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ABSTRACT

Analysis of the use of educational technology in public education reveals the following. First, technology is generally an added-on, teacher-dependent tool, although there is a trend to student-focused, individualized uses. Second, technology does not lead to increased learning, although it can offer advantages such as time savings and curricular enrichment. Third, educational technology is expensive and as long as student time in school is fixed independent of learning, less capital intensive approaches will be more cost effective. Finally, the activities of the Federal agencies are focused upon the newer technologies such as educational television, simulations, computer-assisted instruction and multimedia systems. Thus, it is evident that technology is not about to revolutionize education by radically lowering costs or increasing instructional effectiveness. There is a need for both the coordination of Federal activities in the area of educational technology and for greater dissemination of information about successful implementations. Finally, educational technology's hardware needs to be standardized and more attention should be paid to the use of technology for special applications and with special populations, rather than as a substitute for conventional instruction. (Author/PB)

TECHNOLOGY IN PUBLIC ELEMENTARY AND SECONDARY EDUCATION

A Policy Analysis Perspective

Research Report

EPRC 2158-3

Prepared for:

OFFICE OF THE ASSISTANT
SECRETARY FOR EDUCATION
DEPARTMENT OF HEALTH
EDUCATION AND WELFARE
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EDUCATIONAL POLICY RESEARCH CENTER

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GLOSSARY

ADA	average daily attendance
AECT	Association for Educational Communications and Technology
AIT	Agency for Instructional Television
B&W	black and white (monochrome) television
BEH	Bureau of Education for the Handicapped
BESE	Bureau of Elementary and Secondary Education
BSSR	Bureau of Social Science Research
CAI	computer assisted instruction
CBI	computer based instruction
CMP	Cresap, McCormick & Paget
CRT	cathode ray tube
CTV	cable television (an older abbreviation was CATV--community antenna television)
DDC	Defense Documentation Center
DoD	Department of Defense
EPIE	Educational Products Information Exchange
ERIC	Educational Research Information Clearinghouse
ETV	educational television
FCC	Federal Communications Commission
GLC	General Learning Corporation
HEW	Department of Health, Education, and Welfare
HumRRO	Human Resources Research Organization
ITFS	instructional television fixed service
ITV	instructional television
MPATI	Midwest Program on Airborne Television Instruction

NASA	National Aeronautics and Space Administration
NCES	National Center for Educational Statistics
NDEA	National Defense Education Act
NIH	National Institutes of Health
NIT	National Instructional Television
NSF	National Science Foundation
NTIS	National Technical Information Service
OE	Office of Education
PGIS	Projects and Grants Information System
PHS	Public Health Service
PLATO	programmed logic for automatic teaching operations
SF	sound-filmstrip
SIE	Smithsonion Science Information Exchange
SRA	Science Research Associates
SRI	Stanford Research Institute
SRS	Social and Rehabilitation Service
TICCIT	time-shared interactive computer-controlled information television
UHF	ultra high frequency
VA	Veterans Administration
VT	videotape
VTR	videotape recording

EXECUTIVE SUMMARY

This is a report of a policy analysis of educational technology in public elementary and secondary schools, conducted for the Education Division of the Department of Health, Education and Welfare. The analysis is intended to clarify a national debate of long-standing--What should be the role of technology in public elementary and secondary schools? Currently this debate is complicated by a thicket of more or less extravagant claims about the efficacy (or lack of it) of technology in the service of public education. This report is meant to be useful to policy makers and program planners in making more informed decisions concerning the federal role in the use of technology in public elementary and secondary schools.

The analysis was based almost entirely on secondary sources of information, including the literature, data archives, and conversations with authorities in the field. We were guided by a working definition that views educational technology as primarily consisting of instructional media. This definition is consistent with the one used in the report of the Commission on Instructional Technology, p. 21.[1*] We recognize that technology is more than just media, a point that is dealt with in Section I.

Four questions were addressed. Each question and a summary of the answer follows:

(1) How is education technology used in the schools?

Our analysis of utilization was based on a comparison of the definitive Godfrey[2] data in the early 1960s with data available on current usage. In the early 1960s, technology was used infrequently and almost always as an "add-on" at extra cost. The critical element in technology utilization was the teacher, and in the early 1960s the teacher was not using much. Current information, while provisional, suggests things are pretty much the same today. The teacher still determines to a great extent the utilization of the technology.

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*References are listed at the end of Section VI.

However, several trends were identified that distinguish current patterns of utilization from those ten years ago:

- Wider use of simpler devices suited for local production and student manipulation.
- Emphasis on technology tailored to the needs of individuals.
- More local school autonomy in curriculum and budgeting, leading to decentralized decisions regarding technology.

(2) How effective is the technology?

Virtually all of the research on the effectiveness of technology in education finds that technology is as effective in terms of standardized test scores as conventional instruction. The primary reasons for using technology (since it is almost always an added cost) are:

- Enrichment of courses where technology supplements the teacher; e.g., audiovisuals for art instruction.
- Saving time (not always desirable in a public school).
- Bringing instruction to remote areas.
- Adding subjects for which teachers are not available.
- Teaching technology; e.g., using computers to instruct in computer programming.

(3) How much does educational technology cost?

Systematic, detailed examinations of overall budgetary costs were undertaken for five representative types of media. Results indicated that at current prices, adding instructional media to the present program of a school can cost anywhere from \$0.05 per student-hour (for printed programmed instruction) to almost \$2.00 per student-hour (for computer based interactive instruction)--though this figure may drop significantly in the next several years. For comparison, conventional instruction, exclusive of buildings, administration, and custodial functions, costs about \$0.42/student-hour. With present knowledge and organization patterns of public education, even a zero-cost media system with no classroom or operating personnel might save a school system at most 11 percent of the total budget, and current uses of technologies would save considerably less, if anything at all. As long as student time in schools is fixed independent of learning, other less capital-intensive means of reducing costs, such as differentiated staffing and year-round schooling, appear more attractive than technology. If this situation were to change (at the secondary level, for example), another look at costs would be justified.

(4) What have been the federal R&D activities in the recent past in the field?

Most of the federal dollars have gone into R&D on the newer technologies: educational television, simulation, computer assisted instruction, and multimedia systems. The three federal agencies primarily involved in the field are the Department of Defense (DoD), the National Science Foundation (NSF), and the Office of Education (OE). The NSF devotes most of its funds to computer based instruction and to higher education. The DoD has a heavy investment in simulation. The OE invests in a wide range of technologies and forms of support, and targets more money than the other two to disadvantaged and handicapped audiences.

All the foregoing suggests that technology is not about to revolutionize traditional public elementary and secondary education, either by making it significantly more effective or by radically lowering costs. It seems likely that public schools will continue to be dominated by patterns of instruction sanctioned by generations of use. Large scale and effective use of technology will await fundamental changes in school organization that seem unlikely in the near future. The most promising uses of technology might be in areas outside the one that we have investigated, i.e., in higher education and in the education of special-need groups.

Finally, several recommendations are derived from the analysis:

(1) Claims about the power of technology to reform and improve public elementary and secondary education should be moderated and brought into accord with the limited knowledge of the subject.

(2) Initiatives taken by the Education Division should be formulated in the light of other federal activities. Investments in computer applications are an important case in point. Both DoD and NSF have made important gains in computer based instruction which should be built upon.

(3) The information about federal R&D projects in education is inadequate. Since this type of information is essential to policy evaluation and reformulation, steps should be taken to improve the appropriate federal information systems. The Project and Grants Information System (PGIS) is the Education Division's Computerized information system. This system is apparently inadequately financed and lacks the authority to obtain inputs from all sources.

