy and the right of the school and the teacher to prepare and present educational materials to meet the needs of students. On the other hand modern technology tends to be economical only when used on a regional or national basis. This conflict in values creates a choice. Is it worth giving up individual freedom of choice of educational materials for economies of cost and the increases in quality that cooperative efforts can bring? Most school systems when faced with this choice vie for autonomy.

As it stands now only large school districts can afford the media systems. Eleanor Godfrey found in her study of the state of audiovisual technology that participation in NDEA media projects was directly related to the size of the school district. Most of the large school districts used audiovisual devices while the small districts did not. She found that district administrators who did not have media systems were reluctant to commit funds because they considered their districts to small to profit from media.[2]

The size of the administrative unit as a deterrent to effective education has been noted by the Advisory Commission on Intergovernmental Relations. It reports that large cities usually constitute a single school system and usually have adequate capital facilities and administrative organization to conduct adequate educational programs as well as sufficient number of students for efficient and relatively low unit-cost operation. Suburban school districts are smaller and usually lack plant and staff to be comprehensive schools but if taken as a whole, the numbers of students could justify such programs.[3]

Another factor contributing to high costs is related to the marketing and procurement practices in education. While many manufacturers have a sincere interest in developing low cost educationally effective equipment, they require a mass market in order to obtain reasonable unit costs. Most manufacturers are more than willing to do their own marketing and research but are overwhelmed by the thought of surveying the approximately 23,000 school districts and 2,300 colleges and universities to determine educational needs only to find that purchasing and decision mechanisms are so varied that they cannot produce a common salable system.

To further complicate matters, technological systems are only as good as the instructional materials they use and in order to demonstrate that they are cost-effective, complete curriculums are required. To date, no manufacturer or publisher has been willing to invest the large sums of money necessary to develop and test total education systems.

On the other hand, school administrators find it difficult to obtain information and even more difficult to comprehend the effects of adopting complex, technological systems. From the administrator's viewpoint it would be an act of blind faith to invest in any large scale technological system. The lack of a marketing mechanism from which common educational needs can be identified, and unified decision-making and purchasing practices exercised has lead to high costs and custom-built technology.

In many cases, media such as television are used as an add-on to regular teaching sessions. The teacher and a standard-size class watch a program in the classroom. The student-to-teacher ratio is not reduced and no advantage is taken of the media's ability to present a program to large groups of students in different locations. This practice is similar to the story of the first experience of introducing tractors in developing nations. A few backward farmers refused to accept tractors because "they were too heavy for the mules to pull while plowing the fields." No economy of cost can be obtained unless classroom organization is modified to capitalize on the characteristics of the new system.

2) Quality

While autonomy has driven up the costs of technology, the practice of using full time teachers to develop their own materials has reduced the quality of educational technology. Television and computer-assisted instruction are good examples of what has become known as education's "college industry." In even the most publicized classroom television schools you will find that since teachers have little or no time for preparation and only limited resources that most of the programming is in the form of a live lecture.

Frequently, we tend to equate the purchase of equipment with the establishment of an educational system. Recently, one state announced with pride the establishment of a high-cost, state-wide educational television network. Unfortunately, only a meager budget has been allowed for production of materials. In most educational systems the development and production of materials far excede the cost of the equipment. Furthermore, the success or failure of the endeavor will depend upon the quality of the materials.

Similar problems exist with computer usage. In many cases, computer software and curriculum development costs have exceeded the cost of the equipment. While it is theoretically possible to share computer programs and curriculum, more times than not, due to computer configurations and language differences, the materials are unique to one locale and are only usable on the computer for which they were programmed. This tends to restrict widespread use and tends to keep educational costs high.[4]

Jack McBride and Wesley Meierhenry point out that the quality of telecast materials will not improve until some type of distribution system can be initiated to alleviate the great amount of duplication in time, energy and resources. They note that education has always been a local and state function--each school system as well as each teacher within the system has to a considerable degree of autonomy. State laws vary greatly and place severe limitations on cooperative purchase and use of educational technology.[5]

The development of educational technology without the development of high quality curriculum could be likened to the development of the automobile without a complementary highway system or a network of gas stations. The technology can not work without the complementary curriculum production and distribution systems.

3) Extension of Education.

There is a natural time lag between discovery, invention and widespread innovation. Some estimate that the discovery--innovation time lag in education is about 30 years. In the Department of Defense, the time lag is about 4 to 5 years. Where national objectives have been set and crash programs undertaken such as in the cases of the atomic bomb and hydrogen bomb the cycle has been shortened to as little as 3 years.[6] One of the major factors contributing to the length of this cycle is the role of the Federal Government. With military systems, the Government is the sole consumer and once convinced of the merits of the system it is relatively easy to proceed from research and development to widespread use. In education, the

Federal Government plays a more limited role. Consequently, no matter how successful Government sponsored research may be in producing effective educational results, adoption is the prerogative of each school district and college.

