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ABSTRACT

Two authors discuss educational technology innovations, costs, and effectiveness. Sidney Tickton summarizes the CIT report of 1969-70 and new data highlights from the present study. He recommends that government agency sponsors of technology projects demand cost and result information and comparative studies with other systems presenting identical offerings. Sherwood Kohn sets forth the study objectives: (1) probe further into educational technology cost, and (2) attempt to assess potential benefits and costs of educational technology innovations. Mr. Kohn relates that the costs of educational TV, computer teaching techniques, and audiovisual aids were reviewed; the results of technological innovation in "controlled" environments and in disadvantaged and experimental schools examined; and the effect of new educational tools and techniques on productivity determined. Data were gathered from consultations with over 50 authorities; polls of 90 educational TV stations and 50 State education departments; searches at ERIC centers for new reports on instructional technology; and from analysis of reports published by local school units. Data revealed that TV and computers, because of their cost effectiveness promise, are being accepted as teaching tools in crucial areas, and that there exists a deeper understanding and a greater use of technology by educators with a corresponding change in emphasis from teaching to learning and from mass to individual instruction. (For related document, see ED 058 473.) (Author/EA)

The New Instructional Technologies: Are They Worth It?

Prepared by
Academy for Educational Development, Inc.

Submitted to The President's Commission on School Finance

THIS IS ONE OF SEVERAL REPORTS PREPARED FOR THIS COMMISSION. TO AID IN OUR DELIBERATIONS, WE HAVE SOUGHT THE BEST QUALIFIED PEOPLE AND INSTITUTIONS TO CONDUCT THE MANY STUDY PROJECTS RELATING TO OUR BROAD MANDATE. COMMISSION STAFF MEMBERS HAVE ALSO PREPARED CERTAIN REPORTS.

WE ARE PUBLISHING THEM ALL SO THAT OTHERS MAY HAVE ACCESS TO THE SAME COMPREHENSIVE ANALYSIS OF THESE SUBJECTS THAT THE COMMISSION SOUGHT TO OBTAIN. IN OUR OWN FINAL REPORT WE WILL NOT BE ABLE TO ADDRESS IN DETAIL EVERY ASPECT OF EACH AREA STUDIED. BUT THOSE WHO SEEK ADDITIONAL INSIGHTS INTO THE COMPLEX PROBLEMS OF EDUCATION IN GENERAL AND SCHOOL FINANCE IN PARTICULAR WILL FIND MUCH CONTAINED IN THESE PROJECT REPORTS.

WE HAVE FOUND MUCH OF VALUE IN THEM FOR OUR OWN DELIBERATIONS. THE FACT THAT WE ARE NOW PUBLISHING THEM, HOWEVER, SHOULD IN NO SENSE BE VIEWED AS ENDORSEMENT OF ANY OR ALL OF THEIR FINDINGS AND CONCLUSIONS. THE COMMISSION HAS REVIEWED THIS REPORT AND THE OTHERS BUT HAS DRAWN ITS OWN CONCLUSIONS AND WILL OFFER ITS OWN RECOMMENDATIONS. THE FINAL REPORT OF THE COMMISSION MAY WELL BE AT VARIANCE WITH OR IN OPPOSITION TO VIEWS AND RECOMMENDATIONS CONTAINED IN THIS AND OTHER PROJECT REPORTS.

THE NEW INSTRUCTIONAL TECHNOLOGIES: ARE THEY WORTH IT?

Statement to the President's Commission
on School Finance
by
Sidney G. Tickton

Technical Report
by
Sherwood Davidson Kohn

Academy for Educational Development, Inc.
1424 Sixteenth St., N.W.
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September 1971

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Statement to the President's Commission on School Finance*

By Sidney G. Tickton
Los Angeles, California, September 15, 1971

1. The purpose of my appearance before your Commission today is to present the study you asked for some time ago and to make a number of additional comments. Some of these are not derived directly from the data, but are instead inferred from or implied by the data and from our experiences in conducting investigations in various portions of the field of instructional technology, here and abroad.

2. Two years ago, as you know, we prepared the report for the Commission on Instructional Technology. The CIT report pretty much skirted the issue of the cost of instructional technology projects actually in operation. A few papers were commissioned to cover the subject of costs in general, but the Commission didn't go into the cost matter in depth. The fact was that our analysts found that data on costs of individual projects were not going to be easily available. The accounting and record-keeping systems of the nation's schools and colleges just didn't provide adequate cost

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* Note: Mr. Tickton used this outline for his presentation to the Commission. The discussion that followed expanded on some of the points in the outline as well as on some of the matters covered in the Technical Report.

information for most projects. These systems had been set up for and worked well for fiduciary purposes. They did not provide analytical material. If analytical data were going to be required, they would have to be arranged separately. A separate research job would be needed for each project.

3. The CIT staff also found that there were no convenient measures of cost effectiveness. Specialists in the field of educational television, radio, programmed instruction, etc. had not sought such information. Moreover, the CIT staff found that in the past there had been no real interest in the subject of cost-effectiveness among practitioners of instructional technology. The attitude was that instructional technology was a tool of learning, very much as a school or university library is a tool of learning. No one asks if a library is cost effective. No one asks if Harvard would still be Harvard if the Widener Library had only half the number of volumes. So, goes the argument, why raise the question about films, tapes, and television programs?

4. Last winter your Commission asked us to look into the matter of the costs of instructional technology in greater detail than we had for the CIT report, check into the costs of "Sesame Street," and look at computer developments, etc., to see if there were any new data or information that would prove that instructional technology was worth the cost.

5. We undertook this assignment reluctantly. From the beginning we avoided trying to make this into a big project. Our feeling was that the necessary inventory of data did not exist in the field; and that what did exist was neither worth tabulating too extensively nor analyzing in too great of detail. As everyone knows, if the original data are inadequate, further processing won't make them much better.

6. Nevertheless, in order to be sure that we hadn't missed anything, we talked to 50 of the leading and most experienced practitioners in the field. In addition, we sent out a series of questionnaires to television stations, school systems, and state education departments. Our intention, frankly, was to blanket the field.

7. We did find some data. For example, we found that

- Educational television stations throughout the country claimed station costs for in-school programs ranging from .6 of a mill to $7.00 per student per week.

- "Sesame Street," with an estimated audience of 7 million children, cost 65 cents a viewer for its first season.

- The PLATO system of computer-assisted instruction at the University of Illinois (the computer for which has just been put into production by Control Data Corporation)

was expected to cost 50 cents a student contact hour. With 10 million contact hours of instruction a year the computer would pay for itself in five years.

- The Philadelphia schools employ two computers to teach reading and mathematics to about 2,000 students. The cost per terminal amounts to about $1.00 every 24 hours.

- The New York City schools use one computer to teach remedial arithmetic to about 6,000 students. The cost is about $89 per student per year.

8. Upon analysis it became clear, however, that data such as these were neither adequate nor useful as a basis for arriving at nationwide conclusions. There were at least three important reasons:

   a. The accounting was not uniform in the various school districts and colleges and, therefore, the data were not comparable;

   b. At most projects the classifications of costs and the calculation of unit costs and estimates of savings were made in a somewhat arbitrary manner; and

c. Cost generalizations for the country as a whole could not be made on the basis of a series of projects, all of which seemed to be pretty specialized.

9. We also found that there were some projects for which good data could probably have been obtained and these could have been provided to us. However, the managers chose not to assemble the data, not only not for us but not for themselves too. We believe that they didn't want to know too much about costs or cost effectiveness. The knowledge might be embarrassing, particularly since Dr. Wilbur Schramm of Stanford University concluded, after reviewing more than 200 published studies of educational television projects, that there was "no significant difference" in the amount of or rate of learning as compared with conventional teaching practices.*

10. We also found that where data were assembled and submitted in detail, there were usually some good promotional reasons that would justify the effort involved in obtaining the information. For example, "Sesame Street":

> Here there was a clear need to prove low cost per student so that the grant for the second year could be obtained from the Office of Education, the Ford Foundation, and the other foundations involved.

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* Godwin C. Chu and Wilbur Schramm, Learning from Television, What the Research Says. Final report to the U. S. Office of Education, Stanford University, Institute for Communication Research, 1967.

Another example, some of the computer projects:

> Here there was a need to justify the large investment in a complex piece of electronic equipment at a time when educational institutions were in the midst of a budget squeeze.

The data submitted by projects such as these are interesting and possibly indicative, but some people believe that because of the self interest involved the data are suspect until other evidence is in.

11. I mention these points because they are relevant to an examination of this field; also, to emphasize further that studying a field without hard data ends up now as it did two years ago for CIT, with a relatively limited range of findings and conclusions. They are:

    a. The cost of instructional technology as it is utilized in American education today is a drop in the bucket compared with total educational costs.

    b. At the present time instructional technology is practically always an "add-on". It is practically never a substitute for the teacher or teaching. Therefore, it is practically always an additional cost in the education budget.

c. Considering "dollars alone" and "measurable results" no one knows whether instructional technology is worth the cost. However, if other factors are considered too, that is, the side effects and the collateral benefits, practitioners of instructional technology can be and are appropriately enthusiastic usually about the results being achieved, and the low cost levels. Other people, on the other hand, are frequently neutral. Some reduce projects to ineffectiveness by remaining silent, dragging their feet, calling endless meetings, or nitpicking at the programs.

d. The only way to reduce unit costs substantially is to increase the pupil-teacher ratio dramatically.* The reason "Sesame Street" is cheap is because the pupil-teacher ratio is probably 7,000 to 1 instead of the usual 30 to 1.

12. This last item is an important point: my guess is that cost data on many projects now in operation would probably not show low unit costs because, except for "Sesame Street" and the PLATO project, no one seems to be working with a large enough critical mass of students or a large enough volume of equipment or programs to produce low unit costs and high quality

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* Some observers believe that a reduction of costs could be achieved by using paraprofessionals in the classroom. Our study found no projects which had used this technique successfully to bring down costs.

results that are proveable. An automobile assemblyline can manufacture a good car at a low unit cost only when a large number of automobiles are produced. Audiences of the size of "Sesame Street" could involve low unit costs and good quality programs. But audiences of 2,000 or 3,000 students per program, requiring hundreds of programs per grade per semester, do not generate enough mass production to yield the low unit costs desired by school boards, legislatures, foundations, and government funding agencies.

13. Against this background, I then turn to the question: How can anyone acquire a substantial amount of cost-effectiveness data? And, how can anyone arrange for comparisons that will make it clearer than is now possible that one system of teaching is better than another system, even at a higher cost; or that with the same quality of education one system costs less than another system?

14. I believe that there is a way. It has philosophical difficulties for American educators because it is authoritarian and requires the giving up of a good deal of local autonomy to be effective. The way is for the funding agency to specify that the "price" of an educational technology grant this year, next year, or the year after is the preparation of detailed information on unit costs, detailed information on results, and direct comparisons with other systems presenting the same educational offerings. The funding

agency could make no compromise. It would have to say: Provide the comparisons and the unit cost data, or there will be no further grants.

15. So far nobody has been willing to be this authoritarian. However:

- The National Science Foundation is coming closer in some of the computer projects that it is now supporting.
- The Agency for International Development is coming closer on some of the educational technology projects it is supporting in underdeveloped countries, particularly in El Salvador.
- The PLATO projects may produce some actual cost data in order to promote future sales of the system.
- Performance contracting, under the stimulus of the Office of Economic Opportunity, is expected to produce tangible cost-benefit results in a number of public-school systems.

16. In addition to the authoritarian nature of my proposal, there is another real problem. That is, so far, few people have been willing to say that the major goal of their educational enterprise is good quality at low cost and then to go on to develop a project that would meet this goal. If this should occur,

the projects developed would be very different from most of those of the past. For example:

a. There would be many more children involved and far fewer teachers.

b. There would be much more standardization of course materials.

c. There would be great effort to adopt the "systems approach" from the very beginning. This would require:

(1) Revising the curriculum so that it meets the most rigorous tests in performance,

(2) Training the teachers to use the new curriculum and the technology.

(3) Developing high-quality programs.

(4) Developing new workbooks and textbooks for the children.

(5) Developing guidebooks and lesson plans for the teachers.

(6) Setting up an evaluation team and working out a mechanism to feed back results.

(7) Setting up a cost analysis and cost control programs.

(8) Setting up control groups that are comparable.

d. It would then be necessary to orchestrate all these factors so that they would work together smoothly, with the programs running on time, the teachers trained on time, the guidebooks and the workbooks delivered on time at the right place in the right quantities, the evaluators getting the results and feeding them back in time to improve future programs, etc.

e. In addition to all of this, it would be necessary to freeze the curriculum for a period of time, in order to be able to amortize the costs of the program over a number of years, thereby making the cost per unit low enough to be worthwhile.

17. The small country of El Salvador in Central America is attempting to carry out this type of program. The Minister of Education is directing a systematic approach to improving education by the use of instructional television. AID is providing the development funds. The program covers the junior-high school grades with 40,000 students. Cost comparisons are being made and the unit cost is expected to decline when a great many children are involved and the teacher-pupil ratio rises substantially. Advanced instructional technology will make

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this possible. The country never could have had such a program without it.

18. I turn now to the specific question raised by your staff members when they asked me to come to this meeting; that is: What can the President's Commission on School Finance recommend on costs?

My suggestion is:

- That all future educational technology projects funded by government agencies require as the "price" of the grant the presentation of detailed information on costs, detailed information on results, and direct comparisons with other systems presenting the same educational offerings.

- All of the information should be assembled according to a standard format put together by a small ad hoc team assembled especially for this purpose.

- Representatives of the United States Office of Education, the National Science Foundation, and the Commission on Instructional Technology ought to be on the team; also a few other knowledgeable people in the field.

19. I believe this is a workable suggestion and would very much like to confer with you further about it if your Commission wishes to include it in your report.

Technical Report
by
Sherwood Davidson Kohn

ACADEMY FOR EDUCATIONAL DEVELOPMENT, INC.
WASHINGTON OFFICE
1424 SIXTEENTH STREET, N.W.
WASHINGTON, D. C. 20036

AREA CODE 202 265-3576

September 10, 1971

Mr. Norman Karsh
Executive Director
President's Commission on
School Finance
1016 16th Street, N.W.
Washington, D.C. 20036

Dear Mr. Karsh:

Some months ago you asked the Academy for Educational Development to conduct a study and prepare a report for the President's Commission on School Finance addressed to the question:

> Are the new technologies which are being utilized in education throughout the nation increasing or decreasing costs and are they worth it in terms of instructional effectiveness?

You asked that this study be built upon our experiences as the staff support team for the Commission on Instructional Technology and that it go beyond the activities conducted for that Commission two years ago.

You also asked that the study be done rather quickly and on a limited budget. This eliminated the possibility of our making extensive surveys. We agreed, however, that the state of the art was such that even if new surveys were made they would not be likely to provide more useful information than a quick "look-see" at the field. Therefore, during the spring and early summer of this year, members of the Academy's staff wrote to, consulted with, and polled some of the leading practitioners in the teaching-by-the-new-technologies field. We also gathered a limited amount of information by questionnaire.

During our contacts we were much impressed, as we have been on other occasions, by the wide range of educational technology activities being carried on throughout the country and, at the same time, by the dramatic absence of hard data on results or costs. The plain fact of the matter is that now, as in the past, the entire field is characterized by paucity of controlled experiments, and by a failure of individual projects to set goals and conduct tests that would indicate the extent of achievement, and at what cost, compared with

alternative systems. Also, the educational and financial data assembled by a few projects do not permit anyone to arrive at firm conclusions, or to say, unequivocally, for a particular school system that:

- this approach is better than that approach; or
- this approach is cheaper and less effective but worth it; or
- this approach costs more but is worth it anyway.

Nevertheless, we are glad to note that some steps toward progress have been made during the past two years. We are pleased, therefore, to have the opportunity of bringing to your attention in this report the information that is available.