(4) There is no recent systematic information concerning utilization of technology in public schools. Since coherent federal policy should depend heavily on such information, a utilization survey along the general lines of the Godfrey Study[3] of the early 1960s is a high priority.

(5) There is a need for some form of consumer (i.e., teacher) information on available materials (films in particular). Information is needed that would enable a user to identify materials suitable for a given instructional objective along with an evaluation of effectiveness. The Educational Products Information Exchange (EPIE) has made a valuable start in this direction for hardware. The Education Division should explore the dimensions of the demand for this type of information for software and means of supplying it.

A related problem is that hardware is often of poor quality and durability. Incompatibility is more the rule than the exception. The Education Division should analyze the interaction between the technology industries and public education with a view to encouraging improved quality and standardization. Examination of the incentives for industry to improve products and services seems a particularly high priority issue.

(6) Education Division technology R&D expenditures were targeted mostly on "normal"[4] populations in both fiscal years 1971 and 1972. This is inconsistent with the broad mandate for emphasis on the "disadvantaged" at the federal level. Analyses of these expenditures should be made to determine whether heavier investments in technology for special problem areas, especially the disadvantaged, are appropriate.

(7) Education Division policy should stress technology for special applications and not as a substitute for conventional instruction. There are a number of promising areas of special applications. These include:

- Intensive instruction for the disadvantaged.
- Technology for higher education.
- New opportunities in adult and continuing education.

There is not a sufficient basis in knowledge and experience to permit the development of an integrated federal policy on such special applications. The Education Division should explore these applications with a view to conducting policy analyses.

I INTRODUCTION

A recurrent theme in debates about American education is the potential role of technology in educational reform. Each new device, medium, or process that emerges is typically hailed as the solution to a variety of pressing educational problems. This pattern has been followed with film, radio, television, and the computer.

In recent years the severe financial problems of public education have led to a search for means of reducing costs. At the same time, a growing number of observers have been criticizing public education. It is not surprising in a period of such ferment that many have seen in technology a high potential for reform in general and, more specifically, a means of increasing productivity and improving the quality of education. This has led to what amounts to a national debate about the proper role of technology in education. There is no systematic body of evidence to inform this debate; hence, claims and counterclaims abound. Some see in technology the saviour of a severely malfunctioning educational system. Others see technology as a threat to a free democratic society. And in between are many more moderate positions and expectations. It is in this context that our analysis finds its basic meaning and purpose.

Objectives and Scope

One concrete objective of our work was to develop information useful to policymakers in the Education Division of HEW in understanding the basic issues involved in the debate. It is hoped that more informed decisions can be made based on this understanding concerning the federal role in educational technology.

As we proceeded with the analysis we reached agreement with staff members of the Education Division on several specific questions whose answers seemed most critical to an informed federal perspective.

These were: (1) How effective has the use of educational technology been in public elementary and secondary education? (2) How much does educational technology cost? (3) How is educational technology actually being used in public elementary and secondary education?

To provide, hopefully, some wisdom from the past, we also agreed to review recent federal R&D activities in educational technology. Through such a review we hoped to identify the major federal initiatives and the implicit or explicit theory behind those initiatives.

Method of Approach

Primary reliance was placed on secondary sources of data and information. Prominent among these sources were (1) the research literature, (2) various data archives and repositories (e.g., the Educational Resources Information Center), and (3) conversations with authorities in the field and with educators. As always, we found serious limitations in the available data. In many cases, it was simply impossible to reach any conclusions. In others, informed speculations seemed warranted. In still others firm conclusions were possible.

One of our early and most difficult methodological problems was to define educational technology. While there is currently no agreement on any single definition, there is fairly widespread acceptance of the idea that technology is more a system or a process than a collection of devices and associated programs. The preferred definition of the Commission on Instructional Technology embodies most of the elements of a system definition:

> It is 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 (Ref. 1, p. 21).

This definition avoids the problems inherent in viewing technology as simply a collection of devices. It allows for technology as an integral part of larger instructional programs, such as differentiated staffing, peer instruction, and parent involvement. It also allows for viewing instructional technology as a coherent entity, not the adding on of a hardware item here and there.

However, the systems definition has disadvantages as well. As the Commission on Instructional Technology points out, "In nearly every case, these media have entered education independently, and still operate more in isolation than in combination" (Ref. 1, p. 21). This means that educational technology as it is used in current practice is more educational media and their associated software than it is a systematic manner of creating and evaluating the entire teaching and learning process guided by objectives. Because technology is used in this way, the Commission adopted the following working definition of educational technology:

> In its more familiar sense, it means the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard. In general, the Commission's report follows this usage. In order to reflect present-day reality, the Commission has had to look at the pieces that make up instructional technology: television, films, overhead projectors, computers, and the other items of "hardware" and "software" (to use the convenient jargon that distinguishes machines from programs)--(Ref. 1, p. 21).

Howard Hitchens of the Association for Educational Communications and Technology (AECT) has more recently grappled with the problem of defining the field of educational technology. He endorses the systems definition and agrees that educational technology is more than just media. But, he also goes on to point out that the systems definition is having difficulty being born (Ref. 3, p. 3).

Our final resolution on the problem of defining educational technology was to adopt the working definition of the Commission on Instructional Technology, as noted above. This amounts to defining educational technology as essentially educational or instructional media.*

In the pages to follow, we briefly report our findings on these four major subjects:

- Effectiveness of educational technology in public elementary and secondary schools.
- Cost of using technology in public elementary and secondary instruction.
- Utilization of technology in public elementary and secondary schools.
- Inventory of recent federal R&D activities in educational technology.

The report concludes with a section entitled Summary Implications and Recommendations.

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*We are indebted to Howard Hitchens and James Wallington of AECT for guidance on this problem.

II EFFECTIVENESS

The examination of the effectiveness of educational technology was made in light of the larger question of the effectiveness of schooling as a whole. During this century, there has been much research on the effectiveness of schooling, but no definitive conclusions have been reached. No one pedagogical method has been shown to be measurably superior to all others. A RAND[4] review of the evidence on the effectiveness of schooling concluded that "Research has not yet identified a variant of the existing system that is consistently related to students' educational outcomes." A recent analysis by Jencks et al.,[5] reached much the same conclusion about effectiveness in the cognitive domain (as measured by test scores): "We see no evidence that either school administrators or educational experts know how to raise test scores. Certainly we do not know how to do so." Jamison et al[6] examined many studies dealing with the effect on educational outcomes of variables from class size to per-pupil expenditures to teacher attitudes. They conclude that "What does emerge from those studies, and from the tabular summary, is a striking lack of uniformity concerning the significance of various variables." Their overall conclusion is that "few variables consistently make a difference on student performance. ... This conclusion does not, however, imply that schools make no difference in the cognitive development of their students [emphasis theirs]. ... (However) it remains to be seen that variations in school inputs are consistently related to variations in school outputs." It is in the light of these conclusions about research on the effectiveness of schooling as a whole that we examine the effectiveness of educational technology.

The effectiveness of any educational practice can be evaluated against any of a variety of criteria, or goals of education. In this study, we confined our definition of effectiveness primarily to cognitive effectiveness as measured by standardized tests. To the extent that the literature contained studies of the noncognitive effects of technology in education, we looked also at this; however, this was restricted for the most part to studies on the attitudes of students and teachers toward the technology, and the effects on student motivation.

