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ABSTRACT

Although there has been much criticism of research and development activities in the field of education, the criticism has not been aimed at the real problem. The large amount of uncoordinated research activities and the lack of pre-planned linkages between research and practice has led to the existence of an expensive cottage industry in educational technology which tends to re-tool every academic year. Computers hold much promise in solving educational problems, but there are several questions which must be answered if computers are to become internalized into the educational process. Computers may be either a tool or a medium; they may be internalized gradually or all at once; they may be centralized into regional computer systems or diffused around the nation in the form of mini-computers. What is needed now is not another demonstration of the value of computer-based instruction, but a critical mass that is capable of providing a complete system and total curriculum. Educational research is basically sound; however, it must attack larger, more complex problems in a systematic way if we are to alter and improve the educational process. The necessary catalyst to unlock the potential of computer-based instruction could come from business, from education, or from the Federal Government. (JY)

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THE FUTURE OF EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT

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I. Federal Support of Educational Technology Research and Development.

A recent historical review of educational research and development in the United States identified the mid-1850's as the beginning of education as a serious topic of study.(1) One hundred years later the National Science Foundation (NSF) was established to promote scientific progress in the United States. In 1954, in addition to support for research, graduate study and symposia in science, NSF began its first support for Course Improvement in Mathematics and Science in elementary-secondary education. Also in that year, the passage of the Cooperative Research Act authorized the Commissioner of Education and the U.S. Office of Education (U.S.O.E.) to enter into financial agreements for research, surveys and demonstrations in education. And so began the Federal commitment to educational research and development.

While these Acts squarely acknowledged the commitment of the Federal Government to the support of Educational Research and Development, the amount of support has been consistently small. In fiscal year 1968, the

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total expenditure for education reached 54.6 billion dollars. The financial resources for educational research and development for that year, from all Federal sources, was estimated to be 193.3 million dollars or 31/100 of one percent of the total expenditure for education.(2)

For educational technology research, it remained for the launching of Sputnik to stimulate the enactment of National Defense Education Act (NDEA) of 1958. Title VII of that Act provided for research and dissemination of research findings in the fields of instructional media and technology. During the following decade 40.3 million dollars were spent on approximately 600 grants and contracts for research and experimentation in the more effective utilization of television, radio, motion pictures and other related media.(3) In a study of the impact of research on the utilization of media for educational purposes supported by NDEA Title VII 1958-1968, Dr. Robert Filep and Dr. Wilbur Schramm concluded that Title VII research did contribute (a) to the application of the systems approach to education, (b) to providing more individualized instruction, (c) to securing greater teacher acceptance of new media.(4)

More recently, the Public Broadcasting Act of 1968 established the Corporation for Public Broadcasting and under the provisions of Title III of that Act, the Commission on Instructional Technology was established. The Commission, after a thorough study of instructional technology, concluded that one shot injections of a single technology medium are ineffective and at best offer only optional "enrichment."(5) They observed that technology can carry out its full potential for education only insofar as educators embrace instructional technology as a system and integrate a range of human and non-human resources into the total educational process. The Commission extended the definition of Instructional Technology beyond equipment to include process and procedures and defined the ultimate goal of Educational Technology as the improvement of education. Finally, the Commission recommended the establishment of a National Institutes for Education and urged that one of the Institutes be a National Institute of Instructional Technology.

II. Current Trends of Educational Technology Research and Development.

Today a wide array of scientific and social developments are reshaping our society and with it modern education. This trend has placed a great deal of stress on education and has lead some to lament that education is failing and others to say that we don't know how to teach. I would argue that it is not a question of whether we know how to teach, but rather can an instructor teach 40 students with a wide variety of backgrounds while permitting the students to progress at their own individual pace, in an inadequately designed classroom, with minimal instructional materials in a wide variety of dynamic subject areas for a cost-per-student hour that is about what we pay a baby-sitter. Like a bridge designed for certain stress loads, the educational system can fail if its critical limits are exceeded. More times than not, it is the limit that is in question and not our ability to teach.(6)

However, as educators and researchers, it is important to recognize that as new requirements are placed upon education, it is only logical that we should re-evaluate our techniques and examine new approaches. Today, we have been challenged to design new systems that will permit fewer teachers to effectively assist larger numbers of students to attain higher specifiable levels of performance for lower costs.