We also use this occasion to acknowledge with thanks the assistance we received in preparing this report from many educators, television specialists, and government officials. While the staff of the Academy takes the full responsibility for the report and for its various findings and conclusions, we note here that much of the material presented in this document has been developed out of discussions with persons in the field.

The staff work for this report was carried on by Mr. Sherwood D. Kohn, whom the Academy appointed as project director for this assignment. However, Mr. Robert B. Hudson, former Executive Vice President of National Educational Television, now on the Academy staff, and I have been involved at every step in the conduct of this study and the preparation of the final report. We have also been assisted greatly by discussion with our associate, Dr. Richard E. Speagle, Professor of Finance at Drexel University, who wrote a cost-benefit paper for the Commission on Instructional Technology and is now carrying on a cost analysis study of a large educational television project in El Salvador sponsored by the Agency for International Development of the U.S. Department of State.

Sincerely yours,

Sidney G. Tickton

Sidney G. Tickton
Executive Vice President

PREFACE

The final report of the Commission on Instructional Technology (CIT)* to the Secretary of Health, Education and Welfare, which was transmitted by him to the President (August 1969) and then to Congress (January 1970), contained an unavoidable but important deficiency. It did not, in fact, could not, answer the question of whether or not the new technologies were increasing or decreasing the costs of education, nor whether they were worth the expenditure in terms of instructional effectiveness.

At the time of the CIT report educators were inclined to feel that the components of instructional technology -- especially the learning tools -- were good to have on hand, like a school or college library, but that one should not look too closely at their cost effectiveness. They tended to overlook the need for hard data on the cost of operating an educational system using the "new" instructional media. Moreover, few educators were facing the question of whether students were actually deriving some identifiable benefit from the media at a justifiable cost.

Subsequently, a few factors have begun to change, giving promise of growing attention to cost benefit and to the preparation of new data in the future. Some important developments have been that:

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* Sidney G. Tickton (ed.), To Improve Learning, Vol.I (New York: R.R. Bowker & Company, 1970).

(1) Schools all over the country are experiencing financial problems; these are moving them closer to accountability and to more imaginative solutions to tightened budgets; and

(2) The pre-school television program, "Sesame Street," after a successful season, appears to have demonstrated significantly the effectiveness of television as an instructional device, both with respect to learning and with regard to cost.

Moreover, although information was sparse and scattered, there were indications that when initiative, creative programming, budget consciousness, and a willingness to try innovative approaches to learning were combined, instructional technology was not only being accepted as an educational tool, but was actually being asked for by both teachers and parents.

There was also evidence of a small but growing trend in the leading schools of education toward the teaching of the theory of the learning process rather than a concentration on instruction in teaching method. Some observers believe that this is a sign that the society may be accepting, or at least recognizing, the basis for an effective application of instructional technology. And in this recognition, or conditional acceptance, lies the implication that education may be moving toward deep and sweeping changes; changes that could help society cope with technological achievements that threaten to overwhelm man's ability to control them.

In view of these indications, but without knowing whether definitive conclusions could be arrived at, the Academy undertook the study requested by the President's Commission on School Finance. The study was designed to probe further into the cost of educational technology than the CIT report and to attempt to "assess the potential benefits and costs of technological innovations in education and their implications." The Commission also asked the Academy to

- Review the costs of educational television, including "Sesame Street," computer teaching techniques, audio-visual aids and other technological developments;
- Examine the results of technological innovations in "controlled" environments, if there were any such experiments, and in "disadvantaged" and experimental schools; and
- Determine the effect of the new educational tools and techniques on productivity, if any.

The resulting task was herculean, and the time for investigating such a broad assignment extremely short. Moreover, only two years had passed since the original CIT report. Many of the obstacles that hampered the original CIT research still blocked a comprehensive study of cost effectiveness.

First and foremost: U.S. education is not organized or even seriously considered as a business-type activity. Most people, including even the most budget-conscious educators, are averse to considering teachers as production-line workers and students as products. The human factor is too deeply involved for that sort of simplistic analogy. People are too complex to study like an automobile assembly

line, and educators traditionally regard cost-benefit analyses with a suspicion that springs from fear of dehumanization, impersonalization, a possible threat to personal and professional position, and a feeling that educational budgets may be trimmed into ineffectuality if the "efficiency experts" begin looking into expenditures that many laymen regard as "frills."

In his report to the Commission on Instructional Technology, Richard E. Speagle, Professor of Finance at Drexel University, pointed these matters out saying:*

> Cost-benefit decisions in education cannot be ground out mechanically by formula. Most factors, moreover, are not predictable with certainty, but must be weighed according to some estimated probabilities. Educators face all the hurdles of business and 'then some.' These can be summarized under at least four standard stages of cost-benefit analysis as follows:
>
> (1) Objectives: The taxonomy of educational objectives is exceedingly complex: measures and goals are difficult to define at all levels of the school -- total curriculum, grade, course, lesson, and block of study.
>
> (2) Costs: Costs of instruction are crudely measurable in terms of teacher and materials inputs; the pricing of new media rests either on an experimental scale or on projections whose value is limited by highly restrictive assumptions.
>
> (3) Benefits: The pecuniary benefits of education are roughly measurable by future income differences, but nonmonetary benefits resist measurement; the learning input of students is only imperfectly quantified by achievement tests.

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* Richard E. Speagle, Cost-Benefits: A Buyer's Guide for Instructional Technology. Paper submitted to the President's Commission on Instructional Technology. Reprinted in To Improve Learning, Vol. II, Sidney G. Tickton (ed.), (New York: R.R. Bowker & Company, 1971.)

(4) Rate of Return: A monetary return on cost, or investment in education at any level is roughly measurable when compared with no education at all; cost-benefit comparisons among instructional alternatives, as offered by the new media, remain feasible in theory only.

Secondly: In its research for this report, the Academy's staff found that most school administrators were unable or unwilling to report accurate cost-effectiveness figures. For those who could and would, the data were difficult to compare because of wide variances in collection, evaluation, and accounting practices.

With these limitations in mind, the study staff:

- Consulted with more than 50 acknowledged authorities in various aspects of the field concerning current activities in their areas of specialization. (See Appendix A)

- Polled by questionnaire some 90 educational television stations throughout the United States. The replies by telephone enabled the researcher to question respondents personally to obtain answers to the standard questions, as well as additional information about instructional goals, community attitudes, etc. (See Appendices B,D, and G)

- Polled by questionnaire state departments of education in each of the 50 states, and frequently local educators, as well. Replies to these questionnaires were also largely by telephone, making more detailed interrogation possible. (See Appendices C, E, and G)

- Searched the appropriate Educational Resources Information Centers (ERIC) of the National Center for Educational Communication for new reports on instructional technology in general, and its cost effectiveness in particular. Thereafter, reviewed all of the literature that seemed appropriate. (See Appendix F)

- Analyzed, wherever possible, reports published or in the process of preparation by local school units concerning the cost effectiveness of instructional technology systems being set up. (See Appendix F)

The results of some three months' research, which are reported in the following pages, reflect all of these investigations and shed some light -- imperfectly, it is conceded -- on the problem we set out to study.

FINDINGS

1. Today only a few instructional technology projects attempt to prove that the newer technological media are cost effective when used for teaching public-school students.

2. Generally, cost-effectiveness data remain scattered and unreliable, partly because of the decentralized nature of the U.S. educational system, partly because of the inherent difficulties in identifying and quantifying educational results and their causes, and partly because of educators' reluctance to apply the impersonal standards of business and technology to their "products," i.e., students.

3. As far as this study could determine, there are no "model" schools that combine a wide range of instructional media with cost-effectiveness study.

4. Cost-benefit data are sparse, in some cases nonexistent, for the public-school use of programmed books, computer-managed instruction, educational radio, and the traditional audio-visual aids, such as filmstrips, slides, movie film, projectors, and sound recordings.

5. A few examples of cost-benefit data are beginning to emerge in the areas of instructional television and computer-assisted instruction. The data indicate that where properly applied, and with a large enough number of pupils involved, instructional technology costs could decrease per unit and effectiveness could increase.

6. Some increase in the use of instructional technology is turning the emphasis of teacher education away from the mechanics of teaching and toward learning theory, which is the basis for effective application of instructional media and for accountability criteria.

7. In any given year only a few evaluation studies are conducted under "controlled" conditions, i.e., with two classes, started at the same level, taught the same subject under similar conditions, but learning through different channels; one traditionally, the other through the "new" media.

8. Experimental schools, and particularly those of the partitionless or "open" type, demand greater than usual use of instructional technology, since the emphasis in many such schools is on increased employment of individual learning techniques; one of the ultimate objectives of instructional technology.

9. Instructional technology is reported to be as effective in so-called disadvantaged schools, given the proper application, as it is in "advantaged" areas. In fact, it may provide a quality of teaching skill and experience heretofore denied the children in "disadvantaged" schools.

10. Pilot projects indicate that special cultural approaches are unnecessary when instructional technology is properly applied to the teaching of "disadvantaged" children.

11. Creative application of what little is known about the learning process can produce an effective form of education, as in the case of "Sesame Street" and other current applications of instructional technology.

12. "Sesame Street" is, in fact, an encouraging demonstration of a cost-effective union between concern with the learning process and creative, high-quality programming.

13. Although "Sesame Street" was aimed primarily at pre-schoolers during the 1970-71 school year, it seems to have contributed considerably to educator acceptance of instructional technology in general, and of educational television in particular.

14. Since "Sesame Street" was designed for a home-based viewing audience, its apparent success demonstrated the feasibility of effectively instructing large audiences outside of the traditional classroom environment, without a professional teacher in attendance.

15. Although the general picture has begun to change, instructional technology remains far from total acceptance, use, and development as a practical and economical learning tool.

16. Most schools that use instructional technology employ it for "enrichment" or "supplemental" purposes, rather than for direct instruction.

17. Computer-assisted instruction offers the benefits of individual instruction, direct interaction between student and machine, relative privacy, immediate reporting of results, and closer accountability than other media forms. Therefore, many people believe that there is great possibility for realizing significant cost effectiveness with computer-assisted instruction.

CONCLUSIONS

As a result of its research, which was admittedly limited in time and scope, but which polled crucial sources of educational data, this study concludes that:

1. Instructional media can be cost effective in certain areas in which objectives can be clearly defined, such as reading and arithmetic, but only under near-ideal conditions of creative programming, accurate record-keeping, and thorough, continuous evaluation.

2. The costs of instructional media, spread over a reasonable period -- say five years -- are no greater then those of traditional educational agents, but it is too early to promise decreased costs as numbers grow. It is also too early, except in certain isolated cases, to evaluate general effectiveness.

3. Instructional technology, adapted as a cost-effective instrument for individualizing and humanizing learning, is likely to be employed increasingly in the public schools in the years ahead.

4. The form of instructional technology used in the future can be expected to vary according to need. Television, for instance, is particularly suited to subjects that require visual demonstration, such as art. It is helpful in music and bilingual education. Computer-assisted instruction lends itself admirably to drill-and-practice situations. Language laboratories provide language drill including remedial English. As instructional technology develops and becomes more flexible, its cost effectiveness can be expected to increase.

5. At this stage in its development, instructional technology is not likely to become a total substitute for traditional instruction, partly because it is not readily adapted to varied learning situations, partly because good programmers are scarce, and partly because the public is not ready -- nor should be -- to accept its unqualified use.

6. Instructional technology should certainly be used to teach the disadvantaged. The reports to this study were that disadvantaged children respond equally well, if not better, to media-oriented learning, chiefly because it tends to individualize the presentation of information and its assimilation by students. Secondly, no special cultural approaches seem to be necessary.

7. Instructional technology, properly applied, cannot help but alleviate the current urban education crisis, primarily because it requires an emphasis on learning rather than on teaching; on the individual rather than on the group.

8. Instructional technology is greatly in need of a complete "model," employing all new media forms, a school set up with a view toward cost-effectiveness analysis, adequately staffed with creative educators, researchers and administrators, and open to a representative group of students.

9. Instructional technology in the schools will have to be exposed to wider audiences than is now the case in order to become cost effective.

10. Cost data for the use of the various media must be collected and analyzed more efficiently before they can be compared with measures of effectiveness.

11. Evaluation should be on a "closed loop" basis in order to achieve maximum effectiveness; that is, with feedback applied almost directly to production techniques and applications.

12. Teachers will have to be encouraged by educational leaders and theorists to achieve instructional technology as a tool of learning, rather than as a competitor.

13. Several school systems, and even regional groups and media organizations, should organize to develop plans for the use of mutually beneficial instructional technology systems, to purchase equipment, and to share the expenses of media that can transmit instructional programs over wide areas.

14. Teachers should be taught to concentrate first on the learning processes of the student, and only afterwards on the best methods of teaching him. The integration of instructional technology into a curriculum immediately changes the philosophical emphasis from teaching to learning, and makes the entire process both more human and more manageable.

15. Educators should study instructional technology in more "controlled" learning and classroom situations.

16. As it becomes more cost effective, instructional technology can be expected to be applied increasingly to education on a direct, rather than an enrichment basis, i.e., integrated into the individual curriculum, rather than added to it. The trend is already apparent in greater use of team-teaching

techniques, where one team can, and often is, employed to cope directly with media, in cooperation with other teaching teams.

17. Creativity -- the utilization of art and imagination as motivational factors, for instance -- must be applied in attaining the educational goals of instructional technology, and the rewards to resourceful, creative teachers must be increased. Unless this is done, instructional technology's effectiveness will remain limited.

18. Computers can perform multiple jobs -- instructional as well as record-keeping -- on a time-sharing basis at a reasonable cost if the number of students is large enough. They will have to be used more efficiently and economically than they are today if they are to be adapted widely by school systems.

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RESULTS OF THE STUDY

In its 1970 report to the President and the U.S. Congress, the Commission on Instructional Technology broadened the parameters of its study from teacher-aided media, such as television, films, overhead projectors, computers, and assorted other items of educational hardware and software. The expanded concept included a "systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction."*

The major conclusion of the report was discouraging; that is, the report said that "the present status of instructional technology in American education is low in both quantity and quality." The report went on to say that the greatest obstacles to improvement were piecemeal application, a lack of data and uniform criteria, and failure to develop unique methods of applying the new media. As a corollary, the report said that schools had failed to adapt traditional teaching methods to a new age, many educators were hostile toward technology, and education in general lacked creativity, innovation, and flexibility in accepting and applying technology to the solution of instructional problems.**

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* Tickton (ed.), op. cit., p. 7.

** Ibid, pp. 14-27.

Implicit in these criticisms was the knowledge that American education was not cost effective, and that its expenditures on technology were probably out of proportion to results, if, indeed, those results could be determined. In fact, the Commission said, "A true technology of instruction that integrates human resources into a comprehensive system to improve learning is unlikely to save money." It then went on to say, "Quality comes high."*

At the time the CIT report was prepared, researchers found that they were unable to discover any comparable unit cost figures for instructional technology systems. Valid cost-effectiveness information was nonexistent. Most contributors to the report agreed, however, that in the preponderance of school systems, only a small percentage of the annual budget was available for instructional materials of any kind, including books.

The CIT researchers confirmed, however, what businessmen have known for a long time: that costs per unit could probably be reduced most easily and directly by increasing the number of people using the materials, or by extending the amount of time they spent using them. Approaches to the cost-effectiveness problem included:

- stepping up educational production;
- designing the instructional technology, as well as its individual machines, for specific educational purposes;
- increasing student learning speeds;

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* Tickton (ed.), op. cit., p. 24.

- increasing the scope and depth of cost data to help educators and educational administrators make policy decisions regarding instructional technology; and

- comparing the cost of instructional technology with other forms of instruction, as well as with the real costs to society of an unproductive educational system.