Due to limitations of time and resources, our study of the effectiveness of educational technology depended on summaries, overviews, and critiques of the existing research that have been conducted by others.

This means that we have not done a critical review of the many studies we looked at; rather, we have just taken our sources at face value. A more penetrating look at the research on educational technology might weigh more heavily the results of research determined to be of high quality (i.e., characterized by careful attention to experimental method, use of control groups, and so on). Such a study might also do an analysis of the quality and relevance of the software used in each experiment, and the effect of this on the learning outcome. Such analysis might well produce a different result than this study has.

The overall conclusion to which all of the overviews of the field came was that the use of educational technology has been shown to be as effective as conventional instruction. As William H. Allen[7] suggests, research demonstrates that people do learn from educational media and that this learning prevails under many different instructional conditions, with a variety of subject matter contents, and with all kinds of learners. Chu and Schramm[8] have arrived at essentially the same conclusion.

A comment is in order regarding the nature of the effectiveness research that has been done to date. Almost all of the research has followed one model: the comparison of one medium, such as film (not further specified), with conventional instruction (not further specified). The fact that this type of research does not uncover any consistent evidence about the superiority of any medium over conventional instruction is ascribed by most reviewers to the poor model of research that has been adopted. Allen (Ref. 7, p. 6) noted that this model was adopted some time ago, and

> Even though this research is of questionable value, the reasons for conducting such studies at the time (and their counterparts with television and programmed instruction in more recent times) are apparent: the educational establishment demanded proof of the effectiveness of these innovational techniques, and the baseline for comparison was clearly current teaching practices. As a consequence, the general perception of instructional media research even today is in these terms.

Bearing in mind the very limited generality of the results of most of the research, we turned to the studies of individual media. Rather than discuss at length the studies that have been done on each medium here, we present some of the major studies in Table 1. Each of the studies listed reviews one or more experiments comparing media with conventional instruction. For each study, the table shows the number of experimental cases where (1) the medium was shown to be significantly

Table 1

REPRESENTATIVE STUDIES ON MEDIA EFFECTIVENESS*

Medium	Number of Cases Where Medium Was More Effective than Conventional Instruction	Number of Cases with No Significant Difference in Effectiveness	Number of Cases Where Conventional Instruction Was More Effective than the Medium	Comment
Film (Hoban and Van Ormer)[9]	6	6	6	Especially effective for teaching concrete concepts
Radio (Wells)[10]	5	5	0	
Television				
(Pflieger and Kelley)[11]	119	637	44	
(Kelley)[12]	75	225†		
(Schramm)[13]	83	255	55	
(Dubin and Hedley)[14]	102	2	89	
(Schramm)[13]				
Elementary	50	86	16	
Secondary	30	85	26	
Higher	3	84	13	
(Chu and Schramm)[8]				
Elementary	10	50	4	
Secondary	24	82	16	
Higher/adult	29	176	30	
Programmed Instruction				
(Peterson)[15]	24	8†		
(Schramm)[16]	17	18	1	
(Silberman)[17]	9	6		Time saving in all cases
(Zoll)[18]	3	7	3	
(Lange)[19]	55	46	11	
(Wells)[10]	2	5		
Computer Assisted Instruction				
(Suppes and Morningstar)[20]	10	26	4	Significant time saving
(Weiner)[21]	3	2		
(Wells, Whelchel, and Jamison)[22]	3		1	

*A detailed discussion of these studies is included in Appendix A.

†Number of cases where medium was not more effective than conventional instruction.

more effective, (2) no significant difference was found, and (3) "conventional instruction" (as defined by each author) was shown to be significantly more effective. For more information on specific studies, see Appendix A.

One characteristic of the research that is obvious from the table is that results from different studies are not consistent. The overall result for all media except film is that no significant difference can be found from conventional instruction, but some studies did find that the medium was significantly more effective than conventional instruction; some also found that conventional instruction was significantly more effective than the technology. This variation in results is further complicated by the fact that few of the studies are easily replicable; although some efforts to replicate studies have succeeded, many more have failed.

One more interesting point illustrated by the table is that a greater percentage of the studies of the effectiveness of television showed a significant difference for elementary students than for secondary students. This is interesting, especially as it parallels the feelings of most teachers, students, and parents that television is a medium more appropriate to elementary education than to higher grades. For example, both the Santa Ana Unified School District in California and Hagerstown use TV almost exclusively for the lower grades, and though Hagerstown started out with a lot of televised instruction for high school and junior high, its use at those levels has sharply diminished in recent years.

In these studies, the things that have made the use of the technology more effective are the same things that make conventional instruction more effective: good organization of material, a practiced delivery, strong student motivation, integration of knowledge of the effects of the instruction into the teaching, rest pauses at appropriate times, and cues that direct pupils to those points essential to learn. There is no consistent evidence that making the media more sophisticated enhances effectiveness. For instance, for televised instruction, there is no consistent evidence that color, animation, humor, or dramatic rather than expository presentation improves effectiveness, although it does attract a larger audience--Sesame Street is a prime illustration of this.

Both programmed instruction and computer assisted instruction (CAI) have often demonstrated dramatic reductions of the student time required to complete a unit of instruction. This saving of time is not as useful to a school as it would be to industry, or to the military, where time is money, for public schools have a custodial function to perform that requires them to keep students in school and occupied for a certain number of hours a day and days a year. Although saving time may not save money, it can still be of use to schools. If a school were interested in expanding its curriculum, or adding options like work-study programs, for instance, this time saving might be significant and useful. Of course, adding to the curriculum often means the expenditure of more resources, so this might be more expensive for the school. It has also been suggested that this time savings means that these media are especially appropriate for remedial instruction, since they would allow children that are far behind to catch up before their contemporaries get too far ahead of them.

Table 1 summarizes the result of studies along cognitive dimensions. It is interesting to look at some of the noncognitive aspects of computer assisted instruction. Students felt that computers had greater expertise than teachers, and were clearer in their presentation of material and fairer in grading, since the computer graded only on task related items while teachers often graded on other items, such as behavior in the classroom.

The fact that the computer has been found to be more effective than teachers in certain dimensions, and that films have been more effective than verbal instructions in conveying certain kinds of concepts, suggests that if we could successfully match student characteristics, characteristics of the subject to be learned, and attributes of media, the media might be found to be consistently more effective. This thought has occurred to many educational researchers, and is the basis of the study of what is called Aptitude-Treatment Interaction. Allen (Ref. 7, pp. 11, 12, 14, 15) summarizes this research:

> The study of this three-way interaction of stimulus, task, and learner is extremely complex, but some evidence is building up that could lead to a more precise understanding of the place of media in the instructional process. ... The time is far off, if in fact it ever arrives, when we can identify an instructional problem and then faultlessly select the proper instructional mix to solve it. ... There is reason to expect that the present growing attention being given to the study of the unique attributes of instructional media and their relationships to the characteristics of the learner and the nature of the instructional task will be increased in the future. The folly of assigning generalized and all-inclusive attributes to specific classes of media (e.g., television, film, print, computer-assisted instruction) under all conditions is finally being appreciated, and we should observe more intensive research efforts to discover how to design and manipulate the media so

as to enhance their effectiveness under specific instructional conditions. Such research will occupy our attention for some time, leading to the evolution of taxonomies of unique media effects so that we can predict that the use of a particular instructional medium will lead to specified learning outcomes with different kinds of learners.