Similarly, just as education has been attacked so has the educational researcher drawn public criticism. In spite of the excellent research, it is frequently pointed out that little if any of the new innovations ever reach the classroom and none have effected any significant change. Some say that educational researcher is someone who if you point a finger at a problem will study the finger. Some say that there is no discipline with finer techniques and yet so little to show for them as educational research. Some have said that the research produced is not relevant to current needs and there has been at least one Congressional recommendation for a moratorium on Federal funding of educational research. Again, I would argue that there is nothing wrong with educational research and that the discrepancy between performance and expectation is largely due to the changing requirements and the creation of new educational needs by a dynamic society.

Historically, most of the research on education and educational technology has been done without Federal support. Both Federal and non-federally supported research have been done in a piecemeal manner and could be characterized as diffuse and uncoordinated. Individuals with good ideas have tended to follow them with little regard for other related research. The lack of comprehensive, coordinated programs is largely attributable to the lack of financial resources. However, one wonders what the outcome of the space program might have been if it had been conducted by educational researchers in the same uncoordinated manner characterized by our previous efforts. One could imagine dozens of superior nose cones and elaborate factorial studies on the flange, but no power units and certainly no plans to finalize or agree on one workable configuration.

Probably, the greatest critics of educational technology research are the researchers themselves. There seems to be a double standard in the evaluation of educational technology research. It seems to me that only in educational technology is an "all-or-none" standard applied. Unless the innovation or development is capable of solving <u>all</u> educational problems it is rejected, ignored or attacked as insignificant.

For example, the report and recommendations of the Carnegie Commission on Education Television in 1967 are typical.

> It says: "even the claims made for instructional television by its most passionate defenders are in their essence defeatist. It is maintained that students learn as well from television as by conventional means. Such statements scarcely intimate that there is a powerful medium of communications capable of making its own impress upon the process of education."(7)

One wonders if this same group of critics would attack researchers in the physical sciences for finding no significant differences in well over several hundred experimental attempts such as were found in the uses of instructional television or would they accept the consistency of the findings? Or, would they chastise engineers because they found a cheaper substitute material or process that was as good as the original? Many feel we should ignore educational technology until researchers can demonstrate its superiority beyond a shadow of doubt for all kinds of learning and for all kinds of students. In the meantime, for a great majority of our rural schools, migrant populations and children in the urban ghetto who lack teachers, materials and funds, a technology that produces student performance which is <u>no better</u> than that obtained in a conventional classroom is a significant improvement. Educational technology could substitute for missing teachers and inadequate materials and overcome the lack of resources. Many times, a partial solution immediately applied is far more beneficial than delaying all action in the hope that someday the perfect answer will emerge.

However, times are changing. Correlation studies are no longer ends in themselves. Today, the ultimate test is not statistical significance but whether the intervention is capable of producing demonstrable results in the classroom.

Similarly, attitudes are changing in the classroom. Local autonomy in the schools and an unwillingness of teachers and administrators to define educational goals is yielding to a public demand for accountability and with it performance criteria. While there still is a lack of linkage between research findings and educational practice, the pressures of a changing society which is dissatisfied with the educational status quo and the increasing costs of education are forging major changes in thinking.

The large amount of uncoordinated research activities and the lack of pre-planned linkages between research and practice has led to the existence of an expensive, cottage industry in educational technology which tends to re-tool every academic year. Researchers and educators frequently demonstrate a strong resistance to the use of someone else's innovation. It has been said that if there was a Nobel prize for educational research, we would have to nominate an entire generation of researchers for their co-discovery of the wheel. This, too, is changing.

The pattern for Federal support for research and development in educational technology is also being affected. While there is no formal policy, it is becoming clear, in my opinion, that Federal programs are moving away from the uncoordinated support of individual researchers to the development of comprehensive, goal-oriented efforts which lay heavy emphasis on the potential impact of the research products upon education as a whole.

In the past, in order to get support it was sufficient to have a good idea. Later, during the Robert McNamara era, in addition to having a good idea you had to be able to prove that it was a good idea. Now, not only must you have a good idea and be able to prove it, but you must be able to demonstrate that others will be willing to use your findings or products. Thus, some linkages, no matter how weak, are being formed between Federally supported research and development and educational practice.