The State of the Art

1. Audio-Visual Aids

Many of the gadgets of instructional technology have been available for some years without being developed beyond the stage of miniaturization or adapted to use as tools of direct instruction. Moreover, educators have paid little attention to the cost effectiveness of such garden-variety classroom audio-visual equipment as films, filmstrips, slides, tape recorders, and projectors of various kinds. Most of these devices have been purchased as "add-on" items. Few have been integrated into curricula. Such media are used only supplementarily in the classroom, sometimes only occasionally, and frequently purchased and then used not at all. And since the demand has not been specific or exacting, development has been slow. As for cost or cost effectiveness, the Academy could find no recent study on cost or the effect of the use of audio-visual equipment in a representative public school.

2. Radio

Largely as a result of its commercial use, radio has evolved technologically into a highly flexible, mobile method of communication. However, educational radio, despite such instances of success

as the Wisconsin School of the Air, which is utilized by 81 percent of the schools in the state,* has not developed significantly as an instructional tool. The reason is not inadequate technology, but disuse, a lack of interest, and insufficient attention to its development. Most teachers have simply not learned how to apply radio to education, and administrators know neither its cost nor its effectiveness.

3. Programmed Instruction

Programmed instruction, a technique demanding maximum clarity in specifying detailed, ordered, instructional objectives, laid the basic foundation of technology-oriented instruction. It was originally based on B. F. Skinner's learning process theories. As adapted to forms applicable in business and the armed services, it was clearly cost effective, but the variables were fewer, the instructional motivations clearer, and the demand for accountability much more pressing than in public education.

Now, combined with other media, programmed instruction is being integrated in learning "packages" that make lessons more palatable to the young student. The result is that programmed instruction is being used more frequently in schools that cannot afford the high initial investments for instructional television and computer-assisted instruction. In some instances, researchers are attempting to apply the cost-benefit standards evolved in industry. But there are no data or analyses available for study.

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* Dolores A. Hegemann, Educational Consultant, Report on the Wisconsin School of the Air Survey, Wisconsin School of the Air-Radio, 1969.

4. Language Laboratories

Elaborate language laboratory systems, which have begun to break with the grammar-based technique that led to their general rejection some 12 years ago, are still plagued by an unfortunate reputation for ineffectiveness and exhorbitant cost. They are, however, adaptable to many forms of individualized instruction, and as further applications are introduced, should be returned to use. When they do, educators will have to justify their expenses on an as yet unproven cost-effectiveness basis.

5. Television

Technically speaking, television shows tremendous promise as a direct teaching tool, with color, portability, miniaturization, and the capacity for use with other media contributing heavily to the adaptability of the medium.

In addition, of all present instructional media, television offers the greatest opportunity for creativity, and hence the most chances for the development of separate, specialized, teaching "teams," which can concentrate on motivating the learner and improving the learning environment.

Educators are now exploring the integration of television with the other tools of instructional technology, and looking into the implications of such developments as cartridge video tape and the possibilities of its contribution to learning. Educators are also making some efforts to place instructional television on a

cost-effective basis. They are driven to this point partly because instructional TV involves initial expenditures and partly because teachers hope to utilize its apparently glamorous assets. Moreover, at present, television offers greater possibilities than all other media for direct instruction, particularly in areas such as historical illustration and laboratory demonstration and in art and music subjects, where many teachers are either delighted to be relieved of the burden, or do not feel professionally threatened.

6. "Sesame Street"

During the school year 1970-71, "Sesame Street," the hour-long, daily television show distributed over national networks to a general audience of pre-schoolers, provided a breakthrough in the development of a new media system incorporating learning theory concepts.

From the beginning, the Children's Television Workshop, the producers of "Sesame Street," proposed that the program do something bold and highly unusual, that is, that it try to creatively apply elements of learning theory and test the product on a mass audience. This was not to be done by pure instinct but in a very specific way by using techniques of commercial TV advertising to teach children. In effect, the goal was to educate by entertaining. Combined with these techniques were several other marketing and educational testing methods.

Among the goals of the program were such specific skills as number recognition and counting ability; letter recognition and simple phonics; basic language skills; space and time concepts; beginning

logic and math concepts; reasoning skill development, and an awareness of the individual child's own basic emotions as a step toward helping him master them.

These goals, strategies, and techniques together constituted the Children's Television Workshop's learning process approach to television teaching. The first five pilot programs were tried out on representative audiences. Subsequent programs used continuous feedback of evaluative information on a "closed loop" basis, an almost immediate data-gathering and evaluation technique used in broadcast marketing practice. Continuing evaluation, in fact, constituted one of the most important factors in the success of the program.

At the end of the first year the record shows that the techniques of "Sesame Street" had paid off, both educationally and financially. Success was due to the fact that the show's producers approached carefully plotted learning goals, expressed in clear behavioral terms,* from the viewpoint of educators with commercial television experience. The producers felt that their audiences would first have to be "captured," then "held," and finally induced to learn. The underlying teaching techniques, partly derived in the bitterly competitive marketplace of TV huckstering, owed a great deal to the behaviorist theories originally propounded in the academic

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* Children's Television Workshop, Proposal: Television for Preschool Children, February 19, 1968.

world, and to the concept of financial accountability hammered out on the carpets of advertising agencies, or in sponsors' and network executives' offices.

The Educational Testing Service reported that pre-school viewers of "Sesame Street" gained significantly in letters, numbers, and classification skills, and that disadvantaged children, at whom the show was primarily aimed, gained in relation to the amount they watched.

On the cost side: "Sesame Street" with an estimated audience of about 7 million pre-school children cost about 65 cents a viewer for its first season.

"Sesame Street" has encouraged its designers to apply similar techniques at other levels. "The Electric Company," a new series scheduled to start in October 1971, is based on many of the learning principles tested in producing "Sesame Street." The overall objective of the program is to help teach reading skills to children ages seven to ten.

But the good results of the first year do not provide conclusive evidence that the particular learning process approach of the Children's Television Workshop is valid in all learning environments nor that it can or should be emulated by education in general.

Indeed, critics have challenged the program for not finding the correct balance between entertainment and teaching or learning. John

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* Samuel Ball and Gerry Ann Bogartz, The First Year of Sesame Street: An Evaluation, Educational Testing Service, Princeton, New Jersey, 1970.

Holt, the educational reformer, for instance, claims that "Sesame Street" is too concerned with traditional scholastic skills and not concerned enough with the child's world and how facts function in it. He also feels that the sales-pitch techniques of the show assume unnecessarily that children don't want to learn and therefore need to be coerced.*

Further, Mr. Holt warns that exactly what the children have learned is by no means clear; i.e., they may write and recognize the letter "R," but what can they do with it? Tests of the program's effectiveness do not provide clear answers to this important question.

Other "Sesame Street" critics** ask what happens to pre-schoolers presumably stimulated by "Sesame Street's" entertaining, imaginative programs when they enter the conventional, often uncreative and less entertaining environment of traditional school activity? Are they then "turned off?" The "Sesame Street" staff says that the shows' format has been specifically designed to ease the transition, an assertion that has yet to be verified in practice.

Such criticism points up the experimental nature of "Sesame Street," and adds a cautionary note to the unqualified paeans of praise that many sing for it. Considered rationally, the show is

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* John Holt, "Big Bird, Meet Dick and Jane," Atlantic, May 1971, pp. 72-78.

** Shortly after this report to the President's Commission on School Finance was completed, the British Broadcasting Corporation refused to carry "Sesame Street" on its channels and made numerous criticisms of the techniques and value of the program.

only a good beginning, demonstrating that careful curriculum design, based on what little we know about learning, built on a commitment to creativity, high quality, and a willingness to use new techniques, can produce a powerful learning tool.

But what about cost? Does it cost too much to achieve the results obtained? For "Sesame Street" the results have been reported to be highly favorable; that is, with a large audience, the unit cost was low. But "Sesame Street" is not a complete curriculum, therefore how can the low unit cost be translated to a formal school setting? Have the more conventional schools corroborated the low unit cost principle?

7. Localized Television Applications

The Academy's questionnaire-and-telephone poll of educational television broadcasting stations in all parts of the country (see Appendix D) showed that some which provided data (located in large metropolitan areas and serving student populations of more than 100,000) were able to operate at minimal per-pupil costs.

The significance of the poll's results could not be interpreted literally, however, because of local differences in accounting, the amount spent on lesson preparation, the sophistication of the equipment, and the amount of actual instruction administered directly, rather than supplementarily. And, although this study's research apparently substantiated the idea that educational television is cheaper for large groups, it produced only a little evidence that heavy expenditures for media systems produced more effective learning.

A few specific examples, which are particularly worthy of note, follow:

A. Anaheim, California:* A 12-year-old instructional television system, which claims responsibility for teaching 12 percent of district's curriculum in science, social sciences, foreign language, music and art, and which tested its ideas using "control groups." Anaheim reported that "the groups receiving instruction by means of related classroom and televised teaching were found to be consistently superior to the conventionally taught groups." Other advantages included the following:

- The redeployment of teachers and the regrouping of students into large or small instructional groups, according to need; this permitted greater instructional flexibility and individualization;
- Reduction of teachers' total work and planning load;
- More careful and systematic planning of curriculum for day-to-day instruction;
- Improved utilization of space and personnel;
- Increased teacher-acceptance of instructional technology;
- A basis for curriculum quality control;
- Better student retention of the television-taught subjects; and
- Cost effectiveness.

* Information for the Anaheim system came from a report of the Anaheim City School District Department of Instructional Media entitled Teaching with Television, Anaheim, California, 1971.

To many observers, not the least of which were the community's taxpayers, cost effectiveness of the ITV system was among the most important of its accomplishments. "Savings due to increased efficiency in the use of personnel and resources under Anaheim's ITV system," said the report, "are estimated at approximately $152,000 per year. Therefore, the District's investment in its instructional television system will liquidate itself in about seven years." Moreover, said the Anaheim report:

> Under the traditional arrangement, 5th and 6th grade students require 158 classrooms in 22 schools. Land acquisition and construction costs are approximately $19,300 per classroom, or a total of approximately $3,100,000. Under the Anaheim system of regrouping, only 136 classrooms for the same number of students are required, for a total of $2,600,000, reflecting a savings of $500,000 or the approximate cost of a new school.
>
> Generally speaking, the television system handles approximately twelve percent of the curriculum at less than three percent of the instructional dollar.

Among the most significant results of the Anaheim experience were the facts that (a) the television classes were consistently ahead of their "control" groups in academic achievement and lesson retention, and (b) much of the evaluation (performed by a testing group from the University of Southern California) grew out of clear comparisons between television-taught classes and traditionally-taught "control-group" classes, exposed to identical standards.

Also significantly, the curriculum and the lesson guides, developed cooperatively by classroom teachers, television teachers, and

producer-directors, were laid out on the basis of learning objectives and then specifically designed for viewing. A parallel to the creative learning theory basis of "Sesame Street" is obvious.

B. Washington County (Hagerstown) Maryland: A 15-year-old instructional television system which transmits over a county-wide cable network of 46 schools. The Hagerstown system claimed that:

> The redeployment of personnel and equipment made possible by television has produced savings which cover the annual operating costs. And in terms of duplicating in conventional classrooms what is now offered on television, the county's savings are substantial. Without television, the county would require more than one hundred additional teachers and a budget increase of almost $1,000,000 to duplicate the courses that have been added to the instructional program. This is more than three times the annual operating cost of the television network. For example, without television it would cost more than $250,000 annually to provide art and music specialists for the elementary schools.*

Moreover, Washington County's educational cost per pupil in 1969-70 was $772.51 compared with a statewide figure of $816.30,** a reduction which Hagerstown's school administrators feel has been one of television's major contributions. Other contributions are reported to be:

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* The Board of Education of Washington County, Maryland, Washington County Closed Circuit Television Report, Hagerstown, Maryland, 1963. These 1963 conclusions were confirmed as still valid in 1971 by a personal visit to the project.

** Maryland State Department of Education, Division of Research, Evaluation and Information Systems, Selected Financial Data, Maryland Public Schools, Part I, 1969-70.

- Improved pupil achievement;
- Acceleration of teachers' professional growth;
- Greater use and economy in upgrading and enriching the curriculum;
- Greater availability of teacher expertise;
- Better integration and use of the team-teaching concept;
- Greater equality of pupil opportunity; and
- A widening of community-service possibilities.

C. Los Angeles County: The county based its evaluation on teacher observation of some 338,000 students who watched 38 instructional programs a week. The county reported that television encourages teacher and student enthusiasm, maintains student interest, and motivates pupils to work on their own. In the case of one unit, a 15-show primary science series, a five-year evaluation listed the program as "most used and needed by teachers." (See Exhibit 1)

In general, Los Angeles County reported that its instructional television program cost the district 75 cents per student per year. For the science series, the "effective costs (were) amortized over a five-year period" ... and "costs per pupil for the series amount to 15.8 cents per student per series or about one cent per lesson."

This series, according to Mrs. Elinor Richardson, consultant-in-charge of telecommunications for Los Angeles County's Division of Educational Media, was clearly the most successful in the entire program.*

D. Oklahoma City:** Paul Ringler, director of broadcasting at station KOKH-TV (which is entirely supported by the municipal school system) reported a weekly broadcast schedule of 67 programs and a cost per student per week of 19 cents. He said that televised instruction was saving his board of education $1.5 million a year, when based on what instructional television service would cost if provided in other ways. "It's not only a saving," said Mr. Ringler, "its the very best we can offer." For example, he said, if the Oklahoma City School System were to employ a full art faculty for its 75,000 elementary and secondary students, it would have to hire 85 specialized teachers. Not only would it be difficult to find 85 good and qualified art teachers, but it would cost the local board of education an average of $8,000 a year per teacher, or an annual total of $680,000. The same principle is applied to Oklahoma City's music, science, and history programs.

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* Elinor Richardson, ITV Case Study Primary Science. See Exhibit 1, p. 7.

** The information on the Oklahoma City instructional television service was obtained in a personal interview with Paul Ringler, Director of Broadcasting, Station KOKH-TV, Oklahoma City, August 24, 1971.

This study's survey of educational television stations throughout the country showed station costs for in-school programs ranging from .6 of a mill to $7.00 per student per week, with variations in cost accounting responsible for much of the range. The average of 43 cents, however, seems reasonable despite lack of a standard cost-computing formula, high-audience claims by some, low claims by others, and the intrusion of a number of special cases. Included among the special cases are American Samoa, where television accounts for the greatest portion of the school budget; Lubbock, Texas, where some 540 kindergarten children watch "Sesame Street" at a cost to the school system of about $750 a week; and the City of Los Angeles, which does not have a sizeable budget for television instruction in the schools, bootlegs most of its programs from Los Angeles County's KCET, and claims some 5 million student viewers at a weekly cost of two cents per student.

Evaluation, however, proved to be another matter. "Sesame Street" had indicated that television:

1. Could teach and teach economically;
2. Could provide education, even outside the classroom, without an overt dialogue between learner and medium and without the intervention of a live teacher;
3. Could produce lessons which could be broadcast to large numbers of children, including the disadvantaged, without introducing specialized cultural approaches; and
4. Would pose no threat to the humanistic elements of education when designed humanly and creatively.

However, few schools had made detailed studies of the achievements of their instructional technology programs, and even fewer had judged program effectiveness in contrast to "control" groups receiving only traditional instruction.

The results of this study's educational television station survey must therefore be taken qualifiedly, as indicators, rather than as objective findings. The "Sesame Street," Anaheim, Hagerstown, Oklahoma City, and Los Angeles County projects all indicate, in general, that instructional television, creatively applied and properly used, can probably meet cost-benefit tests.

8. Computer-Assisted Instruction

Despite the fact that computer-assisted instruction provides a highly individualized form of instruction, offers opportunities for dialogue between learner and machine, and provides high motivation for many students, educators have only recently employed the medium in situations that could be measured, studied, and evaluated.