Until such research bears fruit, however, we are left with the body of research that has been done to date. Looking at this body of evidence, we cannot but conclude that we have no grounds for believing educational technology to be, on the whole, any more effective than conventional instruction. Thus, the only reasons for adopting such technology that are supported by the research are:

- To enrich courses. Pictures are often worth a thousand words. Art, for example, is made much more effective through audiovisuals.
- To save time. Under certain conditions more materials can be presented and learned in a shorter period of time with technology than with conventional instruction.
- To bring schooling to remote areas. Technology can bring schooling to remote areas that otherwise would not have access to it.
- To add subjects. Technology can add subjects to the curriculum for which teachers are not available.
- To teach technology. An obvious example is the use of computers to teach computer programming.

III BUDGETARY COSTS

The costs of instructional technology in the sense of the "things of learning"[23] or instructional media were reviewed to answer two questions: (1) what would each of several specific technologies cost a school district to use as an integral part of instruction? and (2) how much might the use of technology be expected to save a school district? The scope of these questions was confined to budgeting costs as opposed to the broader concept of social costs (e.g., the opportunity cost of student time spent in school). In order to answer each of these questions realistically, we made a detailed specification of the ways in which a school district would employ an educational technology--the number of pupil-hours per year that the technology is used, the number of subjects that are taught using the technology, the number of classrooms that would share the use of any piece of equipment, and, most importantly, the flexibility of scheduling needed to fit each medium into instructional procedures of schools.*

Present Budgetary Costs of Selected Instructional Technologies

The most natural source of budgetary cost estimates would be school district budgets. Unfortunately, the accounting and record-keeping systems of the nation's schools do not provide adequate cost information, since these systems are neither complete in themselves nor comparable across schools.[24] Cost estimates already available in the educational literature, on the other hand, vary widely both in dollar amounts and in the care and completeness with which they were determined. Some are ballpark estimates, offering only a very rough approximation of the cost per student-hour and including no description of the conditions under which they were obtained. A few sources supplied timely detailed and reasonably complete cost breakdowns, specifying prices for each piece of equipment, salaries of personnel, and operational and maintenance costs. For these few, costs per student-hour are calculated through a series of assumptions about every aspect of use: the expected life of hardware and courseware, the number of students that use it and over what periods of

*Thus explicitly, this study was oriented toward hypothetical reconstructions of public education around the use of different technologies.

time per day and per year, and so on. Between ballpark estimates and detailed cost breakdowns the literature contains figures of every degree of precision and detail in between. Furthermore, cost estimates can cover ranges of as much as 200 to 1, depending on the conditions of utilization.[25] These wide variations indicate that careful specification and detailed examination are necessary in developing meaningful cost estimates.

Obtaining comparability across different technologies, on the other hand, requires normalizing these estimates to a common set of assumptions about utilization. Unfortunately, few of the estimates in the literature provided sufficiently detailed descriptions of their derivation to make such normalization possible. Even those studies with enough detail may make arbitrary or unrealistic assumptions concerning patterns of use that cannot be corrected without altering the entire structure being examined. None of the studies or estimates found for instructional television, for example, gave adequate attention to the problems and costs of achieving flexibility in scheduling classroom use of the medium. Finally, no detailed cost studies using any set of assumptions could be located on the costs of several media receiving increased attention for individualized instruction--sound-filmstrip and computer based instruction, for example.

In summary, there was no detailed, complete set of estimates performed for a sufficient range of media, under common set of conditions, that could be summarized or readily updated to respond to the question posed by OE. As a result, the main effort of this study on costs had to be devoted to developing such a set of estimated from existing studies and articles, and conversations with media system and component suppliers and school district users.

The Technologies Examined

The limitations of time permitted studying only a few technologies in suitable depth. Those selected were (1) broadcast, cable and videocassette instructional television; (2) 16mm film; (3) programmed text; (4) computer based instruction; and (5) audio cassette sound-filmstrip. The first two media were considered for group instruction, the second two for individual instruction, and the last for both. The media examined, therefore, span four basic hardware technologies of widely varying complexity--print, audiovisual, television, and computer--and include both individual and group modes of presentation.

Component costs for each of these technologies were gathered from the sources mentioned previously, plus market reports, catalogs and equipment directories. Every effort was made to bring costs up to date and to include several different delivery systems for the major technologies (such as videocassette television systems), although reports from suppliers of expected sharp reductions in the cost of color television equipment caused us to concentrate on monochrome television in this study. The intent here was to describe the current cost situation rather than to forecast future developments. For computer based instruction this meant attention was paid to systems that have actually been employed in elementary and secondary schools for simple drill-and-practice and tutorial instruction, rather than the more advanced systems such as PLATO IV and TICCIT that are under development.[26,27] Neither costs nor patterns of utilization have been established for these systems in enough precision and detail to permit cost estimation on a comparable basis with the other technologies (media) considered.

Method of Approach*

In brief, for all the media examined, a set of common instructional tasks for each media system to perform and a set of environments (numbers of students and geographical areas containing them) over which to perform those tasks were defined. Three instructional tasks were chosen to cover different intensities with which a medium might be used. Tasks are expressed in terms of an average number of contact minutes (per student) with a media system per week or per day. The values selected were 20 minutes per week, 20 minutes per day, and 60 minutes per day. This dimension is called the intensity of media use. The 20-minute unit was chosen because it approximates the average length of films and is reasonable for other media.

To limit the size of the modeling effort, the number of environments was limited to four, designated Local District I, Local District II, City, and Metro:

(1) Local District I--An ex-urban local district of 10,000 students spread over an irregularly shaped 53 square miles in ten elementary schools and three secondary schools.

(2) Local District II--A suburban district or pair of districts having 30,000 pupils in a rectangular area of 50 square miles housed in 34 elementary schools and seven secondary schools.

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*The basic framework of analysis is an extension of that employed by the OE-sponsored General Learning Corporation study of 1968.[28] More details on methodology are included in Appendix B.

(3) City--A city-wide district or consortium of districts having 150,000 pupils over a rectangular area of 70 square miles, housed in 169 elementary schools and 35 secondary schools.

(4) Metro--A metropolitan area consortium of districts having 600,000 students contained in an irregularly shaped area of 1,500 square miles in 677 elementary schools and 139 secondary schools.

The dimension described in the above categories is called the <u>extensiveness</u> of media use. These specifications of <u>intensiveness</u> and <u>extensiveness</u> cover a sufficiently broad range to permit examination of different media systems over the same but widely varying set of circumstances.

So that the cost estimates incorporate all factors for which school districts must realistically budget in the adoption and effective use of media instructional systems, each element of cost was categorized as direct or support, and estimated separately. They were then cross-categorized as either one-time costs (applicable to items having a useful life of more than a year) or recurrent costs (items used up within a year, or purchased annually).[29] Initial planning, administration, and testing and evaluation for system improvement compose the support costs. The direct cost elements included were:

Initial teacher and administrator training

Facilities

Initial equipment and courseware

Operation of equipment

Maintenance of equipment and facilities

Continuing teacher planning and training

Related classroom materials for planning and scheduling.

To compare instructional systems having different proportions of one-time and recurrent costs, each one-time cost was amortized over its useful lifes* at 10 percent interest and added to the costs to form an

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*In general, the life of locally produced courseware was taken to be three years, purchased courseware and some equipment five years, other equipment ten years, and buildings 25 years. Each media system was assumed to be used for ten years with the exception of computer based instruction where rapid technological advance was assumed to render current systems obsolete in five years. Annual costs were then derived from these values.

equivalent annual cost. The resulting single figures can then be examined across technologies and across changes in intensiveness and extensiveness of use.