III. The Computer and Education.

The United States is the first nation to have developed technology to a point where less than half the labor force is required to furnish material goods. Our society has moved from one based upon industrial production to one based upon educated manpower -- a knowledge society.(8)

It is estimated that by the end of the decade computers will be involved one way or another in 30% of our gross national product. The computer is destined to play a significant role in the knowledge society. In addition to its influence on society the computer will have an equally significant impact on education.

Within a relatively short span of 15 years, computing in education has progressed to where nearly all universities and more than a third of the four-year colleges provide computing services for research instruction. Approximately 70% of all college students are enrolled at institutions at which there is a computer of some kind for instruction. Another large number of institutions are members of computing networks and have access to a remote terminal on campus.[9] The National Science Foundation is contributing to the support of 18 such regional cooperative networks that include universities, colleges, community colleges and secondary schools.[10] Still others purchase commercial computing services.

A recent, soon to be published, survey of secondary schools by the American Institutes for Research under contract to the National Science Foundation estimates that 34% of the nation's approximately 23,000 secondary schools have access to and use a computer for administrative and/or instructional uses.[11] Most of the use of the computer in instruction has been devoted to instruction about the computer as a subject of study or as a tool in problem solving. However, the use of the computer as an instructional medium is also expanding. In 1968, ENTELEK listed 230 instructional programs.[12] A more recent 1970 survey by Dr.Helen Lekan which was published by the Sterling Institute provides an index to 910 instructional programs.[13]

In addition to the classical computer-assisted instruction applications in education, it is of special significance to note the breadth and depth of the adjunct use of the computer as an instructional tool in education. The "Conference on Computers in Undergraduate Curricula" held last year at the University of Iowa is one notable example of a multidisciplinary conference on the instructional uses of computers in education.[14] A second conference will be held at Dartmouth College this year.[15]

Of course, there have been an increasing number of conferences on computers in Undergraduate Education, computers in small colleges, as well as disciplinary conferences in Mathematics, Physics, Statistics, Chemistry, and the Humanities.(16,17,18,19,20)

In my opinion, there are several interrelated issues that will have to be resolved if computing is to reach a take-off point in education, and resolution of these issues will, in all likelihood, determine the forms in which computing will be internalized into the educational process.(21)

1. Computer -- Tool or Medium?

One could argue that if computers are to have an impact upon education it will be through the development of the computer as a tool. This approach would encourage the support of computer innovations in research. Innovations such as modeling, simulation and graphics would be readily absorbed into the various disciplines just as all new information is, and as microscopes, telescopes and windtunnels were adopted in the past. From an educational point of view, all that would be required for students would be an introduction to computing and access to a computer.

Another approach would focus on the computer as a medium and on the development of a total curriculum. For, if we are to improve the quality of instruction, we must tailor curriculum to meet the needs of the individual, and only through a massive attack on the curriculum problem will the quality of education be affected. This approach would establish permanent national commissions to operate on a regular basis, rather than once every decade as has been typical with curriculum reform. The Commissions would work with instructional teams which would assist in the development and field testing of materials. They would probably devote their attention to introductory materials. If there was common agreement on the type of curriculum required and with a large market assured, this could be the catalyst necessary to make computer-based instruction attractive to commercial interests.

Another aspect of this issue is the "learner" versus "programmer control" of learning materials. Programmer prepared materials usually require relatively large amounts of time be devoted to diagnostic testing. Since individual differences among learners are great, and since learners tend to bring their own learning preferences and mental organization to learning tasks, it is argued that the most effective use of the computer will be for information storage and retrieval from personal files and for use as a tool in problem-solving. Programmer control advocates would counter that, if the algorithm for solving problems is known and if the structure of instructional materials can be presented in an organized way, why have the student spend his time in ineffective search? Why not have the programmer prepare, write and test the program.

While the strategy of focusing on the computer as a tool has the potential for improving science and the advantage of easy assimilation into the current educational structure, it does not seem to offer a great deal of hope for improving the general quality of education. On the other hand, while the computer as a medium offers the potential of meeting the need of educating ever-increasing numbers of students at lower costs, its adoption would require significant changes in the organization and processes of education.