At this writing, cost-effective data are only beginning to emerge from the field. This study's survey of leaders in the use of computer-assisted instruction turned up only a handful of cost-effective studies. Nevertheless, these strongly indicate that when the medium is used in quantity, or for specific purposes, it is not prohibitively expensive and can be extremely useful.

Moreover, computer technology offers a promising basis for applying learning research. Computer-based education is often easier to evaluate than traditional instruction because responses are usually overt and often recorded by the machine itself.

In addition, computer-assisted instruction does not have to rely so heavily upon the entertainment talents of the programmer, as does television, although computer programmers can be and frequently are highly creative in program design and in the techniques of student motivation. One of the medium's chief assets lies in its ability to offer each learner infinite patience in rote learning, absolute privacy in the face of repeated and otherwise publicly embarrassing error, individualized dialogue systems, and built-in motivation. CAI is therefore especially effective in the education of the retarded and in programs designed for remedial education.

Computer-assisted instruction comes closer than other instructional media to achieving individually-adapted instruction. Some of the information obtained by this study's survey follows:

A. PLATO Project: In their report on the PLATO (Programmed Logic for Automatic Teaching Operations) project at the University of Illinois, Drs. Donald Bitzer and Dominic Skaperdas say that instructional computers can control other audio-visual devices, interact with each other in games, keep detailed performance records, provide remedial training, encourage development of critical thinking skills,

simulate experiments, and aid teachers in improving course content, designing better learning strategies, and planning more advanced computer-assisted instruction systems.

According to Drs. Bitzer and Skaperdas:

> The cost of a computer meeting our requirements (that is a third-generation computer of the Control Data 6,000 class) is approximately $2.5 million. The additional cost for a million words of memory and other input-output equipment is approximately $2 million. The software for the system including some course development programming, cost another $1.5 million. The total will be about $6 million, which if amortized over the generally-accepted period of five years indicates a net cost of $1.2 million per year.
>
> Assuming that such a computer will be tied into 4,000 terminals and will be in use eight hours a day for 300 days a year, there will be approximately 10 million student contact-hours per year. The system cost, excluding the terminals will be 12 cents per student contact hour. In order for the equipment cost to be comparable to a conventional elementary classroom of approximately 27 cents per student contact hour, the terminal costs must be limited to 15 cents per student contact hour, or to a total cost of about $7.5 million over a five-year period. The cost for each of the 4,000 terminals, which included a digitally-addressed graphical display device and its driver, a keyset, and a slide selector, must therefore be a maximum of approximately $1,900. Present indications are that this cost can be met.*

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Bitzer and Skaperdas then went on to say:

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* D. I. Bitzer, D. Skaperdas, The Design of an Economically Viable Large-Scale Computer-Based Education System, Computer-Based Education Research Laboratory, University of Illinois, Urbana, Illinois, February 1969, pp. 9, 16.

> The teaching versatility of a large-scale computer is nearly limitless. Even while teaching 4,000 students, the computer can be idle 50 percent of the time and can use this time to perform data processing at half its normal speed. In addition, 16 hours per day of computer time are available for normal computer use. The approximate cost of 12 cents per student contact hour pays completely for the computer even though it utilizes only one-sixth of its computational capacity. The remaining five-sixths of its capacity are available at no cost.*

In a subsequent conversation with the Academy's researcher, Dr. Bitzer said: "With 10 million contact hours of instruction a year at 50 cents an hour, the system will pay for itself in five years. If present economic trends and technological developments continue, such a system will soon cost only 35 cents a contact hour.**

As this report moved into its final stages, the Academy learned that the PLATO computer had been accepted for production by the Control Data Corporation of Minneapolis, Minnesota, and that both Bitzer's office and the firm were being flooded with inquiries. Dr. Bitzer said that the terminals were currently priced at about $4,800 each, and that the initial cost of the computer for a 4,000-terminal system would be about $5 million.

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* Ibid., p. 17.

** Personal interview with Dr. Bitzer, June 1971.

B. Philadelphia Schools Project: The experience of the Instructional Services Division of the Philadelphia Public Schools, headed by Dr. Sylvia Charp, reinforces Dr. Bitzer's theories.* The Philadelphia system employs two computers serving some 200 terminals located in various elementary, junior, and senior high schools in the metropolitan area. The computers teach reading and mathematics to about 2,000 students. The cost per terminal, each used by about 20 students a day, amounts to approximately $1 every 24 hours.

Individualized computer instruction enables teachers to enlarge some classes. For example, one teacher, an aide, and 32 computer terminals now teach general mathematics and algebra to 64 students at once.

Both of the Philadelphia computers are used also to perform several additional functions on a time-sharing basis. One is used by more advanced students for gaming or problem-simulation. The other is used as a vocational guidance retrieval system** and for a number of management functions, such as high-school classroom scheduling and the preparation of payrolls. A data bank keeps accurate current records on the progress of all computer-assisted students, and provides data on teachers or administrators upon request.

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* Information in this section was obtained from a personal interview with Dr. Charp in Philadelphia, June 7, 1971.

** To present a student with as many available career choices as possible, rather than trying to evaluate him in terms of specific jobs.

At this writing, Dr. Charp's division is evaluating the computer-assisted instructional system. Preliminary data show that significant learning advances have been made by students using the system rather than traditionally-administered instruction.

Dr. Charp says that the computer's infinite patience in rote-memory situations is particularly well suited to the slow learner, whose plodding pace is not exposed to ridicule, and who is immediately rewarded for correct answers by the machine itself. Moreover, the use of computer terminals for rote lessons diverts the student's impatience from the teacher to an inanimate, obviously impersonal machine. Favorable computer printouts, Dr. Charp reports, enhance reading skill motivation and are often prized by students as status symbols. For some reason, she says, computer terminals are never molested even in the most vandalized schools.

C. Aurora, Illinois, School Project:* During the 1970-71 academic year, the Aurora, Illinois, public school system undertook an instructional technology project designed largely by the Westinghouse Learning Corporation, employing a modified form of Westinghouse's multimedia, computer-managed instructional system. Mr. Andrew Hook, Superintendent, Aurora Public Schools, and Dr. Marvin Powell, a psychology professor at the University of Northern Illinois who studied the project, reported spectacular advances among the

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* Most of the information in this section was obtained from personal interviews with Andrew Hook, Superintendent of Schools, Aurora, Illinois, and Dr. Marvin Powell, Professor of Psychology, University of Southern Illinois, July 26, 1971.

elementary and secondary school students who participated in a pilot project which included mathematics, social studies, language arts, and science. The project was designed to

(1) Make possible the individualization of the educational program for the learner to meet his present and future needs.

(2) Encourage the student to take more responsibility for his own educational development and to have knowledge of it.

(3) Close the education gap between the disadvantaged and other more fortunate students.

(4) Identify the motivational needs of children and increase their motivation.

(5) Provide more flexible opportunities with a variety of options for the student.

(6) Eliminate failure.

(7) Help teachers become facilitators of learning.

(8) Do all these things with full educational and fiscal accountability inherent in the process.*

Part of Dr. Powell's study observed two kinds of schools -- the traditionally-taught variety, which was used as a "control," and the media-equipped kind -- and attempted to assess comparative achievements in learning as well as in self-esteem.

Dr. Powell reported that the cost of the technologically-taught program was approximately $816 per student per year, which compared favorably with that of the more conventional system. The target group was "disadvantaged" and mobile, and drew a high percentage of children from poor white, black and Spanish-speaking families.

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* Marvin Powell, Studies of Aurora, Illinois Pilot Project, University of Northern Illinois, Dekalb, Illinois, 1971.

Dr. Powell's evaluation was highly favorable, even enthusiastic. Class attendance improved, social interaction became freer, children began regarding school as "fun" and themselves as better individuals, and learning improved by leaps and bounds. Teachers cooperated more readily and even parents became involved. Mr. Hook said also that the educational achievements of the entire target population "skyrocketed," and that there was no evidence that any special cultural approach, beyond the introduction of bilingual programs in some cases, was necessary to reach the disadvantaged student.

D. Kansas City Schools: Dr. A. Frederick O'Neal, director of a computer-assisted instruction project in Kansas City, is highly optimistic about his project. "This is the year," he said, "that computer-assisted instruction passed the economic hump."* The keys were highly improved hardware and more experienced and, therefore, better program authors. The immediate results are drops in operational costs and student learning time.

He reported that educators in Chicago, St. Louis, Atlanta, and other cities are investing in late-model computers which promise striking improvements in cost effectiveness over the machines developed during the 1960s.

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* Personal interview with Dr. A. Frederick O'Neal on July 15, 1971.

E. Texas Project: Dr. C. Victor Bunderson, director of the University of Texas Computer-Assisted Instruction Laboratory, reports that:

> The most striking finding in /computer-assisted instruction/ evaluation studies has been that students are able to achieve educational objectives in much less time. Savings of 40 percent or more are not uncommon ... Another important finding is that lower ability students are able to achieve important performance gains by means of CAI, often approaching the same levels as the higher ability students.
>
> Because I am skeptical about very complex systems working reliably, I prefer the notion of a small computer driving a cluster of 30 to 100 cathode ray tube terminals, and requiring a capital investment of around $200,000. Given a sizeable market, such systems are within the state of the art today. Such a system could be completely justified for the administration of a small number of courses, which are feasible to develop soon, and would cost somewhere between 40 cents to $1.20 per student hour... Since with cathode ray tubes and good design, one hour of computer-assisted instruction may produce results equivalent to two or more classroom hours, a cost of 40 cents to $1.20 per hour becomes highly competitive under an appropriate organizational model for instruction.*

Less conservative estimates predict 23 cents per hour, doubled learning speed, and improved student attitudes that make it possible to extend on-terminal time from one-half hour to five or six hours a day.

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* C. Victor Bunderson. "Justifying CAI in Mainline Instruction." Paper presented at the National Science Foundation-Sponsored Conference on Computers in the Undergraduate Curricula, the University of Iowa, June 17, 1970.

F. New York City Schools Project: A study by Drs. Dean Jamison and Patrick Suppes of Stanford University on the cost effectiveness of a federally funded New York City compensatory computer-assisted instruction program projected that a single computer terminal would cost New York City $2,230 to operate during the 1970-71 academic year.* About 6,000 students at 15 Manhattan elementary schools used the computer's 192 terminals for arithmetic drill-and-practice. Substantial proficiency gains were achieved at a median cost of $89 per student per year. Expenses for such a limited and specialized use of computer-assisted instruction could be expected to be high. However, the authors of the study concluded "that the New York City computer-assisted instruction program in elementary arithmetic is a highly cost-effective compensatory education technique."

G. Other Projects: The New York study did not find any conclusive evidence of the cost effectiveness of computer-assisted instruction in disadvantaged areas. However, in a later report (after studying arithmetic drill-and-practice computer programs in California, Kentucky, and Mississippi), Jamison and Suppes teamed with J. Dexter Fletcher and Richard Atkinson, of the Institute for Mathematical Studies in the Social Sciences at Stanford University to conclude:

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* Dean Jamison, Patrick Suppes and Cornelius Butler, "Estimated Cost of Computer Assisted Instruction for Compensatory Education in Urban Areas," Educational Technology, September 1970, pp. 49-57.

> We have found strong and consistent achievement gains by disadvantaged students when they were given computer-assisted instruction over a reasonable fraction of a school year ... We conclude ... that the cost of computer-assisted instruction seems to have decreased to the point that computer-assisted instruction is now quite attractive compared to alternative compensatory techniques with roughly similar performance. This holds true whether one considers computer-assisted instruction as an add-on cost or as a substitute for teacher time.*

Interviews with teachers assisted by computers in disadvantaged areas in Philadelphia confirmed these findings: children responded to creatively administered learning processes, regardless of their cultural backgrounds or conditioning. No special concessions beyond those of basic English-language comprehension were needed to teach them.

The experience of computer-assisted instruction project directors in Montgomery County (Maryland), Pittsburgh, and Kansas City tend to corroborate the results in Philadelphia. So far, however, none of these projects have published specific findings.

The number of computer-assisted instruction projects is increasing rapidly. Educators are accepting computer-assisted instruction more readily, and many teachers are being trained to apply it. But there are many constraints and many questions left unanswered.

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* Dean Jamison, et al., "Cost and Performance of Computer-Assisted Instruction for Education of Disadvantaged Children". Paper presented before Conference on Education as an Industry, June 4 and 5, 1971, New York City.

There will soon be enough data, however, to begin evaluating the computer's instructional use along specific cost-benefit lines.

9. Special Adaptations of Instructional Technology

Today education has just begun to catch up with and utilize the machines that the technological explosion is pouring into our society. The lag between acceptance and implementation is great, and the full impact of instructional technology, or even of its major segments, such as CAI, will probably not be felt in the country for at least five years. Public acceptance of its philosophical implications should take even longer.

There are, however, places in which the changes, both implied and actual, are already taking place. The "open school," which most educators agree demands a greater complement of instructional technology simply because its curriculum is more individually-oriented, is actually operating. For example, the Nova High School of Broward County, Florida, started in 1963 with more experimental concepts and facilities than any other school in the country. Nova was almost totally equipped with the latest forms of instructional technology. Now Broward County has modeled 25 of its schools on the original Nova plan, which its board of education judged eminently successful, and is investing heavily in individualized education. Its administrators, however, do not wish to release cost-effectiveness data. They prefer instead to give instructional technology an

unqualified vote of confidence on the basis of its use as a motivational factor; obviously, a highly elusive (though crucial) component of the educational process.*

Caveats

Despite the optimism reported by managers of computer-assisted instruction projects, it should be borne in mind that many factors still limit computer applications in education and dramatic cost-reductions and/or effectiveness.

For example, Dr. Anthony G. Oettinger, Professor of Linguistics at Harvard University, says in Run, Computer Run that some specific criticisms can be leveled at "the vision" of a cost-effective, centralized, instructional technology. He goes on to say:

> What, for example, guarantees that such a system could work in practice as well as in principle?
>
> Where, indeed, do the teachers come from? What degree of contact can remain between really good, sensitive teachers and the students when the machines frequently know more than the teacher? How can student-teacher training be pointed toward guidance in the creative arts and laboratory work? And what about the transitional problem of re-educating teachers of the old school?
>
> The teacher ... would have to move freely between the abstract and the concrete, a knack which all too few possess. Hence, in spite of the high degree of automation of the visionary system, there might not be enough talent to start it. The vision implicitly assumes that teachers will be able to guide students from all walks of life and levels of competence.

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* Personal interview with Dr. Julian Biller, Research Associate, Division of Research, Broward County School System, Florida, July 12, 1971.

> If this ideal is unattainable, it would quickly seem more efficient to group students by ability for clustering around an appropriate advisor. Thus, grading and lockstep would be reinvented.
>
> The new system might overcome the current great importance of factors of birth in determining which students receive higher education but it might also leave far behind the student without intellectual potential. The natural elitism of the educated might therefore be sharpened.

Dr. Oettinger then states:

> It seems likely that any partial step toward the vision would be based on an evaluation of the educational system and of the economics of computers, communications, and so on, as they are now. It should be clear that the prospect of a system which might radically alter patterns of book distribution and hence the stability of the book trade would lead to a reaction that might alter the assumption on which original plans are based so significantly as to preclude their rational implementation.*

Some of Dr. Oettinger's questions are already being answered. Some school systems have initiated on-the-job teacher training programs to re-educate traditionally-oriented instructors in the new techniques. Others are using instructional technology to give students direct training in the creative arts and laboratory work. But most of his questions are extremely difficult to answer, and his list of implied criticisms is by no means all inclusive.

For example, drill and practice -- one of computer-aided instruction's greatest assets at this point -- is usually a supplementary activity. Its costs will, in large measure, be

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* Anthony C. Oettinger, Run, Computer Run, (New York: Collier Books, 1971), pp. 11, 12, 13.

added to education's current instructional costs. The use of the computer in assuming a full instructional burden in areas less precise than that of remedial mathematics is still very limited.