The cost figures obtained reflect the purchase of all hardware and the purchase or (for television and computer-based systems) the lease of all courseware needed by the school district or consortium of districts to implement a technology. Thus the figures represent full costs, the costs of starting from zero inventory, rather than the incremental costs of adding to whatever inventory of equipment, materials, facilities, and specific training that the school district(s) might already possess. For the audiovisual media and programmed text those inventories can be substantial, although some of the material might be obsolete or in bad repair and thus not suitable for regular use in instruction.

The costs of classroom personnel (other than training costs) are not included as instructional systems costs, because deployment of classroom personnel is quite flexible and not closely coupled to the technology in use. Indeed, various technologies may be used as elements of a given team teaching or differentiated staffing plan that reduces instructional staff costs. However, one would be hard put to determine how essential the technologies alone are to such a plan. Instead, the consideration of how much media instructional systems might save a district will deal with straight substitution of media instruction for classroom teachers, the most radical use contemplated, with differentiated staffing (possibly involving media use) viewed as an alternative approach. Meanwhile, estimates obtained in this part of the study essentially represent the costs of adding each system to present school expenditures.

Some Caveats on the Present Methodology

The patterns of utilization for every technology are specified on the common basis of full integration into each school's curriculum as a means of direct instruction rather than as a supplement to traditional activities. This is not necessarily the way each is used, and this specification can have a significant impact on costs per student-hour. Thus 16mm film is represented, not in its usual role as a medium on call by each teacher for supplementation, but as a means of direct instruction used by many schools simultaneously during a given period each year. Integration into the curriculum is represented by the requirement that each film title be seen at the appropriate point of the school year by all intended student viewers in all schools during a single three-week period of instructional relevance. During the rest of the school year the film is unused. Most of the costs reported here for 16mm film are a result of the large number of prints of each title that are required to fulfill this task in this fashion. This is the most extreme example of the impact of scheduling and the role of technology on its costs, but the lesson it teaches about the need for careful specification and full explanation of procedures extends to all other technologies considered. For this reason, Appendix B contains a complete explication of the methodology, and the design specifications for each technology (including the several television and computer based systems examined).

One additional general point is that the estimates for the life of the courseware used in each system (three years for internally produced courseware, five years for courseware from commercial or nonprofit national sources) reflects the time that the materials could be expected to be "current" in terms of curriculum revision and pedagogical quality in a district. These figures do not reflect the time that it actually might be physically possible to use the courseware without regard to instructional utility (e.g., films tend to become obsolete before they are worn out).

Both these caveats reflect the consequences of the choice made in this study to obtain costs for technologies used as integral, constantly updated direct instructional delivery systems that could potentially substitute for teachers. The study of the costs of audiovisual aides, occasional television use, or small-scale, less frequently updated instructional materials might obtain different results, but these latter could not be extrapolated to the higher intensities of use or integral instructional roles considered here.

Results of the Calculations*

The direct costs for each technology are shown in the bar charts of Figures 1 and 2. These charts allow the reader to see how economies of scale depend on student user population (extensiveness of use) and on minutes per day of instruction (intensiveness of use). Each bar shows an aggregate of production, distribution, presentation, and support costs, as indicated by the letters *P*, *D*, *R*, and *S*; the total height of a bar

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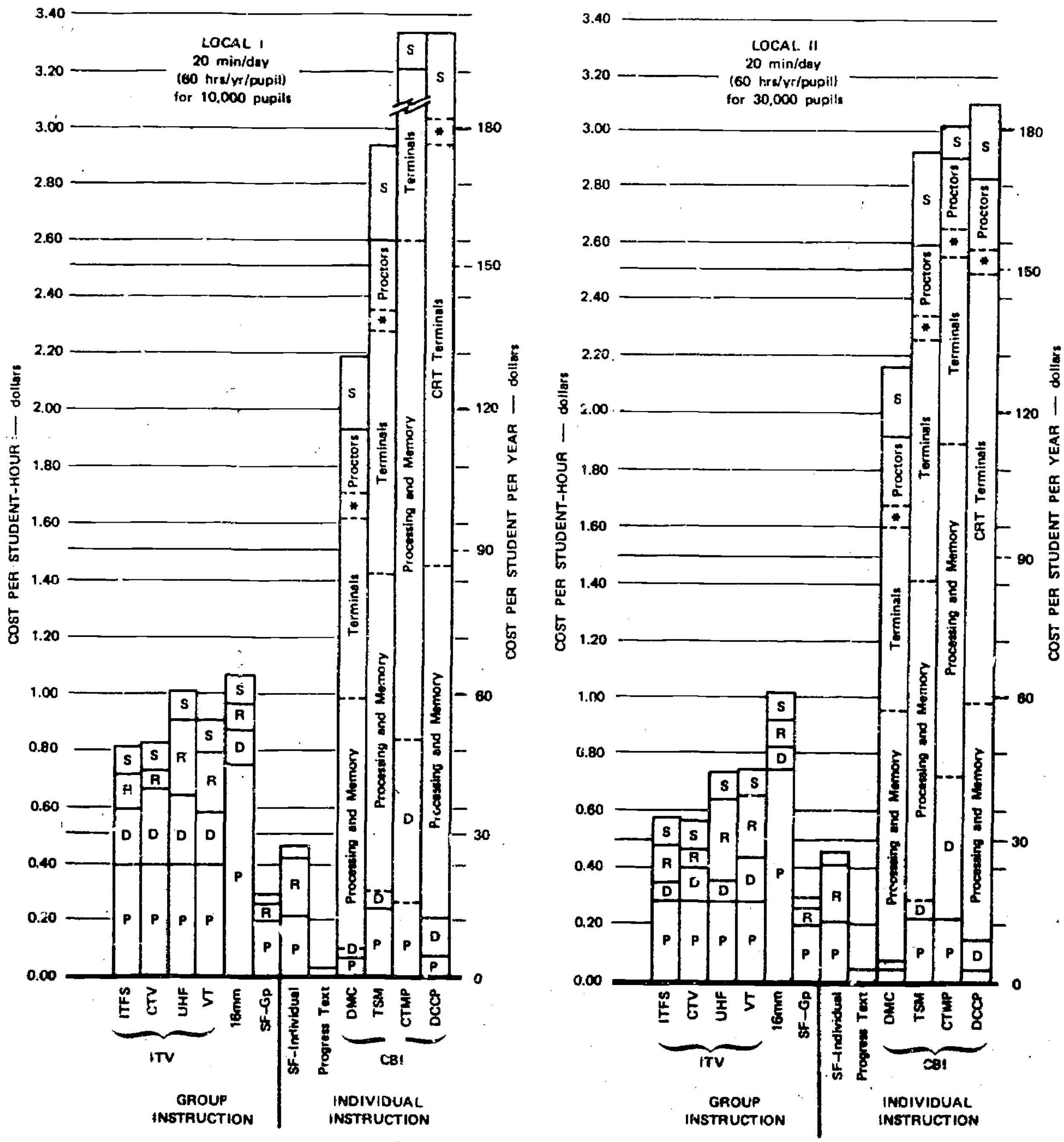
*The reader who is interested in more details than can be given here or in Appendix B concerning the methods used to reach the cost estimates may write to SRI, 333 Ravenswood Ave., Menlo Park, California 94025, Attn: Mr. Norman B. McEachron.