Another factor which restricts innovation in education is that even if a school system should adopt educational technology and develop useful instructional materials, there is no incentive or mechanism such as that which exists in business to see that the system is adopted elsewhere. Consequently innovation occurs by the fortuitous discovery of a demonstration project and the trial-and-error reconstruction of the discovery at the new location.

Within the current organizational structure of education, innovation tends to be more readily accepted in areas peripherial to teaching such as libraries or in administration. Educational technology tends to be more readily accepted in the newer institutions such as junior colleges where tradition is not so strong and teaching patterns not so well established and where shortages of teachers, funds and facilities are more acute. Crisis is probably one of the greatest facilitators of change. When all traditional means have failed, new methods and practices become attractive.

Educational technology probably has the greatest potential in areas such as the ghetto school which characteristically has large student-to-teacher ratios; in geographically dispersed or isolated populations such as those in rural areas or on Indian reservations; and among mobile groups such as migrant workers. In the crowded

ghetto areas individualization of instruction and the infinite patience of educational technology provides the best hope for the widely disparate needs of the disadvantaged. In the isolated, rural areas and for the mobile migrant populations, the use of modern telecommunications can overcome time and distance and bring high quality education and resources to the most isolated student at a reasonable cost.

While there are many excellent Federal programs to help these groups, most are designed to attack limited parts of the overall problem. In order to handle community or social problems, it usually requires the pyramiding of grants through various pieces of legislation. All to frequently projects fail because one of the pieces of support fails to materialize or restrictions make it difficult to apply the funds to the solution of the problem. The fractio.. .ization of various programs precludes, in many cases, a systematic attack on the problem. Most of the urban and social problems are interrelated with educational problems.

For example, on a recent visit to an OEO supported day-care center in a ghetto area, the mother-in-charge pleaded for educational materials so that she could work with the children. The use of educational materials or television programs directed at a "captured" audience of pre-school children with an adult for follow-up is but one example where social-action projects can be tied to the use of educational media.

It is interesting to note that we provide free lunches to be sure children have at least one meal per day. Wouldn't it be just as logical to provide for minimum level of education? By law, we compel parents to enroll their children in schools accredited by the state, yet, there is no requirement that a child be provided a minimum education. The Advisory Commission on Intergovernmental Relations recommended that in order to reduce such educational disparities that each state should make a critical review of its present school grant formula to insure that it provides for an educational level which no community should fall.[7]

III. Cost Benefits.

From studies conducted on the relative costs of educational technology it is clear that it becomes economical when used on a regional basis or areas of high population density.[8] It is also clear that with respect to effectiveness that it is at least as effective as a conventional teacher.

Many critics are quick to point out that since instructional technology is no better than a conventional classroom teacher that we can ignore it until researchers can demonstrate technology to be superior. On the other hand, for a great majority of rural schools, migrant populations and urban ghettoes which lack teachers and materials, student performance which is no better than that obtained in a conventional classroom is a significant improvement. Since educational technology can substitute for missing teachers and

inadequate materials and facilities, it should not be overlooked because it only establishes a parity. In terms of cost-benefit ratios, the greatest educational gains can be obtained by using educational technology in these neglected areas of education.

Many large cityschools seek to provide a comprehensive education curriculum. Some of the functions provided in the comprehensive schools, such as remedial programs, are expensive in cost and in student-to-teacher ratios. Many suburban and rural schools because of their size cannot provide such services. However, if the costs of these functions were shared through cooperative arrangements, the costs per student would be reduced without infringing upon the autonomy of the school.

Many cost-benefit studies tend to evaluate the new technology on the basis of incremental improvement in current practices and tend to ignore the benefits associated with adding new concepts and understanding to education. The computer can be us to solve mathematical problems which can also be solved with use of paper and pencil or a desk calculator. However, the computer opens up higher orders of conceptualization and problem solving which were nonexistent ten years ago. In medicine the use of the endoscopy technique paired with closed circuit television permits medical students to visually see the internal parts of the body whose condition they had to infer from tactual cues only a few years ago. The new medium provides more than an efficient teaching device; it is a medical tool. The same is true of the magnification ability of television when used to view delicate eye operations or when used to show vocational students the inner working of mechanical machinery.

While the cost of education has received considerable attention of late, little attention is paid to the cost of not educating. The economic costs associated with welfare, crime, civil unrest and loss to the gross national product due to inadequate education are incalculable. The loss of human potential is more difficult to justify. In a free, competitive, industrialized society, if an individual's only limitation is to be his ambition and energy then he must be provided the minimum educational skills necessary to compete.

If education is to take advantage of the new media, larger cost accounting units will be required. For example, in a U.S. Office of Education supported computer utility study, it was found that if the administrative work was done on the computer at night, for a small additional increment in cost, a wide variety of computer services could be provided to students during the day. It has also been proposed that if we were to develop a nation-wide computer system for medical care that sufficient savings would be realized to permit doctors to have free access to a medical information system. Commercial television operates in this manner, the public service component is paid for through the commercial use of the network. Multi-functional use and broader cost-accounting categories can permit us to take advantage of the new technology without significantly increasing costs.