Furthermore, computer technology and program design have yet to cope with the almost infinite branching possibilities that more sophisticated learning objectives would require.

Computer programming is still the privilege of a very few. If planners wished a system that would allow easy access for as diverse a group of authors as those who now write or lecture, Kopstein and Seidel's 1967 warning would still apply today: "The informational requirements would outstrip any sort of improvement that we could make in the instructional model, and thus cause CAI to be completely unfeasible and highly inefficient as a means of instruction."* In other words, the diversity of styles and amount of information which the machine would have to accept, store and process would far exceed its powers.

Unless accurate data are available, instructional technology cannot bring accuracy to bear on the problems of education, and unless teachers can take advantage of the new media, they are useless.

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* Felix Kopstein and Robert Seidel, Computer-Administered Instruction Versus Traditionally Administered Instruction: Economies. Alexandria Virginia: George Washington University, Human Resources Research Office, April 1967, pp. 7-9.

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Moreover, current instructional technology design, beyond a few striking exceptions such as "Sesame Street," is not tapping the sources of creativity. Team teaching may help, by pooling human resources more effectively, but imagination is a scarce commodity, and will probably remain so.

Good program quality, flexible enough to meet the demands of each learner, is rare in current technologically-based projects. It is a necessary component of humanistic education, and cannot, indeed, dare not, be overlooked in learning designs.

The questions about effectiveness are myriad, and largely unexplored. For instance, are students' accelerated learning rates, so often cited by instructional technology exponents, merely the result of a medium's newness -- the much cited "Hawthorne Effect?" If a teacher is required to lock himself into a curriculum planned around instructional technology, how does he say, if the program doesn't call for it, "Let's skip Page 31 and go to Page 35?" How flexible can a media-oriented lesson plan become? These questions are vital enough to give us pause in the headlong dash to deal with the data explosion, and to bear in mind the fact that computer hardware is not usually designed especially to meet educational needs or to reduce educational costs. This situation was called to the attention of the Commission on Instructional Technology by Lawrence Parkus of Westinghouse Learning Corporation in a sobering and practical statement which says in part:

There is a rather widely held belief within the educational community -- by those who are involved in computer-assisted research and development as well as those who are users or potential users of the medium -- that the advancing state of the art of computer technology will significantly reduce the costs of computers and peripheral equipment. This belief reflects a serious misunderstanding of the computer industry and the nature of its major marketing thrust.*

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* Lawrence Parkus, "Computer-Assisted Instruction in Elementary/Secondary Education: The State of the Art." A paper submitted to the Commission on Instructional Technology. Reprinted in To Improve Learning, Vol. I, Sidney G. Tickton (ed.). (New York: R. R. Bowker & Company, 1970).

SUMMARY AND CONCLUDING NOTE

As a nation, we already own and are producing daily more instructional technology than most educators are equipped to apply effectively to learning. The data search for this study revealed a slowly awakening awareness of the gap between the separate development rates of technology and of education.

Few alterations seem to have been made in applications of the more conventional forms of instructional technology, such as relatively simple, add-on audio-visual aids. However, this study's inquiries did suggest that the more glamorous, complex, and initially expensive teaching tools, such as television and the computer, are beginning to gain acceptance in crucial areas chiefly because they show promise of cost effectiveness. This study also noted a deeper understanding and greater use of technology by a number of educators and a corresponding change in the emphasis of education -- from teaching to learning; and from mass instruction to the education of the individual.

The next step in the change is a closer relationship between learning and cost effectiveness in attaining it. Comparisons will not be easy to make because costs can be expected to vary widely depending on the amount of time a teacher invests in preparing a lesson, how much individual attention he gives to a student, and how much actual effort he expends on the instructional activity. However, when the emphasis changes from teaching to learning, the process can

be defined more clearly in terms of goals and strategies for achieving specific results. The cost and effectiveness of instructional technology then become identifiable factors, and the entire economic process assumes a much more easily quantifiable character.*

Here and there around the country, educators are coming to grips with this change. Public acceptance is another matter, however. The speed at which instructional technology is integrated into education depends on society's realization that traditional teaching is a creature of the Industrial Revolution, which has passed, and that a sharper focus on learning is an emphasis appropriate to the Technological Age in which we live. In order for society to accept instructional technology, it must also accept the shift in philosophical approach from a concentration on the needs of the teacher to the needs of the learner.

The technology itself offers few if any serious obstacles, Today technology is far ahead of our ability, or even our desire, to use it. But its development cannot be ignored. It must be employed as a device for controlling its own products. The human organism is no longer physically or mentally capable of performing that function for itself. Man must utilize the tools that he has developed to give him leverage on the products -- data alone are among the most oppressive fruits of man's industry. Man must understand that employment of these tools is his only effective method of survival and that mastery of them starts in the education of the young.

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* The experience of the Children's Television Workshop is an excellent example, as is that of Los Angeles County.

Along the way, there seems little chance that education can escape the necessity for placing itself on a businesslike footing, that it must become subject to the same cost-benefit relationship that controls industrial output, and that the computer will aid and encourage this change.

At the same time, since education deals with human beings, on an increasingly individual basis, it must, if it is to prepare them well, devote more attention to those variables that compose the unique personality, and in particular, its creative capacities.

Time and again, and dramatically so in the case of "Sesame Street," creative design demonstrated a high capacity for motivating learners. Creativity is education's magic wand; wherever it touches the human learning process, knowledge leaps forward, and instructional technology cannot succeed without it.

However, all of the new steps that will have to be taken will face many obstacles. The variables are great, quality is low, standards almost nonexistent, data gathering sporadic, the students involved too few, and generally accepted educational philosophy still too dedicated to outdated methodologies.

Moreover, says Andrew R. Molnar of the National Science Foundation, "While the concept of cost effectiveness is one analysis that can usefully be applied to the evaluation of media systems, it should

not be considered to be the only criterion for action, and because of its limitations, must be discriminately applied."*

There are several steps that can aid in the task at hand:

1. A concerted campaign of public education, partly through the continued use of favorable exposure, by means of such programs as "Sesame Street;" partly through emphasis on the individualization of education through instructional technology, rather than its dehumanization, and partly through direct parent involvement in education by various media.

2. Teacher training, along clearly media-oriented lines, in an effort to accustom teachers to the integration of instructional technology in curricula, and to overcome their reluctance to adapt its advantages to their specific goals. Teachers' colleges must also be encouraged to change their philosophical attitudes and emphasis from teaching to learning. On-the-job training could create an immediate cadre of teachers to begin using the technology and spreading their expertise. Several pilot programs are already engaged in this activity, but their graduates are too few.

3. A centralized gathering and retrieval system, designed to keep educators abreast of the latest developments in technology and learning process investigation, is a necessity. The present facilities are too scattered, and retrieval is a lengthy, bureaucratic, and cumbersome process that is often encumbered by technical jargon.

4. Central data banks, located at each school or school system, programmed to keep current and accurate reports of the testing and progress of individual students, for the purposes of evaluation. Such records, however, should not be regarded as totally representing the highly complex and variable emotional factors that often influence an individual's ability to learn.

5. The establishment of standards for cost and evaluation, and possibly the founding of a central data gathering

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* Andrew R. Molnar, "Media and Cost Effectiveness," Transactions, October 1970, Vol. II, No. 10, p. 297.

and retrieval system, cross-referenced with the literature bank, designed to absorb and disseminate cost-effectiveness information from as many education sources as possible.

6. The formation of regional groups or consortia of schools and school systems and media organizations for cost sharing of instructional media.

7. The devising of a system to present to the student and the teacher the widest possible range of literature and data, in order to avoid the dangers of homogeneity of subject matter and the suppression of material that might result from biased administrative influence.

8. The design of instructional media programs that are as clear, flexible, and non-technical as possible to enable the teachers who must implement them or integrate them into their lesson plans to take full advantage of their assets. What teachers do not understand, they will not use.

* * *

APPENDICES

APPENDIX A

Educators and Technology Specialists Interviewed or Contacted By the Academy During the Course of This Report

Mr. Robert Backer
Principal
Hauppauge Senior High School
Hauppauge, Long Island, New York

Mr. Julian Biller
Research Associate
Division of Research
Florida School System
Tallahassee, Florida

Mr. Donald Bitzer
Director, PLATO Project
University of Illinois
Urbana, Maryland

Dr. William M. Brish
Superintendent
Washington County Public Schools
Hagerstown, Maryland

Dr. Victor Bunderson
Director
Laboratory for Computer-Assisted Instruction
The University of Texas
Austin, Texas

Mr. Robert D. B. Carlysle
Director of Educational Projects
Corporation for Public Broadcasting
Washington, D.C.

Dr. Sylvia Charp
Director of Instructional Systems
School District of Philadelphia
Board of Education
Philadelphia, Pennsylvania

Dr. Thomas Clemens
Chief, Research Utilization Branch
Deputy Director, Division of Information Technology
U.S. Department of Health, Education and Welfare
Washington, D.C.

Mr. Edwin Cohen
Executive Director
National Instructional Television Center
Bloomington, Indiana

Dr. Donald Coombs
Director
ERIC Clearinghouse on Educational Media and Technology
Stanford University
Stanford, California

Mr. William T. Dale
Director, Instructional Services
National Association of Educational Broadcasters
Washington, D. C.

Mr. Robert Davidson
Director of Development
Children's Television Workshop
New York, New York

Mr. David Engler
Vice President
McGraw-Hill Company
New York, New York

Dr. Robert Filep
Vice President
Institute for Educational Development
El Segundo, California

Dr. Lee Franks
Executive Director, WHA-FM
University of Wisconsin
Madison, Wisconsin

Dr. Robert M. Gagne
Professor of Educational Research
Florida State University
Tallahassee, Florida

(continued)

Appendix A - Educators and Technology Specialists Interviewed or Contacted
(Page 2 - continued)

Dr. Lawrence Grayson
Acting Deputy Director
Division of Education
U.S. Office of Education
Washington, D.C.

Dr. Les Greenhill
Vice President
Pennsylvania State University
University Park, Pennsylvania

Mr. George Hall
Economist
The Rand Corporation
Santa Monica, California

Dr. Howard Hitchens
Executive Director
Division of Audio Visual Instruction
National Education Association
Washington, D.C.

Mr. Andrew Hook
Superintendent of Schools
Aurora, Illinois

Dr. Clara Howell
Coordinator, Development Division
Georgia State Department of Education
Athens, Georgia

Mr. Robert B. Hudson
Retired Senior Vice President
National Educational Television
New York, New York

Dr. Anna Hyer
Executive Secretary
Department of Audio Visual Instruction
National Education Association
Washington, D.C.

Dr. Claire Kenzler
Director of Radio Instruction
Wisconsin Educational Network
Madison, Wisconsin

Mr. Jonathan King
Vice President
Caudill, Rowlett & Scott
Houston, Texas

Dr. Felix Kopstein
Economist
HumRRO
Alexandria, Virginia

Mr. Mortimer Lockett
Specialist for Evaluation
Bureau of Navy Personnel
Washington, D.C.

Miss Harriet Lundgaard
Executive Director
Educational Media Council
Washington, D.C.

Mr. James Macandrew
Director of Broadcasting
New York City Board of Education
WNYE-FM/TV
Brooklyn, New York

Ms. Angela McDermott
ETV Consultant
Buffalo, New York

Mr. Michael Mèars
Director
The 21 Inch Classroom
Newton, Massachusetts

Dr. Andrew Molnar
Director
Computer Oriented Curricular Activities
Computer Innovation in Education Section
National Science Foundation
Washington, D.C.

Mr. John Montgomery
General Manager
KDPS-TV
Des Moines, Iowa

(continued)

Appendix A - Educators and Technology Specialists Interviewed or Contacted
(Page 3 - continued)

Mrs. Catherine Morgan
Acting Project Director
Montgomery County Public Schools
CAI Demonstration Project
Rockville, Maryland

Mr. Kenneth Nielsen
Assistant Superintendent for
Business
Temple City Unified School District
Temple City, California

Mr. Frank Norwood
Executive Secretary
Joint Council on Educational
Telecommunications
Washington, D.C.

Dr. Gabriel Ofiesh
Director of Educational Technology
Center for Educational Technology
Washington, D.C.

Mr. A. Frederick O'Neal
Director, Kansas City Public Schools
CAI Project and
Brigham Young Junior High School
CAI Lab
Kansas City, Missouri

Dr. P. Kevin O'Sullivan
Head, Training Department
National Audio Visual Association
Fairfax, Virginia

Mr. Edward L. Palmer
Vice President and Director of
Research
Children's Television Workshop
New York, New York

Mr. Lawrence Parkus
Manager of Visual Education
Westinghouse Learning Corporation
New York, New York

Dr. Philip Piele
Director
ERIC Clearinghouse on Educational
Administration
University of Oregon
Eugene, Oregon

Dr. Marvin Powell
Psychologist
University of Northern Illinois
Dekalb, Illinois

Dr. Julian Prince
Superintendent
Macomb Public Schools
Macomb, Mississippi

Mrs. Elinor Richardson
School TV Section
Los Angeles County Schools
Los Angeles, California

Dr. Robert Scanlon
Program Director, Individualized
Learning Program
Research for Better Schools, Inc.
Philadelphia, Pennsylvania

Dr. Paul H. Schupbach
Director
Great Plains Network ITV Library
Lincoln, Nebraska

Dr. Robert Seidel
Director, CAI Project
HumRRO
Alexandria, Virginia

Mrs. Rhea Sikes
School Services
WQED Channel 13
Pittsburgh, Pennsylvania

Mrs. Joyce Stern
Researcher
Office of Assistant Secretary
for Planning and Evaluation
Office of the Secreatry
U.S. Department of Health,
Education and Welfare
Washington, D.C.

Dr. Patrick Suppes
Professor of Philosophy and
Statistics
Stanford University
Stanford, California

(continued)

Appendix A - Educators and Technology Specialists Interviewed or Contacted

(Page 4 - continued)

Dr. Donald Thomas
Associate Director
Student Behavior Laboratories
University of Kansas
Manhattan, Kansas

Mr. Peter Wahl
Vice President
Westinghouse Learning Corporation
New York, New York

Dr. Harold Wigren
Associate Director, Division of
Educational Technology
National Education Association
Washington, D.C.