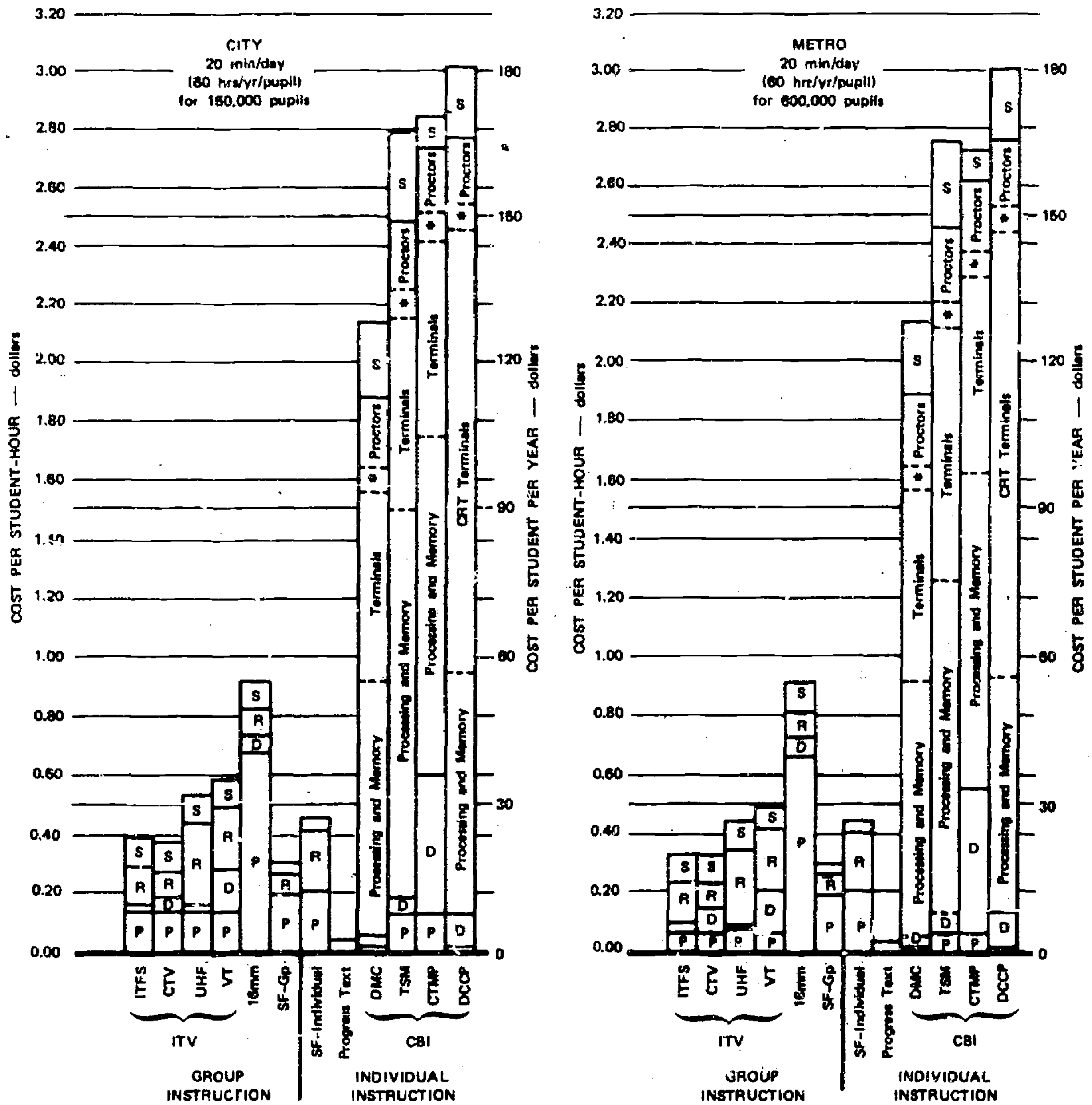


P = Direct Product Costs R = Direct Presentation Costs
D = Direct Distribution Costs S = Support (planning, administration, and evaluation)

*Facilities and Supplies.

(a) LOCAL DISTRICTS I AND II

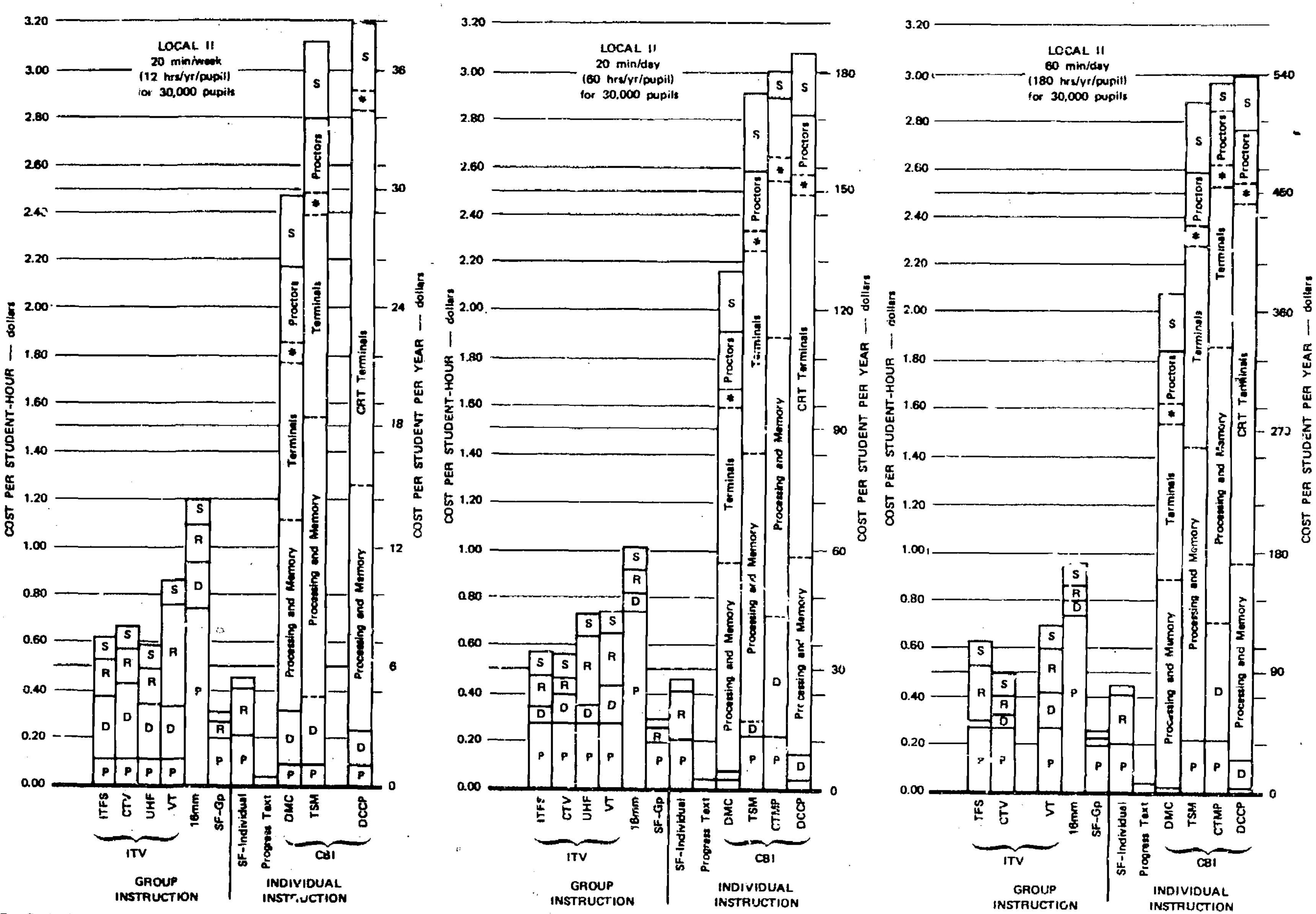
FIGURE 1 BUDGETARY COST VARIATIONS WITH EXTENSIVENESS OF USE



P = Direct Product Costs
R = Direct Presentation Costs
D = Direct Distribution Costs
S = Support (planning, administration, and evaluation)
*Facilities and Supplies.