2. Evolution or Revolution?

The evolutionists would argue that the best way to internalize an innovation is to permit those who are motivated to use the innovation to use it in their own way. While the quality of use may be inferior in the beginning, at least the innovation is accepted and eventually the quality may improve.

The revolutionary approach would seek to retool disciplines based upon the availability of the computer. For example, it is frequently pointed out that there are computer-based instruction programs in college statistics and biology that teach a learner to use paper-and-pencil techniques to solve a problem. There are also computer-based instruction programs that teach elementary school children multiplication by paper-and-pencil techniques. These programs are based upon the assumption that the student will not have access to a computer when he leaves the course. One could argue that with the rapid increase in the availability of computers this is not a valid assumption. It is also pointed out that there are computer programs that permit elementary school students to perform calculus-type operations through non-numerical analyses with a computer. Not only can the children learn these concepts, but they are able to solve complex problems using the computer. One might question whether the sequential structure of mathematics presentations is educationally necessary or whether the mechanization of mathematical operations can now introduce higher order concepts at an early age. The use of computer-aided graphics for solving engineering design problems is but another example of computer operations revolutionizing a discipline.

3. Centralization versus Decentralization.

It has been proposed that large centralized regional computer systems with remote terminals equipped with audio and visual displays could be built and provide instructional curriculum at costs comparable to or cheaper than those expended for a conventional teacher. Such a system could reduce costs by serving a large number of students. One disadvantage of such a system would be in obtaining consensus on curriculum content and scheduling computer use. One answer to this problem would be to use a high level language and permit students and teachers to program their own lessons. Another obstacle is that, although the costs per student/hour for such systems would be acceptable, the initial costs for the installation and development of such a centralized system may be out of reach. Another potential obstacle is that the system will necessarily have to rely on telecommunications. It is not unlikely that telecommunications channels could be commercially saturated in the next five to ten years, in which case it would seem highly unlikely that the heavy burden education would place upon the telecommunications system would be welcome.

An alternative approach would be one of decentralization through the use of mini-computers. Some maintain that education does not require all of the computing capacity available in large computers and that small computers could easily obtain the same educational results. Since purchase costs are relatively small, educators can ignore the cost-effectiveness arguments by buying a mini-computer and placing it in the same storage rooms where the billions of dollars of unused audio-visual equipment are kept.

Still another approach would be the continued development of regional networks. Schools and colleges could join the network and have access to the vast library of instructional programs already available. Since the institutions would be interconnected, they would use the same computer languages and formats and, thereby, greatly reduce the transportability and duplication problems.

Yet another approach would be the creation of a national center to assist in instructional curriculum development. It would also be the function of this center to provide the documentation and testing necessary to create an instructional product that would be readily accepted by a large group of users. In this way, individuals would have the creative freedom to develop their own programs and the availability of a service organization for documentation and distribution.

While the computer is a difficult technology to be easily absorbed by education, so is it an anachronism in Federal and state programs that are unfamiliar with systems. Only in the space and military programs do we find some understanding of systems and the systems approach.

Russell Ackoff says that we have allocated too much of our science research resources available for work on education to tactical problems and too little to strategic ones.(22) Our primary concern must be with the problem not with the techniques and tools of research. Where the techniques and tools are not adequate for the problems we must develop ones that are.

Ackoff says there are the skeptical who say that in order to solve a problem that is already very complicated you find that you must solve other problems that are even more complicated and difficult. Such a reaction, he says, is based upon the false assumption that science questions can be arranged in a hierarchy of complexity and difficulty. Simplicity, he says, is not a characteristic of a problem but of our current ability to cope with it. Ackoff says that progress must take place along a front not by a series of deep but narrow penetrations into ignorance.

IV. Conclusions.

Education is in a state of transition. There is an increased demand on institutions to tailor education to meet the needs of the individual while meeting the economic necessity of mass instruction. Equally significant is that at all levels there is a new emphasis on accountability. The computer, as a scientific tool and as an educational medium, offers an alternative that can significantly affect the quality and availability of education.

However, the computer is an anachronism and does not conveniently fit into the current educational structure nor into the traditional pattern of Federal funding. Within the last fifteen years, a cottage industry has evolved which now is at a critical take-off point. What is needed is <u>not</u> another demonstration of computer-based instruction, but a <u>critical mass</u> that is capable of providing a <u>complete</u> system and a <u>total</u> curriculum. Anything less will be expensive and ineffective. When it comes to systems, cheap is not inexpensive; and incomplete systems are only rarely better than no system at all. In building technological systems, economic efficiency rarely precedes operational feasibility; only when operating systems exist can we realistically evaluate cost-effectiveness trade-offs.