Dr. Karl Zinn
Center for Research on Learning
and Teaching
University of Michigan
Ann Arbor, Michigan

Educational Television Stations and Persons Contacted by
The Academy During the Preparation of This Report

Station	Location	Person Contacted
KBYU	Provo, Utah	Stephen Anderson, Manager, ITV
KCET	Los Angeles, (county), California	Mrs. Elinor Richardson, Consultant-in-Charge, Telecommunications, Division of Educational Media
KCET	Los Angeles, (city), California	Maynard Orme, Director of Educational Services
KCSM	San Mateo, California	Dr. Jacob H. Weins, General Manager and Director, College of the Air
KCTS	Seattle, Washington	June Dilworth, Director of School Services
KDIN	Des Moines, Iowa	James R. Craig, Director of Instruction
KERA	Dallas, Texas	Barry Wells, Program Manager, Head of ITV
KESD	Brookings, North Dakota	Dr. Ben C. Markland, Director of Educational Media, South Dakota State University
KETC	St. Louis, Missouri	Basil G. Murray, Director, School Services
KFME	Fargo, North Dakota	Donald J. Geiken, General Manager
KGTF	Agana, Guam	Daniel W. Smith, Director of Telecommunications
KHET	Honolulu, Hawaii	Dr. Lark D. Daniel, Director and General Manager
KIXE	Redding, California	J. Allen Larner, Director, Instructional TV
KLRN	Austin, Texas	Myrtle Boyce, Instructional Coordinator
KLVX	Las Vegas, Nevada	John Hill, ITV Specialist
KNME	Albuquerque, New Mexico	F. Claude Hempen, Director of Broadcasting and General Manager
KOET	Ogden, Utah	Nolan R. Taylor, Station Manager
KOKH	Oklahoma City, Oklahoma	Paul Ringler, Director of Broadcasting
KOAC	Corballis, Oregon	Barbara Cole, Instructional Television Specialist
KOAP	Portland, Oregon	
KPEC	Lakewood Center, Washington	J. Albert Brevik, Director of Television Education
KPTS	Wichita, Kansas	Lowell H. Duell, Director of ITV
KQED	San Francisco, California	Lawrence Smith, Director of Educational Services
KRMA	Denver, Colorado	Gerald J. Willsea, Director, Department of Radio-TV Activities
KSPS	Spokane, Washington	Neil S. Dressler, Instructional TV Coordinator

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Appendix B - Educational Television Stations and Persons Contacted
(Page 2 - continued)

Station	Location	Person Contacted
KTB	Miami, Florida	Angeline S. Welty, Director, Department of Educational Media
KTCA	St. Paul, Minnesota	Georg L. Arms, Director, School and Instruction Department
KTSD	Vermillion, South Dakota	Martin P. Busch, Director, Telecommunications
KTWU	Topeka, Kansas	Dottie Stafford, In-School Coordinator
KTXT	Lubbock, Texas	Ronald J. Salladay, Coordinator of Instruction
KUED	Salt Lake City, Utah	Byron J. Openshaw, Program Manager
KUHT	Houston, Texas	Maxine Ferris, Coordinator, GRETA
KUON	Lincoln, Nebraska	Richard R. Raecke, Network Education Coordinator
KVZK	Pago Pago, American Samoa	Grayson Gibbs, Station Manager
KWCS	Ogden, Utah	Ben Van Shaar, General Manager
KWSU	Pullman, Washington	Gordon Tuell, Local Manager, Washington State University
KYVE	Yakima, Washington	Frank E. Roberts, General Manager
WBGU	Bowling Green, Ohio	Mrs. Margaret Tucker, Director of In-School Television
WBRA	Roanoke, Virginia	E. Dana Cox, Jr., Vice President and General Manager
WCAE	St. John, Indiana	Lou Iaconnetti, Station Manager
WCBB	Lewiston, Maine	H. Odell Skinner, General Manager
WCET	Cincinnati, Ohio	Marjorie McKinney, Director, In-School TV Services
WCLP	Atlanta, Georgia	Max Wilson, Director of Instructional Television
WCNY	Syracuse, New York	Miss M.E. Nocera, Instructional Services Director
WCVE	Richmond, Virginia	Mary Anne Franklin, Instructional Program Director
WEBA	Columbia, South Carolina	Henry J. Cauthen, General Manage.
WEDB	Durham, New Hampshire	William A. Brady, Director of Instructional Services
WEHH	Hartford, Connecticut	Don Flight, Director of Instructional Services
WEDU	Tampa, Florida	James S. Tyrrell, Director of In-School Television
WETA	Washington, D.C.	Richard Pioli, Director, Educational Services
WETK	Winooski, Vermont	Francis C. Thompson, Jr., Director of In-School Utilization

(continued)

Appendix B - Educational Television Stations and Persons Contacted
(Page 3 - continued)

Station	Location	Person Contacted
WFSU	Tallahassee, Florida	Edward L. Herp, Director of Broadcasting
WGBH	Boston, Massachusetts	John Irving, Director of Educational Division
WGTE	Toledo, Ohio	Mrs. Helen Davis, General Manager
WHA	Madison, Wisconsin	Nancy McNamara, Manager of Instructional Services
WHRO	Norfolk, Virginia	Mrs. Grace Waters, Director of Instructional Television
WIPR	Hato Rey, Puerto Rico	Providencia Coca De Mendez, Director, School Programming
WJCT	Jacksonville, Florida	William Galbreath, Director of Instructional Television
WKLE	Lexington, Kentucky	Myra Burrus, Director of School Services
WLVT	Bethlehem, Pennsylvania	S.D. Siegel, General Manager
WMAA	Jackson, Mississippi	Fred L. Collum, Film Director
WMEB	Orono, Maine	Erik Van De Bogart, Director of Instructional Services
WMFE	Orlando, Florida	James Hendrickson, ITV Utilization Supervisor
WMHT	Schenectady, New York	Caleb Paine, Vice President
WMPB	Owings Mills, Maryland	Dr. Frederick Breitenfeld, Jr., Executive Director
WMSB	East Lansing, Michigan	Robert D. Page, Station Manager
WMVS-WMVT	Milwaukee, Wisconsin	Thomas Turner, Director, ITV Services
WNIN	Evansville, Indiana	Robert S. Edelman, Director of TV and Radio
WNMR	Marquette, Michigan	Dr. William G. Mitchell, Director of Learning Resources
WNET	New York, New York	Dr. Richard Meyer, Director, School Television Service
WNYE	Brooklyn, New Yrok	James F. Macandrew, Director of Broadcasting, General Manager
WOUB	Athens, Ohio	Laurence B. Stone, Director of Instructional Radio and TV
WPSX	University Park, Pennsylvania	William Barnhart, Executive Secretary, Allegheny Educational Broadcasting Council
WQED	Pittsburgh, Pennsylvania	Mrs. Rhea Sikes, Director of Educational Services
WQLN	Erie, Pennsylvania	Dick Ragan, Instructional Coordinator
WSBE	Providence, Rhode Island	Adrienne R. Dowling, Coordinator of Instructional TV
WSEC	Miami, Florida	Angeline S. Welty, Director, Department of Educational Media
WSIU	Carbondale, Illinois	Leonore High, Coordinator of In-School Programming

(continued)

Appendix B - Educational Television Stations and Persons Contacted
(Page 4 - continued)

Station	Location	Person Contacted
WSJK	Knoxville-Sneedville, Kentucky	Chester Hill, Coordinator, ETV and Radio
WSRE	Pensacola, Florida	Mrs. Judd Gatlin, Coordinator of ETV
WSWP	Beckley, West Virginia	James A. Ostby, Utilization Director
WTHS	Miami, Florida	Mrs. Angeline S. Welty, Director, Department of Educational Media
WTIU	Bloomington, Indiana	James D. Perry, Supervisor of Instructional TV
WTTW-WXXW	Chicago, Illinois	Dr. John W. Taylor, Executive Director
WTVS	Southfield, Michigan	John McArthur, Director of Instructional Services
WUFT	Gainesville, Florida	Dr. Kenneth A. Christiansen, Director of Television, Manager
WUHY	Philadelphia, Pennsylvania	Norman Marcus, Vice President, Programming & Production
WUSF	Tampa, Florida	Ken Stanton, Assistant Director, Division of Educational Resources
WVIA	Scranton, Pennsylvania	Jane Schautz, Director of Instructional Services
WVIZ	Cleveland, Ohio	Alan R. Stephenson, Assistant Manager
WVPT	Harrisonburg, Virginia	Rita H. Gentile, Director of Instructional Programming
WXXI	Rochester, New York	Geraldine McMullen, School Relations Director

APPENDIX C

Officials of State, County, and Outlying Area* Departments of Education Contacted by the Academy During the Preparation of This Report

State	Person Contacted**	Title
Alabama	Ernest Stone	Superintendent of Education
Alaska		Director of Instructional Services
American Samoa		Director of Education
Arizona	Ralph Ferguson	Director, Title III, NDEA Audiovisual Consultant
Arkansas	Curtis R. Swain	Associate Commissioner, Instructional Services
California	Harry J. Skelly	Chief, Audiovisual Education & School Library Service
Canal Zone	J. Weston Seaquist	Audiovisual Specialist
Colorado	W. Henry Cone	Assistant Commissioner, Instructional Services
Connecticut	Robert W. Stoughton	Director, Instructional Services
Delaware	Paul M. Hodgson	Assistant Superintendent Instructional Services
District of Columbia		Superintendent for Instructional Services
Florida	Mrs. Eloise Groover	Director, Educational Media
Georgia	H. Titus Singletary, Jr.	Associate Superintendent, Instructional Services
Guam	Richard G. Tennessen	Deputy Superintendent, Instruction
Hawaii	Arthur F. Mann	Assistant Superintendent Instructional Services
Idaho	V. Reid Bishop	Deputy Superintendent, Instructional Services

(continued)

See last page for footnotes

Appendix C - Officials of State, County, and Outlying Area* Departments of Education Contacted
(Page 2 - continued)

State	Person Contacted**	Title
Illinois	William Bealmer	Assistant Superintendent, Instruction
Indiana	Harold Negley	Assistant Superintendent, Instructional Services
Iowa	LeRoy N. Jensen	Assistant Superintendent, Instruction
Kansas	George C. Cleland	Assistant Commissioner, Instructional Services
Kentucky	Don C. Bale	Assistant Superintendent, Instruction
Louisiana	William F. Beyer, Jr.	Assistnat Superintendent, Curriculum & Instruction
Maine	Ray A. Cook	Assistant Commissioner, Instruction
Maryland	Frederick J. Brown, Jr.	Associate Superintendent, Instructional Services
Massachusetts		Associate Commissioner, Curriculum & Instruction
Michigan		Chief, Instructional Services
Minnesota	E. Raymond Peterson	Assistant Commissioner, Instruction
Mississippi	A.P. Bennett	Director, Instruction
Missouri	P.J. Newell, JR.	Assistant Commissioner, Instruction
Montana	Philip A. Ward, Jr.	Director, Instructional Services
Nebraska	LeRoy Ortigiesen	Assistant Commissioner, Instruction
Nevada	Robert Best	Associate Superintendent, Educational Services

(continued)

See last page for footnotes

Appendix C - Officials of State, County, and Outlying Area* Departments of Education Contacted
(Page 3 - continued)

State	Person Contacted**	Title
New Hampshire	Frank W. Brown	Chief, Instruction
New Jersey	Robert H. Seitzer	Assistant Commissioner, Curriculum & Instruction
New Mexico	Calloway Taulbee	Chairman, Instructional Services
New York	Bernard Haake	Assistant Commissioner, Instructional Services
North Carolina	Cora Paul Bomar	Director, Educational Media & Title II, ESEA
North Dakota	Richard H. Klein	Assistant Superintendent, Instruction
Ohio	Franklin B. Walter	Assistant Superintendent, Instruction
Oklahoma	Jake Smart	Assistant Superintendent & Director of Instruction
Oregon	Joy H. Gubser	Associate Superintendent, Elementary & Secondary Education
Pennsylvania	Nile D. Coon,	Director, Instructional Services
Puerto Rico	Jaime Gonzalez Carbo	Assistant Secretary, Academic Program
Rhode Island	Grace M. Glynn	Associate Commissioner Instructional Services
South Carolina	Charlie G. Williams	Deputy Superintendent, Instruction
South Dakota	Eidon E. Gran	Assistant Superintendent, Instructional Services
Tennessee	James R. Cannon	Coordinator, Instructional Materials & Related Services

(continued)

See last page for footnotes

Appendix C - Officials of State, County and Outlying Area* Departments of Education Contacted
(Page 4 - continued)

State	Person Contacted**	Title
Texas	L. Harlan Ford	Assistant Commissioner, Teacher Education & Instructional Services
Trust Territory of the Pacific Islands	Howard L. Kerstetter	Deputy Commissioner for Elementary & Secondary Education
Utah	LeRoy R. Lindeman	Administrator, Instructional Media
Vermont	Karlene V. Russell	Director, Instructional Services
Virginia	Samuel P. Johnson, Jr.	Director, Elementary & Special Education
Virgin Islands	Phillip A. Gerard	Commissioner of Education
Washington	Tom Welty	Administrator, Educational Communications Services
West Virginia	John T. St. Clair	Assistant Superintendent, Instruction & Curriculum
Wisconsin	Robert C. Van Raalet	Assistant Superintendent, Instructional Services
Wyoming	James L. Headlee	Chief, Instructional Services
West Virginia (selected County Superintendents of Schools)	Raymond S. Dispanet	Superintendent, Berkeley County
	Willis Hertig	Superintendent, Cabell County
	T.A. Lowery	Superintendent, Jefferson County
	Walter Snyder	Superintendent, Kanawha County
	Thomas B. Orr	Superintendent, Logan County
	T.J. Pearse	Superintendent, Marion County
	W.R. Cooke	Superintendent, Mercer County

(continued)

See last page for footnotes

Appendix C - Officials of State, County, and Outlying Area*
Departments of Education Contacted
(Page 5 - continued)

State	Person Contacted**	Title
West Virginia (selected County Superintendents of Schools)	Lawrence G. Derthick, Jr.	Superintendent, Monongalia County
	LeRoy Watt	Superintendent, Ohio County
	Dorsey C. Scott	Superintendent, Wetzel County
	E.S. Shannon	Superintendent, Wood County

*
American Samoa, Canal Zone, District of Columbia, Guam, Puerto Rico, Trust Territory of the Pacific Islands, Virgin Islands

**
Note: The persons listed are those to whom the questionnaire was sent. In many instances the questionnaire was returned by persons other than those listed.

APPENDIX D

Results of Poll of Educational Television Stations

Part I: In School Programs: Data on Number of Programs, Students, and Sources of Funds

Station Call Letters	Location	No. of Programs Per Week	Estimated Number of Students		Source of Funds (Percent)		
			K-6	7-12	School District	Station	Other
KCET	Los Angeles, California (city)	40	350,000	100,000	100%	0	0
KCET	Los Angeles, California (county)	38	304,000	34,290	100%	0	0
KCTS	Seattle, Washington	100	300,000	300	100%	0	0
KDIN-KIIN	Des Moines, Iowa	42	77,286	23,122	0	0	100%
KERA	Dallas, Texas	20	160,000	130,000	80%	20%	0
KESD	Brookings, South Dakota	15	25,000	5,000	0	55%	45%
KIXE	Redding, California	29	18,000	3,000	41%	18%	41%
KLVX	Las Vegas, Nevada	23	37,000	35,000	100%	0	0
KOAC	Portland, Oregon						
KOAP	Corvallis, Oregon	24	200,000		0	25%	75%
KOKH	Oklahoma City, Oklahoma	67	60,000+	15,000	100%	0	0
KQED	San Francisco, California	36	200,000	50,000	90%	0	10%
KTB	Miami, Florida	84	0	7,816	0	100%	0
KTWU	Topeka, Kansas	17+	17,000	1,000	28%	72%	0
KTXT	Lubbock, Texas	5	540±	-	55%	45%	0
KUZK	Pago Pago, American Samoa	380	5,080	2,942	0	100%	0
KWCS	Odgen, Utah	44	8,900	100	82%	0	18%
KWSU	Pullman, Washington	-	-	-	-	-	-
WCAE	St. John, Indiana	27	5,600	0	25%	50%	25%
WCNY	Syracuse, New York	40	86,358	31,858	68.7%	31.3%	0
WETK	Winooski, Vermont	33	62,000**		0	100%	0
WFSU	Tallahassee, Florida	5	-	0	0	80%	20%
WGBH	Boston, Massachusetts	86	600,000**		100%	0	0
WHA	Madison, Wisconsin	38	80,000	-	45%	55%	0
WHRO	Norfolk, Virginia	81	110,000	21,040	100%	0	0
WIPR	Hato Rey, Puerto Rico	25	c.125,000**		0	100%	0
WJCT	Jacksonville, Florida	64	295,000	12,500	100%	0	0
WKLE	Lexington, Kentucky	35	400,000	200,000	100%	0	0
WLVT	Allentown/Bethlehem Pennsylvania	35	50,000	40,000	40%	-	-
WMHT	Schnectady, New York	85	-	-	80%	20%	--
WMVS-MVT	Milwaukee, Wisconsin	45	88,058	66,866	100%	0	0
WNET	New York, New York	95	301,023	33,501	100%	0	0
WNIN	Evansville, Indiana	30	9,129	9,257	100%	0	0
WNMR	Marquette, Michigan	32	5,000	1,000	58%	42%	0
WNYE	New York, New York	71	420,000±	38,500	100%	0	0
WOUB	Ohio University, Athens, Ohio	40	18,000	2,000	2%	0	98%
WSEC	Miami, Florida	94	0	7,816	0	100%	0
WSWP	Beckley, West Virginia	26	c. 60,950*		40%	0	60%
WSJK	Knoxville-Sneedville, Tennessee	43	170,500	56,475	15%	85%	0
WTHS	Miami, Florida	105	50,701	0	15%	85%	0
WTTW-WXXW	Chicago, Illinois	107	c. 1,000,000*		100%	0	0
WUFT	Gainesville, Florida	23	4,500	1,500	100%	0	0
WCLP	8 state-owned stations, Atlanta, Georgia	38+	449,800	53,950	0	100%	0

* Combined figures for stations KOAP and KOAC; separate figures not available.