(b) CITY AND METRO

FIGURE 1 BUDGETARY COST VARIATIONS WITH EXTENSIVENESS OF USE (Concluded)



P = Production, direct costs
D = Distribution, direct costs
R = Presentation, direct costs
S = Support (planning, administration, and evaluation)
*Facilities and Supplies.

FIGURE 2 BUDGETARY COST VARIATIONS WITH INTENSIVENESS OF USE shows the cost of one technology in terms of dollars per student-hour (left scale) and the equivalent annual cost (right scale). The calculations are based on 20-minute units of instruction in both elementary and secondary schools. Figure 1 shows the data for all four environments at one level of intensiveness (20 min/day). Figure 2 shows one environment (Local District II, 30,000 pupils) at three levels of intensiveness. The left scales are kept the same among the charts; the reader should be alert to the changes in the right scales of Figure 2 with changes in intensiveness. All production cost estimates reflect the increased quantity (and estimated quality, if internally produced) required at city and metropolitan levels.

Explanation of Abbreviations

P: Production Costs--Production includes all costs of design and production by the school district or consortium, or acquisition by purchase or lease, of the instructional content or courseware from which the student will eventually learn. For 16mm film, sound-filmstrip, and programmed text, this consists entirely of selection and purchasing costs.

D: Distribution Costs--Distribution includes all costs of content to the learning site (school), its reception there, and the return of any learner feedback essential to subsequent instruction. For computer-based instruction, this includes costs of data transmission to and from student terminals.

R: Presentation Costs--Presentation represents all costs of processing the instructional content to a form suitable for learning, displaying it to the student at the learning site, and obtaining any essential feedback. It includes not only purchase and operation of necessary hardware (e.g., computers) but also teacher training; however, it excludes the salary costs of classroom personnel.

S: Support Costs--Support costs (initial planning, administration, and evaluation) were estimated for each system as a whole.

Group Instruction--The group mode of presentation encompasses four technologies. These are listed below, under ITV:

- ITV: Instructional television systems with a mixture of local production, film, and national television agency rentals as sources for programming (all rentals taken at 20 min/wk). Quality of local production increases with the viewing audience.

  ITFS: Instructional Television Fixed Service as the distribution system, with videotape recording and playback in local schools (none at 20 min/wk, high schools only at 20 min/day, elementary and secondary at 60 min/day) as required to meet scheduling requirements. Videotaping costs are allocated to the presentation function (R above).

  CTV: Leased cable distribution system (Pacific Telephone Company rates) of up to six channels (at 20 min/day and 60 min/day) with high school videotape recording and playback at 60 min/day.

  UHF: Rented broadcast time from one to two local UHF educational broadcasting stations, with in-school videotape recording and playback facilities at 20 min/day. Channel capacity is insufficient to carry the 60 min/day programming requirement.

  VT: School-level video cassette playback centers, each supplied with tape duplicates of required programming stored in school libraries for three years' use before recycling.

  16mm: Sixteen-millimeter film distributed from central film libraries having enough prints to show a given program to all students within a three-week "window" of instructional relevance. (A wider window would lower the production or film print costs.)

- SF-Group: Sound-filmstrip (cassette format) shown by teachers to individual classrooms in groups, with filmstrip libraries maintained at each school.

Individual Instruction--The individual mode of presentation encompasses the technologies listed below:

- SF-Indiv: Sound-filmstrips viewed by students in an individualized instruction format in carrels, with sufficient courseware provided to permit every student to view a given title within three school weeks.
- Prog. Text: Programmed text used individually by students at home or in school.
- CBI: Drill-and-practice and simple tutorial instruction administered by computer. Distribution costs refer to data transmission between school site and computers. Presentation costs include the items shown.

  DMC: Minicomputer systems designed to use only commercially available courseware, not user-originated programs or general-purpose problem solving. Production costs indicate lease costs of courseware. All computers are located within schools. At 20 min/wk and 20 min/day, some terminals are operated by computers located in other nearby schools. Terminals are Teletype® machines, Model 33 KSR.

  TSM: Minicomputer systems designed to permit generation and operation of teacher-produced couseware as well as general problem solving using available computer languages (BASIC). Production costs are a mixture of internal production teams (expenditures and quality assumed to increase with student user population in a fashion similar to ITV) and commercial rentals. Distribution and presentation are similar to the DMC systems.

  CTMP: Large, centralized computer facilities, each operating up to 1,000 student terminals on a variety of instructional programs, including problem solving as well as commercially available materials. Substantial operating costs are incurred for central staff. Terminals are again Teletypes® Model 33 KSR.

  DCCP: Large centralized computer facilities, each operating up to 500 terminals located in different schools, linked by leased phone lines. Systems use only the leased courseware also employed by the DMC systems. Terminals are CRT (cathode ray tube) type having more flexibility than Teletypes, but at higher cost. Production costs are courseware lease costs.

Discussion of Results

The results indicate that costs of technology currently available fit into a general ordering across different environments and intensities. General-purpose computer based systems are more expensive than the specialized drill-and-practice systems, followed by 16mm film (with the caveat previously mentioned), various forms of television (including videotape replay facilities in schools where necessary), sound-filmstrip, and finally a very small unit cost ($0.05 per student-hour) for programmed text.

The bar charts of Figure 1 show that significant economies of scale over variations in extensiveness occur only for various forms of broadcast television and the large computer systems. The estimated cost of instructional television using ITFS and recording and playback facilities in the high schools at 20 min/day declines from about $0.80 per student-hour to almost $0.30 per student-hour as the student population increases from 10,000 to 600,000 pupils. Economies of scale are limited by the expense of the playback facility, since the cost is proportional to the number of schools; thus, the cost per student for the facility does not decline as the number of schools, and the number of students, increases.

The reader will note that the bars dealing with computer systems show more detail than the other bars; in the CBI category, the presentation costs (R) are broken down into four subcosts--Processing and Memory, Terminals, Facilities and Supplies, and Proctors. Presentation costs dominate the total costs of computer based systems in the models of this report. The cost of student terminals forms a significant element of presentation costs, especially for the DCCP system in which cathode ray terminals (visual displays similar to television) are employed in place of the teletypewriters of the other three systems.

Intensiveness is measured in terms of the amount of instruction per unit time received by each student in a district of given characteristics. Figure 2 displays the scale economies for a 30,000-pupil district, grades 1 through 12, or about two suburban districts operating a joint system. When a pupil receives instructional television via ITFS for 20 min/wk, the cost is about $0.60 per student-hour. When intensiveness increases, there is an increased need for in-school recording and playback facilities, and thus no economies of scale are observed. On the other hand, such economies are quite significant for the larger computer systems, the capacity of which to supply student terminals is more efficiently utilized as the total number of student terminals increases, both from increases in extensiveness (Figure 1) and intensiveness (Figure 2).