While ghetto, rural and migrant worker networks might be considered too costly to fund by themselves, if the primary purpose of the network was to serve such community functions as emergency traffic control, police and fire activities, civil defense and civil disturbances, the savings in lives and property from such a part-time or emergency regional network might be sufficient to provide free but limited use to education.

IV. Innovation and Education Technology.

Research has demonstrated the potential of television, computers and other media in education. What is now needed are development projects to organize these findings into effective and efficient systems. As in industry, if we are to obtain a high quality product for the lowest possible cost, development is essential. The purpose of development is to take discoveries and organize them into efficient, reliable systems which can be turned over to others to operate and who in turn can obtain the same high level of efficiency. It is one thing to perform an experiment or demonstration, but considerable additional work is required to make discoveries into a workable system.

The Department of Defense in its research and development efforts in Fiscal Year 1968 spent four dollars for development for every dollar of research.[9] Education does not follow such a model. To date, education and the Nation have been unwilling to support large-scale development projects. Without development, educational technology cannot approach its potential.

After ten years of research, sufficient discoveries have been made to demonstrate the feasibility of large-scale educational systems which can extend education to all while permitting the individualization of instruction and without significant increases in expenditures. However, since the new educational technology systems are recognizable departures from the existing methods used in traditional schools and colleges, they will encounter a natural resistance. This resistance will be facilitated by the organizational structure of education, the desire for local autonomy and the lack of instructional materials necessary to make the new technology work. And if the discovery-innovation cycle runs true to form, it will take at least another thirty years before the widespread adoption of the new technology.

In these times of social awareness and concern one might ask if the Federal role should stop with the support of research and discovery. On the basis of the experiences in the Department of Defense it is possible to shorten the discovery-innovation cycle. If this generation of students is to derive any advantage from the new technology the Federal Government will have to play a more active leadership role.

The Federal Government could take action in those areas where it has clear responsibility, provide assistance to those seeking to undertake cooperative efforts and provide a supporting service to those autonomous schools that wish to proceed on their own.

The Federal Government could undertake large-scale development projects in areas of Federal responsibility. Projects could be initiated in the armed forces or in the training of Federal employees. The overseas dependent schools and the schools in the trust territories are continually faced with teacher shortages and could benefit from educational technology. Prisoners in correctional institutions, many of whom are school dropouts and have never had a successful learning experience, could benefit from individualized instruction. Pre-school education in day care centers is another area of high potential.

For those who face the financial problems created by low student population density and large geographic expanse, such as exist in Alaska and the Rocky Mountain Region, and who seek a regional cooperative arrangement, the Federal Government could provide assistance by the establishment of satellite, microwave or common carrier ground line networks for education. For those in our rural areas, or on Indian reservations, or those children in migrant work camps or in urban ghettoes who now receive little or no education, regional efforts could be undertaken.

For the large group of schools who do not wish to adopt the modern technology at this time, the Federal role can be one of creating conditions which are conducive to adoption. Many schools would like to try the new technology, but lack quality materials and are reluctant to expand the time and effort necessary to develop their own. Similarly, since business and industry are reluctant to enter

this area because of the heavy investments required to develop curriculum and the high risk involved in selling it, the Federal Government could offer incentives to reduce this risk and encourage publishers and others to develop the materials. Once it is possible to demonstrate that private enterprise can market the materials Federal support can be withdrawn.

Another approach could be the creation of regional production and distribution centers to provide each school system with a basic flow of high quality materials which have been tested upon student populations. A regional laboratory could also assist school districts to develop local, special interest material at its facility. This might follow the commercial newscasting model in which general news coverage is the responsibility of the network and state, local and special interest events are the responsibility of the station.

Computer costs will continue to be high if each user must develop his own computer programs and curriculum. If national or regional centers were created, educational specialists could visit with resident computer specialists and common programs could be developed and stored in a national library for use throughout the country. This would reduce the need for every educational specialist to be a programmer; it would permit new programs to be built upon the lessons learned from previous experience; and it would reduce the computer time required to develop programs at each school or campus. The increased interchangeability of computer programs and computer-assisted instruction materials could greatly reduce costs and development time.

Educational technology is expensive; large amounts of money are already being spent. Where is the money to come from? In Fiscal Year 1967, it is estimated that a total of $859,691,000 (including matching funds) was spent by the Office of Education for media and media related activities. Unfortunately, due to the fractionalization of programs, these resources had little national impact upon education. If catagorical restrictions were modified and a portion of these program resources were allocated to regional cooperative efforts no new funds would be required.

Through research, the new technology has been demonstrated to be effective in attacking major educational problems. We must now decide whether we truly wish to educate all our citizens. If we do, the use of educational technology is a reasonable economic and educational approach. Edward Morrow once said of television, "this instrument can teach, it can illuminate, yes it can even inspire. But it can only do so to the extent that humans are determined to use it to these ends. Otherwise it is merely lights and wires in a box." And, I might add--a white elephant.

FOOTNOTES

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