** Combined total; breakdown for K-6 and 7-12 not available.

APPENDIX D

Results of Poll of Educational Television Stations

Part II: In School Programs: Data on Costs

		Station Cost Per Week	Student Cost Per Week	Cost of Instruction Per Year	
				Increase	Saving
KCET	Los Angeles, California (city)	$ 2,000.00	$ .02	$250,000	$ -
KCET	Los Angeles, California (county)	0	.75	-	-
KCTS	Seattle, Washington	6,731.00	.022	-	yes*
KDIN-KIIN	Des Moines, Iowa	6,571.00	.04	-	-
KERA	Dallas, Texas	8,000.00	.70	-	-
KESD	Brookings, South Dakota	1,400.00	.04	-	-
KIXE	Redding, California	1,500.00	-	0	-
KLVX	Las Vegas, Nevada	-	-	yes*	-
KOAC	Portland, Oregon				
KOAP	Corvallis, Oregon	-	-	-	-
KOKH	Oklahoma City, Oklahoma	6,000.00	.19	-	1.5 million
KQED	San Francisco, California	4,200.00	.03	1.10**	-
KTB	Miami, Florida	1,260.00	.05	-	-
KTWU	Topeka, Kansas	57,000.00***	1.50***	-	-
KTXT	Lubbock, Texas	750.00	7.00	15,000	-
KUZK	Pago Pago, American Samoa	20,500.00	2.50	-	-
KWCS	Odgen, Utah	1,700.00	.19	-	-
KWSU	Pullman, Washington	-	-	-	-
WCAE	St. John, Indiana	2,700.00	.48	-	-
WCNY	Syracuse, New York	6,450.00	.05	0	yes*
WETK	Winooski, Vermont	5,635.00	.09	0	0
WFSU	Tallahassee, Florida	1,000.00	-	-	-
WGBH	Boston, Massachusetts	3,500.00	.006	-	-
WHA	Madison, Wisconsin	-	-	-	yes*
WHRO	Norfolk, Virginia	10,760.00	.08	8¢ per week	-
WIPR	Hato Rey, Puerto Rico	-	-	-	-
WJCT	Jacksonville, Florida	370,000.00***	.035	370,000	-
WKLE	Lexington, Kentucky	42,000.00	.06	-	-
WLVT	Allentown/Bethlehem, Pennsylvania	-	1.50***	-	-
WMHT	Schnectady, New York	5,000.00±	.07	-	-
WMVS-WMVT	Milwaukee, Wisconsin	0	.009	-	-
WNET	New York, New York	7,000,00	,02	-	-
WNIN	Evansville, Indiana	3,214.00	.17	-	-
WNMR	Marquette, Michigan	988.00	.24	1% of budget	0
WNYE	New York, New York	16,000.00	.035	-	-
WOUB	Ohio University, Athens, Ohio	74,000.00	.10	-	-
WSEC	Miami, Florida	22,256.00	.28	-	-
WSWP	Beckley, West Virginia	775.00	.063	18,000	-
WSJK	Knoxville-Sneedville, Tennessee	400,000.00	-	1.48**	-
WTHS	Miami, Florida	2,730.00	.05	-	-
WTTW-WXXW	Chicago, Illinois	110,000.00***	-	250,000	-
WUFT	Gainesville, Florida	300.00	.05	-	-
WCIP	8 state-owned stations, Atlanta, Georgia	49,000.00	.08±	-	-
	Average		.43		

* Amount of increase/saving in cost of instruction per year not indicated.

** Per student cost

*** Yearly cost

APPENDIX D

Results of Poll of Educational Television Stations

Part III: Out of School Programs: Data Available

TV Station Call Letters	TV Station Location	SESAME STREET: Percent of Preschoolers in Station Area Who Are Regular Viewers	SESAME STREET: Program Most Popular in: Advantaged Areas	Average Areas	Disadvantaged Areas	SESAME STREET: Preschool Organizations* Receiving: Number	Percent of Total	ACCREDITED AREA HIGH SCHOOL EQUIVALENCY PROGRAM: Yes	No
KUZK	Pago Pago, American Samoa	-							
KCET	Los Angeles (city)	70 - 75%		X		1,000+	-		X
KCET	Los Angeles (county)	-							X
KIXE	Redding, California	70%+	No estimate - equally popular			60	40%		X
KQED	San Francisco	40%			X	300	50%		X
WUFT	Gainsville, Florida	-							X
WJCT	Jacksonville, Florida	50%+	X**			-	10%		X
KTB	Miami, Florida	Not applicable -	secondary level only						
WSEC	Miami, Florida	Not applicable -	secondary programs only					X	
WTHS	Miami, Florida	-		X		100	25%	Elementary only.	
WFSU	Tallahasse, Florida	-		X		14	50%		X
***	Atlanta, Georgia	-						X	
WTTW) WXXW)	Chicago, Illinois	-				1,000	-		X
WNIN	Evansville, Indiana	High		X				-	X
KDIN) KIIN)	Des Moines, Indiana	-						X	
WCAE	St. John, Indiana	80%		X		Most			X
KTWU	Topeka, Kansas	-							
WKLE	Lexington, Kentucky	-	X			00		X	
WCBB	Lewiston, Maine	-							
WGBH	Boston, Massachusetts	60%			X	1,200	75%		X
WNMR	Marquette, Michigan	-	No estimate - equally popular			43	70%		X
KLVX	Las Vegas, Nevada	-	No estimate - equally popular			23	100%		X
WNET	New York, New York	-		X					X
WMHT	Schenectady, New York	-	No estimate - equally popular			140	75%		X
WCNY	Syracuse, New York	-							X
WOUB	Athens, Ohio	-							X
KOKH	Oklahoma City, Oklahoma	High	No estimate - equally popular			Most	80%		X
KOAP	Corvallis, Oregon	-		X		-			X
WLVT	Allentown/Bethlehem, Pa.	75%	X			15	50%		X
WIPR	Hato Rey, Puerto Rico	-							X
KESD	Brookings, South Dakota	50% (est)							X
WKNO) WJJT) WSJK)	Nashville, Tennessee	High		X		-			X
KERA	Dallas, Texas	92%			X	400	85%		X
KTXT	Lubbock, Texas	-	X	X					X
KWCS	Ogden, Utah	90%	No estimate - equally popular			50+	100%		X
WETK	Winooski, Vermont	50%			X	-	50%		X
WHRO	Norfolk, Virginia	-	X			-			X
KWSU	Pullman, Washington	95%		X		101			X
KCTS	Seattle, Washington	75 - 80%		X		50	50%		X
WSWP	Beckley, West Virginia	-		X		-			X
WHA	Madison, Wisconsin	-		X		125	39%		X
WMVS) WMVT)	Milwaukee, Wisconsin	30%			X	150-200+	-	X	

* Including day care centers, nursery schools, kindergartens, community centers, church groups, mother's groups

** Based on community reaction (letters, phone calls to station)

*** Includes 8 state owned stations and 2 affiliated stations

APPENDIX E

Results of Poll of Schools and School Programs

Part I: Students and Instructional Costs

School System	Location	Grades K-6			Grades 7-12		
		Number of Students Enrolled	Year	Instruction Cost per Student/year	Number of Students Enrolled	Year	Instruction Cost per Student/year
State							
District of Columbia School System	Washington, D.C.	88,272	70-71	$ 1,117.00	51,761	70-71	$1,117.00
Florida State Department of Education	Tallahassee, Florida	694,536	69-70	728.20	580,257	69-70	-
Iowa State Department of Public Instruction	Des Moines, Iowa	-	-	-	-	-	-
Kentucky State Department of Education	Frankfort, Kentucky	393,566	70-71	309.00	319,775	70-71	309.00
Louisiana Department of Education	Baton Rouge, Louisiana	884,469*	69-70	578.35	-	-	-
Massachusetts Department of Education	Woburn, Massachusetts	-	-	-	-	-	-
New Hampshire State Department of Education	Concord, New Hampshire	-	-	-	-	-	-
State of Oklahoma School System	Oklahoma City, Oklahoma	-	-	-	-	-	-
Oregon Board of Education	Salem, Oregon	258,697	70-71	-	243,116	70-71	-
Pennsylvania Board of Education	Harrisburg, Pennsylvania	1,264,247	69-70	586.96	1,099,570	69-70	783.56
Utah State Board of Education	Salt Lake City, Utah	165,492	70-71	588.00	138,510	70-71	588.00
Local and County							
Bozeman Public Schools	Bozeman, Montana	2,314**	70-71	670.00	1,954	70-71	778.00
Fort Benton School System	Fort Benton, Montana	385	70-71	685.00	425	70-71	830.00
Ladue School District	St. Louis County Missouri	2,875	70-71	1,000.00	3,123	70-71	1,200.00
Livingston School System	Livingston, Montana	989	70-71	870.00	1,110	70-71	989.00
Lordstown Local School System	Warren, Ohio	350	70-71	988.00+	250	70-71	988.00+
Marion County Board of Education	Fairmont, West Virginia	5,392	70-71	500.00	700	70-71	-
Missoula County High School	Missoula, Missouri	-	-	-	3,800**	70-71	725.00
Monongalia School System	Morgantown, West Virginia	5,772	70-71	688.41	4,953	70-71	486.78
Parma Public School System	Parma, Ohio	350	70-71	10.00	-	-	-
St. Louis Area School System	St. Louis County, Missouri	230,000	70-71	650.00	100,000	70-71	800.00
Wetzel School System	New Martinsville, West Virginia	2,460	70-71	500.00	2,500	70-71	500.00
Average				$ 618.28***			$ 859.51**

* Total, Grades K-12.

** Figures represent grades K-8 and 9-12, respectively.

*** National Average, Grades K-12 was $673.80 for 1969-70. Orlando F. Furno and James E. Doherty, "Cost of Education Index 1969-70," School Management, January 1970, p. 42.

APPENDIX E

Results of Poll of Students and School Programs

Part II: Direct Instruction

School or School System	Location	Percent of Students in School System Receiving Direct Instruction				Annual Cost Per Student			
		ETV	Radio	Computer	Programmed Books	ETV	Radio	Computer	Programmed Books
State									
District of Columbia School System	Washington, D.C.	11%	-	.4%	13%	-	-	-	-
Florida State Department of Education	Tallahassee, Florida	-	-	-	-	-	-	-	-
Iowa State Department of Public Instruction	Des Moines, Iowa	27%	-	-	-	$ 1.30	-	-	-
Kentucky State Department of Education	Frankfort, Kentucky	-	-	-	-	-	-	-	-
Louisiana Department of Education	Baton Rouge, Louisiana	-	-	-	-	-	-	-	-
Massachusetts Department of Education	Woburn, Massachusetts	-	-	-	-	-	-	-	-
New Hampshire State Department of Education	Concord, New Hampshire	40%	-	2%	-	$ .48	-	$70-90	-
State of Oklahoma School System	Oklahoma City, Oklahoma	-	-	-	-	-	-	-	-
Oregon Board of Education	Salem, Oregon	-	-	-	-	-	-	-	-
Pennsylvania Board of Education	Harrisburg, Pennsylvania	1%	0%	0%	0%	$ 1.00	-	-	-
Utah State Board of Education	Salt Lake City, Utah	10%	0%	0%	-	$15.00	$ 0	-	-
County and Local									
Bozeman Public Schools	Bozeman, Montana	0%	0%	0%	0%	$ 0	$ 0	$ 0	$ 0
Fort Benton School System	Fort Benton, Montana	-	-	-	25%	-	-	-	$300
Ladue School District	St. Louis, Missouri	-	-		-	-	-	-	-
Livingston School System	Livingston, Montana	-	-	-	1%	-	-	-	$150
Lordstown Local School System	Warren, Ohio	-	50%	20%	40%	-	$50	$83	$10
Marion County Board of Education	Fairmont, West Virginia	100%	-	-	-	$ .35	-	-	-
Missoula County High School	Missoula, Missouri	-	-	-	5%	-	-	-	$10
Monongalia School System	Morgantown, West Virginia	-	10%	-	-	-	-	-	-
Parma Public School System	Parma, Ohio	-	-	-	100%	-	-	-	$10
St. Louis Area School System	St. Louis, Missouri	90%	10%	0%	0%	$ 1.15	$ .50	-	-
Wetzel School System	New Martinsville, West Virginia	5%	-	0%	-	neg.	-	-	-

* Note: The school questionnaire requested figures on the savings on additional costs incurred in using technology for instruction, but none of the systems were able to report this information.