Basically, educational research is sound. However, research in educational technology of the future requires that we attack larger, more complex problems in a systematic way if we are to alter and improve the educational process. The computer offers us a wide array of economical and educational effective alternatives to effect significant change.

There are several agents that could provide the necessary catalyst to unlock the potential of computer-based instruction. Business could create a market mechanism; education could initiate large-scale cooperative efforts; or the Federal government could provide the necessary leadership. In my opinion, the most critical issue to be faced in the next five years is whether we are satisfied to tolerate the current inadequacies of our educational system or whether we will seek to use educational technology to meet the educational and social needs of our society.

FOOTNOTES

1. "Educational Research and Development in the United States." Prepared by the Bureau of Research, Office of Education, U.S. Department of Health, Education and Welfare, July 1969, Washington, D.C., pp. 46-57.

2. "Educational Research and Development in the United States." p. 156.

3. Andrew R. Molnar, "Ten Years of Educational Technology", Educational Broadcasting Review, (June 1969).

4. Robert Filep and Wilbur Schramm, "A Study of the Impact of Research on Utilization of Media for Educational Purposes Sponsored by NDEA Title VII 1958-1968. Institute for Educational Development, El Segundo, California, 90245, July 15, 1970.

5. "To Improve Learning", A report to the President of the United States by the Commission on Instructional Technology (Washington, D.C.: U.S. Government Printing Office, 1970) p.7.

6. Andrew R. Molnar, "Media and Cost-Effectiveness", Analog/Hybrid Computer Educational Users Group Transactions (October 1970).

7. "The Report and Recommendations of the Carnegie Commission on Educational Television", January 1967, p. 81.

8. Andrew R. Molnar, "Higher Education and the Post-Industrial Society", appearing in "Computers in Undergraduate Science Education", The Commission on College Physics, Summer 1971.

9. 1970 National Science Foundation Authorization Hearings, Vol. I, p. 653. (Washington, D.C.: U.S. Government Printing Office, April 1969).

10. A First Report on An Exploratory Program of Regional Cooperative Computing Activities. (Oregon State University Computer Center, Oregon State University, Corvallis, Oregon, 07331, July 8-10, 1969).

11. Charles A. Darby, Arthur L. Korotkin, Tania Romashko. "A Survey of Computing Activities in Secondary Schools", (Washington, D.C.: American Institutes for Research, October 1970).

12. Albert E. Hickey (Ed.), ENTELEK, Inc., "Computer-Assisted Instruction: A Survey of the Literature", October 1968.

13. Helen Lekan (Ed.), "Index to Computer-Assisted Instruction", (Boston, Massachusetts: Sterling Institute, 1970).

14. "Proceedings of a Conference on Computers in the Undergraduate Curricula" (Iowa City, Iowa; The University of Iowa, June 1970).

15. "Conference on Computers in the Undergraduate Curricula", (Hanover, New Hampshire: Dartmouth College, June 1971).

16. "Computer in Undergraduate Education: Mathematics, Physics, Statistics and Chemistry." (College Park, Maryland, University of Maryland, December 1967).

17. Viavant, William (Ed.) "Computers in Undergraduate Education" (Salt Lake City, Utah: University of Utah, 1969).

18. "Report of the Conference on Computer Technology in the Humanities" (Lawrence, Kansas: The University of Kansas, September 3-7, 1969).

19. "Conference on Computers in Undergraduate Science Education", (Commission on College Physics and the Illinois Institute of Technology, Chicago, Illinois, August 19-21, 1970).

20. John W. Hamblen and Bruce K. Alcorn, "Computer Facilities for Instruction in Small Colleges: A Two Year Progress Report 1968-1970, (Atlanta, Georgia: Southern Regional Education Board, 1970).

21. Andrew R. Molnar, "Critical Issues in Computer-Based Learning", Educational Technology (August 1971).

22. Russell L. Ackoff, "Efficiency in Resource Utilization in Education." (Paris: Organization for Economic Co-Operation and Development, 1969).