APPENDIX E

Results of Poll of Schools and School Programs

Part III: Supplemental Instruction

School or School System	Location	Percent of Students in School System Receiving Supplemental Instruction					Annual Cost Per Student				
		ETV	Radio	Audio-Visual Aids	Computer Managed Instruction	Programmed Books	ETV	Radio	Audio-Visual Aids	Computer Managed Instruction	Programmed Books
State											
District of Columbia School System	Washington, D.C.	10.98%	-	52.47%	.16%	7.7%	-	$3.15	-	-	-
Florida State Department of Education	Tallahassee, Florida	-	-	-	-	-	-	-	-	-	-
Iowa State Deparment of Public Instruction	Des Moines, Iowa	27%	-	-	-	0%	$1.30	-	-	-	-
Kentucky State Department of Education	Frankfort, Kentucky	45%	-	100%	-	-	$3	-	$ .70	-	-
Louisiana Department of Education	Baton Rouge, Louisiana	-	-	-	-	-	-	-	-	-	-
Massachusetts Department of Education	Woburn, Massachusetts	-	-	-	-	-	-	-	-	-	-
New Hampshire State Department of Education	Concord, New Hampshire	-	-	-	-	-	-	-	-	-	-
State of Oklahoma School System	Oklahoma City, Oklahoma	-	-	-	-	-	-	-	-	-	-
Oregon Board of Education	Salem, Oregon	-	-	-	-	-	-	-	-	-	-
Pennsylvania Board of Education	Harrisburg, Pennsylvania	97%	-	100%	.01%	.01%	-	-	-	-	-
Utah State Board of Education	Salt Lake City, Utah	22%	0%	100%	1%	-	$15	$0	-	$35	-
County and Local											
Bozeman Public Schools	Bozeman, Montana	0%	0%	85-95%	0%	0%	-	-	$ .50	-	-
Fort Benton School System	Fort Benton, Montana	-	-	100%	-	-	-	-	$20	-	-
Ladue School District	St. Louis, Missouri	30%	-	100%	8%	min.	$6	-	$2	$11	min.
Livingston School System	Livingston, Montana	-	-	100%	-	10%	-	-	$7	-	$100
Lordstown Local School System	Warren, Ohio	60%	-	100%	100%	75%	$1.75	-	$6.70	$1.55	$5
Marion County Board of Education	Fairmont, West Virginia	85%	-	100%	0%	0%	$2	$0	$3.50	$0	$9
Missoula County High School	Missoula, Missouri	-	-	98%	-	-	-	-	$5	-	-
Monongalia School System	Morgantown, West Virginia	100%	10%	100%	-	-	$2	-	-	-	-
Parma Public School System	Parma, Ohio	-	-	100%	-	100%	-	-	$ .50	-	$10
St. Louis Area School System	St. Louis, Missouri	90%	10%	20%	0%	0%	$1.15	$ .50	$2.50	-	-
Wetzel School System	New Martinsville, West Virginia	5%	5%	100%	89%	-	-	-	$50.00	-	-

APPENDIX E

Results of Poll of Schools and School Programs

Part IV: Instructional Benefits of Technology

School or School System	Location	Superb	Excellent	Good	Minimal	None	No Response
State							
District of Columbia School System	Washington, D.C.			X			
Florida State Department of Education	Tallahassee, Florida						X
Iowa State Department of Public Instruction	Des Moines, Iowa						X
Kentucky State Department of Education	Frankfort, Kentucky			X			
Louisiana Department of Education	Baton Rouge, Louisiana						X
Massachusetts Department of Education	Woburn, Massachusetts						X
New Hampshire State Department of Education	Concord, New Hampshire			X			
State of Oklahoma School System	Oklahoma City, Oklahoma		X				
Oregon Board of Education	Salem, Oregon						X
Pennsylvania Board of Education	Harrisburg, Pennsylvania		X				
Utah State Board of Education	Salt Lake City, Utah		X				
County and Local							
Bozeman Public Schools	Bozeman, Montana		X				
Fort Benton School System	Fort Benton, Montana			X			
Ladue School District	St. Louis, Missouri			X			
Livingston School System	Livingston, Montana		X				
Lordstown Local School System	Warren, Ohio		X				
Marion County Board of Education	Fairmont, West Virginia			X			
Missoula County High School	Missoula, Missouri				X		
Monongalia School System	Morgantown, West Virginia			X			
Parma Public School System	Parma, Ohio		X				
St. Louis Area School System	St. Louis, Missouri	X					
Wetzel School System	New Martinsville, West Virginia			X			

APPENDIX E

Results of Poll of Schools and School Programs

Part V: Type of Technology Most Effective in Disadvantaged Schools

School or School System	Location	Audio Visual	CAI	CMI	ETV	Programmed Books	Radio	No Response
State								
District of Columbia School System	Washington, D.C.	X			X	X	X	
Florida State Department of Education	Tallahassee, Florida							X
Iowa State Department of Public Instruction	Des Moines, Iowa							X
Kentucky State Department of Education	Frankfort, Kentucky	X			X			
Louisiana Department of Education	Baton Rouge, Louisiana							X
Massachusetts Department of Education	Woburn, Massachusetts							X
New Hampshire State Department of Education	Concord, New Hampshire	X						
State of Oklahoma School System	Oklahoma City, Oklahoma	X						
Oregon Board of Education	Salem, Oregon							X
Pennsylvania Board of Education	Harrisburg, Pennsylvania	X						
Utah State Board of Education	Salt Lake City, Utah	X						
County and Local								
Bozeman Public Schools	Bozeman, Montana	X						
Fort Benton School System	Fort Benton, Montana	X						
Ladue School District	St. Louis, Missouri							X
Livingston School System	Livingston, Montana	X				X		
Lordstown Local School System	Warren, Ohio	X						
Marion County Board of Education	Fairmont, West Virginia	X			X			
Missoula County High School	Missoula, Missouri	X						
Monongalia School System	Morgantown, West Virginia	X			X			
Parma Public School System	Parma, Ohio	X						
St. Louis Area School System	St. Louis, Missouri				X			
Wetzel School System	New Martinsville, West Virginia	X		X	X		X	

* Some questionnaire respondents felt that several of the technologies listed on the questionnaire were equally effective; therefore in some instances, more than one item is marked.

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APPENDIX F

List of Books, Reports, Articles and Other Documents Examined During Preparation of the Report for the President's Commission on School Finance

Books

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APPENDIX G

Part I: Questionnaire Sent to Educational Television Stations

Station call letters_____ Location_____

This report submitted by_____Title_____

SCHOOL TELEVISION PROGRAM SERVICE

Number of instructional programs each week _____
Number of students viewing instructional programs each week
Grades K through 6 _____
Grades 7 through 12 _____

Weekly cost to station of instructional service: $_____
Weekly cost per student served: $_____

Sources of funds for station's instructional service:
Per cent from school districts served: _____%
Per cent from station budget: _____%
Per cent from other sources: _____%

Do ITV programs raise or lower the cost of instruction in school districts that support the station's instructional service?

How much increase? $_____ How much saving? $_____

The station's instructional programs are used by types of schools in the area in the following proportions:

Most advantaged schools: _____% Average schools: _____%

Disadvantaged schools: _____%

OUT OF SCHOOL PROGRAMS FOR CHILDREN AND YOUTH

Have you measured the penetration of Sesame Street in the station's coverage area? If so, what is your best estimate of the percentage of pre-school children who are regular viewers? _____%

Is Sesame Street more popular in (1) advantaged _____, (2) average _____, or (3) disadvantaged areas _____ covered by the station's signal?

How many day care centers, nursery schools, kindergartens, community centers, church groups, mothers' groups, etc., are receiving Sesame Street as a part of their regular activity? _____ What proportion of such area organizations does this figure represent?_____

Is the station offering an accredited high school equivalency program at any time during the year? Yes_____ No_____

If yes, please send us a curriculum outline showing the number of students enrolled and the number certificated.

IN GENERAL, HOW WOULD YOU DESCRIBE THE INSTRUCTIONAL BENEFITS DERIVED FROM YOUR STATION'S PROGRAMMING?

APPENDIX G

Part II: Questionnaire Sent to State, County, and Outlying Area Department of Education Contacts

SCHOOL SYSTEM_____ LOCATION_____

This report submitted by_____ Title_____

GRADES K THROUGH 6: No. of students enrolled_____(Year_ _____).
Annual instruction cost per student_____.
GRADES 7 THROUGH 12: No. of students enrolled_____(Year_____).
Annual instruction cost per student $_____.

DIRECT INSTRUCTION

TELEVISION provides direct instruction to_____ per cent of students.
Annual cost per student: $_____.
Added instructional cost: $_____; Instructional saving $_____.

RADIO provides direct instruction to _____. per cent of students.
Annual cost per student: $_____.
Added instructional cost: $_____; Instructional saving $_____.

COMPUTER assisted instruction is provided to _____ per cent of students.
Annual cost per student: $_____.
Added instructional cost: $_____; Instructional saving $_____.

PROGRAMMED BOOKS provide instruction to _____ per cent of students.
Annual cost per student: $_____.
Added instructional cost: $_____; Instructional saving $_____.

ENRICHMENT

ETV enriches instruction for_____ per cent of students.
Annual cost per student: $_____.

RADIO enriches instruction for_____ per cent of students.
Annual cost per student: $_____.

AUDIO-VISUAL AIDS enrich instruction for _____ per cent of students.
Annual cost per student: $_____.

COMPUTER MANAGED INSTRUCTION serves _____ per cent of students.
Annual cost per student: $_____.

PROGRAMMED BOOKS enrich instruction for _____ per cent of students.
Annual cost per student: $_____.

Please circle the kinds of technologies found most effective in serving students, in disadvantaged schools:

Television Computer Assisted Instruction Programmed Books
ETV Audio-Visual Aids Computer Managed Instruction Radio

IN GENERAL, HOW WOULD YOU ASSESS THE INSTRUCTIONAL BENEFITS DERIVED FROM TECHNOLOGY?

None Minimal Indifferent Good Excellent Superb

APPENDIX G

ACADEMY FOR EDUCATIONAL DEVELOPMENT, INC.
WASHINGTON OFFICE
1424 SIXTEENTH STREET, N.W.
WASHINGTON, D. C. 20036

AREA CODE 202 265-5576

Part III: Cover Letter Sent With Questionnaires to Educational Television Stations and Department of Education Contacts

Recently the President's Commission on School Finance asked us to prepare a paper on the question:

> Are the new technologies which are being utilized in education throughout the nation increasing or decreasing costs and are they worth it in terms of instructional effectiveness?

The paper needed is to go beyond the material assembled for the Commission on Instructional Technology two years ago and is to make:

1. A quick review of the status of:
   a. Educational television (including Sesame Street)
   b. Computer teaching techniques
   c. Audio-visual aids
   d. Other technological developments

2. An examination of actual results of these innovations:
   a. In "controlled" environment
   b. In disadvantaged schools
   c. In experimental schools

3. A determination of the effect on productivity, if any.

4. An assessment of the potential benefits and costs of technological innovations in education and their future implications.

We agreed with the President's Commission that the paper ought to be backed up by information from a relatively small number of people who are the most active and knowledgeable in the field; and who could provide us with current information on a limited number of the most important projects.

We are sending you the enclosed questionnaire, therefore, as a card of introduction. I would appreciate it greatly if, after looking this over, you would see what information you could provide us and then call my associate, Sherwood Kohn, collect at the number on the letterhead and tell him what the answers are, what information is available, and what isn't. This is a short assignment, and I am using this quickie approach to get as much information as I can with as little trouble to you as possible.

Many thanks for your assistance.

Sincerely,

Sidney G. Tickton
Executive Vice President and
formerly Executive Director,
Commission on Instructional
Technology

Enclosure

EXHIBITS

EXHIBIT 1

Cost Analysis Material Submitted by the
Los Angeles County School System

In response to the Academy's request for information on educational television in the Los Angeles County school system, Mrs. Elinor Richardson, Consultant-in-Charge of Telecommunications for the Los Angeles County Schools, submitted detailed reports and analyses of costs and effectiveness which proved extremely interesting. In effect, Mrs. Richardson's reply to the Academy's questionnaire showed what a large and populous school district could do in the way of "accountable" education. Some of the material is included on the following pages, in abbreviated form for the benefit of the interested reader.

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LOS ANGELES COUNTY'S REPLY TO AED QUESTIONNAIRE

Essentially, Mrs. Richardson's reply to the Academy for Educational Development made the following points. In many ways, the problems outlined below are representative of instructional technology's complexities throughout the country:

(1) The question "Do instructional programs raise or lower the cost of instruction in school districts that support the stations instructional service?" is a difficult, if not impossible, question to answer. In most districts costs for contracting for televisionservices are a budget line item. Therefore, they would appear to be an additional cost. It is obvious that many districts list them that way, because district participation has fallen off in the past few years. However, television programs provide kinds of lessons which districts are not providing as extensively, if at all, by traditional methods, a fact which emphasizes the importance of finding ways of determining what schools receive for money expended for television.

(2) In many districts that have dropped out of the television project because of financial cutbacks, teachers continue to use the television lessons. This is possible because the lessons are broadcast over an open channel. In these instances, teachers do not have access to all the study guide materials, but find ways of making the necessary adjustments.

(3) Ten years ago, the Office of the Los Angeles County Superintendent of Schools organized the Regional Educational Television Advisory Council (RETAC), made up of 60 school districts in Southern California. In 1966-67, ninety-six school districts participated. For the 1970-71 school year, the number dropped to fifty-four. Districts have dropped out of the television project, assuring RETAC that it is not lack of interest or need -- but finances. It is well known that contractual services are among the first items to be cut when finances become a problem, even though those services may be needed and used.

(4) During 1970-71, RETAC and the Los Angeles County Superintendent of Schools Office are providing over 800 television lessons to classrooms K-8 at an average cost of 75¢ per student. Carefully planned guides are written by subject matter specialists to accompany each lesson. A district showing an average daily attendance of 8,000 students will prepare as many as 1,900 television lesson study guides for teachers at all grade levels.

(5) RETAC also pays for air time to broadcast 111 Los Angeles City television lessons so that students will have the benefit of lessons which otherwise would be resting on the shelf unused.

(6) RETAC provides consultant services in television production, utilization of instructional television programs, system design, and evaluation; holds meetings and workshops for program development and production; reviews and evaluates instructional television materials, and coordinates instructional television activities for all districts in the seven-county area.

(7) RETAC provides television music lessons for every grade level. This service is one example of effective television use that saves school districts money. For example, for $6,000 an 8,000-student district can participate in RETAC and receive one music lesson each week in each of its 266 classes. It would take one traveling music teacher 6½ weeks to reach every class with a music lesson. Or to put it differently, it would take six full-time music teachers and one half-time teacher to provide one music lesson a week to every class in the district. The district's annual cost for 6½ music teachers would be $65,000. Television can provide the same number of music lessons for $6,000 and offer the district an additional 470 television lessons; with study guides, in other subject areas.

(8) In order to determine costs per student hour and lesson, Kopstein & Cave's formula has been used:

$$C = \frac{A}{sxl} \qquad C = \frac{A}{sxh}$$

A = all costs of the association

s = number of students

h = hours of instructional television broadcasting

l = number of different lessons (does not include repeats -- repeats are accounted for in the number of hours broadcast)

RETAC's budget for 1968-69 was $506,000. A balance of $134,049 was carried over to 1969-70, so the actual amount spent in 1968-69 was $471,951. Applying the formula to determine costs:

$$\text{cost/student-hour} = \frac{\$471,951}{320,579 \times 275} = \frac{\$471,951}{891,592,225} = \$.88529$$

$$\text{cost/lesson} = \frac{\$471,951}{320,579 \times 611} = \frac{\$471,951}{195,872,869} = \$.00261$$

Adding 10 percent to the total figure of RETAC's budget to cover the estimated costs of space, utilities, custodial services, and the like, and adding $29,000 for personnel, brings the total expenditures for RETAC for 1968-69 to $505,671. Again applying the formula:

$$\text{cost/student-hour} = \frac{\$505,671}{320,579 \times 275} = \frac{\$505,671}{89,159,225} = \$.00567$$

$$\text{cost/lesson} = \frac{\$505,671}{320,579 \times 611} = \frac{\$505,671}{195,872,869} = \$.00258$$

Obviously, there are not an equal number of students at each grade level or equal numbers of lessons or broadcast hours available for each grade level. On the basis of the figures available, however, the procedures described above approximate costs closely enough to indicate that the amount for each lesson or broadcast hours could be considered infinitesimal. By keeping more accurate figures of numbers of students at each grade level, associations could arrive at more precise figures for costs per student.

EXHIBIT 2

Notes on Cost-Effectiveness Model Users Manual Prepared for the U.S. Navy

(This exhibit, a condensed version of a cost-effectiveness guide prepared by the Institute for Educational Development of El Segundo, California, for the U. S. Navy, is included as a way of roughly determining the practicality of employing a computer-assisted instructional approach.)

Cost-Effectiveness Model Users Manual

In an attempt to provide a guide for potential users of computer-aided instruction, programmed instructional techniques and/or traditional methods of instruction, a "Cost-Effectiveness Model Users Manual" was prepared for the U.S. Navy in 1970 by the Institute for Educational Development of El Segundo, California. Essentially, the manual tries to outline criteria for defining "the cost of a program, its effectiveness (time required to train a student, average grades of students, etc.), efficiency (instruction time required per student, etc.), and benefits (improved operations due to better instruction, for example)."

In general, the authors of the manual concluded that "Traditional methods are to be preferred for 1 to 475 students, that Programmed Instruction is preferred for 476 to 4,249 students and that CAI is preferred when the number of students is 4,250 or more" over a five-year period of instruction.

"Another way of interpreting this," the manual continues, "is that at 475 students, the additional benefits provided by Programmed Instruction in comparison to traditional methods is just balanced by the additional cost of developing and implementing PI. Between 476 and 4,249 students, the additional benefits provided by CAI in comparison to PI are just equal to the additional cost of developing and implementing CAI. For 4,250 students and above, the benefits of using CAI exceed its costs."

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