Potential Budgetary Savings from the Use of Instructional Technologies

The preceding cost estimates reflect the current (1973-74) capabilities and price structures of technologies, some of which--particular computers and television production and presentation--are changing rapidly. Thus current estimates may not accurately represent future possibilities. Furthermore, the costs of the instructional personnel required to be present during use of the media were excluded, on the grounds that local practice varies widely on this point. Yet the possibilities of cost savings through the use of an instructional technology depends on its potential for reducing classroom personnel costs.

Because of such uncertainties, these cost estimates are insufficient to determine the unique possibilities that instructional technologies may offer to reduce the costs of elementary and secondary education as currently organized. An alternative approach has therefore been developed. The thrust of this approach is to obtain an upper bound on potential cost savings attainable under current knowledge based on the substitution of media instruction for classroom teaching within schools. This is the role that technology must play if it is to be essential to cost savings, rather than occupy a supportive role. The approach is limited in that it assumes the continuation of instruction at designated learning sites (schools) rather than at homes or other locations. In this sense it represents possibilities for savings and redeployment of resources short of major redefinition and reorganization of elementary education; thus, the approach represents possibilities for the near term future.

An upper limit on potential cost savings within the bounds of present knowledge and organization can be evaluated if it is assumed that the technological system itself costs nothing and that no classroom personnel are required during its use. This means that the use of technology for an instructional task is assumed to reduce to zero the budgetary costs of that activity.

The following examples indicate that the upper limit of experience with various forms of instructional technology in current institutional settings is almost certainly less than 25 percent of instructional time:

- The elementary school systems in both Washington County, Maryland, and Anaheim, California, (the Ford Foundation-sponsored pioneer systems) use television to carry between 11 and 13 percent of total instruction. Other ETV systems provide less intensive use.[30]

- Computer assisted instruction in elementary and secondary education rarely rises above 20 minutes per day per pupil, less than seven percent of the instructional time.[30]
- The Carnegie Commission has suggested as a reasonable expectation for the year 2000 that between 10 and 20 percent of on-campus instruction be carried out using some form of instructional technology.[31]
- University-level multimedia approaches to instruction (including slide or filmstrip plus audiotape, and videotape) rarely entail more than 20 percent of total time being spent using technological aids.[32]
- Adult enrollees in the British Open University spend only about five percent of their learning time occupied with television and radio presentations.[32]

Thus we conclude that the upper limit of budgetary cost savings to be anticipated using forms of instructional technology now envisaged is from 10 percent to less than 25 percent of total instructional costs, even if the technology (including equipment, supplies, and furniture) is costless and requires no classroom personnel whatever. In contrast, the Anaheim Elementary School District has claimed savings corresponding to approximately three percent of instructional expenditures in comparison to the cost of presenting their television-augmented curriculum by traditional means.*

To express these cost savings in terms of overall costs of elementary and secondary education, we examined the program budgets for typical U. S. elementary and secondary grades as prepared by Education Turnkey Systems.[33] Excluding, as we have previously, the expense of buildings to house students as a constant (this presumes zero cost of alterations required to use another, technological system for instruction), the instructional

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*This was calculated on the basis of the typical program budget reported in the next paragraph. Annual savings of $152,000 reported in Teaching with Television (see Ref. 30) were compared with 44 percent of the 1971-72 total district expenditures of $13,220,000 (obtained from Assistant Superintendent Franzon). The former is 2.6 percent of the latter.

function takes up 44 percent of total costs, including supplies, equipment, and furniture.* A 10 to 25 percent savings in these costs would then amount to 4.5 to 11 percent of the total costs of instruction. We conclude that even by the most optimistic estimates cost savings from the use of technology would not be more than 11 percent of the total cost of elementary and secondary education, using any technology now envisaged and the highest levels of use that have been sustained in practice in developed countries. While not negligible, these savings do not represent the kinds of radical cost reductions that technology has attained in industrial applications.

To further evaluate the attractiveness of these cost savings to school districts, we must consider alternative ways to reduce costs. Typical means employed by districts to cut expenses include eliminating courses or activities of lesser priority, cutting back on the use of media (including subsidies to ETV stations that typically carry courses of lower priority), increasing the pupil-staff or pupil-teacher ratio, and increasing class size (which has been shown not to affect cognitive achievement). These approaches can easily match the savings to be expected even from costless instructional technologies. More systematic means of reducing costs have been described by Cresap, McCormick, and Paget, Inc.[34] They indicated that the most substantial cost saving derived from redeployment of instructional personnel using differentiated staffing. The overall cost reductions indicated over five size categories of school districts correspond to about 8.5 percent of total costs, in the mid-range of savings using a costless technology, and well above the savings on total (instructional plus custodial) costs of the television-expanded curriculum reported by the Anaheim instructional television system--about 1.5 percent. The comments of the CMP staff concerning instructional technology are intersting in this regard:

> A review was made of research findings on opportunities to lessen educational costs through greater use of television, computers, and other technological developments. Definitive cost data are lacking, but it does not appear that the use of

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*This estimate includes only the costs actually incurred in classroom instruction and preparation for instruction; it excludes all custodial and staff services--such as recess, physical education, lunch, homeroom, transportation, principal and staff services, and district administration--that would not be replaced by technology.

instructional technology in itself holds promise for cost reduction (unless a massive restructuring of the form of education is hypothesized). (Ref. 34, p. 12.)

Other cost savings of approximately four percent in the purchase of supplies and equipment and the furnishing of support services were suggested by CMP. The total savings potential estimated by CMP, without the major capital investment that would be required for most schools to employ technology intensively, would exceed the maximum possible savings from such a major capital investment.

Finally, Education Turnkey Systems[35] (on the basis of a pilot program of a 45:15 plan* instituted in four schools of Prince William County, Virginia) estimates overall savings in the 1971-72 per pupil cost of education of 4.9 percent from more intensive use of staff and 4.7 percent from more intensive use of capital facilities. The total cost savings of 9.6 percent is at the upper end of the range for a costless instructional technology.† Again, this approach requires no capital investment beyond planning expenses.

We are therefore forced to conclude that, for the kinds and levels of use of instructional technology with which researchers to date are familiar, the cost savings obtainable are not large, and at present are simply not as attractive as other, more immediate and less capital-intensive means of reducing costs, no matter how inexpensive the technology may be. The promise of technology in elementary and secondary education, within the confines of present knowledge and organization, lies not in directly substituting for classroom teachers, but in aiding their instructional activities. This can be done by improving the capability of a differentiated teaching staff to individualize instruction (Ref. 34, p. 15) and by performing tasks that classroom teachers cannot do well (which may include some aspects of instruction for the disadvantaged and handicapped). The possibilities of significant cost savings, on the other hand, depend more on social policy decisions concerning the custodial functions of schools--the length of time students are required to spend there--than they do on technological variations within the school.

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*A 45-15 plan is a scheme for year-round school attendance. "This plan calls for each of four student groups to spend nine weeks (45 days) in school, four times a year, with three-week (15-day) vacations between in-school sessions. This means that, at any one time, only three of the four student groups are in school" (Ref. 36, p. 5).

†A year-around operation can also reduce by almost 25 percent the equipment costs of most of the technologies examined.

IV UTILIZATION OF EDUCATIONAL TECHNOLOGY

The basic goal of our work in utilization is to understand how various technologies are used in public elementary and secondary schools by analyzing data on what hardware and software is now in place, and by analyzing the patterns of its use in the past, in the present, and in the future. We have used a study conducted in the early 1960s as a benchmark. This study, by Eleanor Godfrey, is the latest comprehensive survey of public, elementary, and secondary school utilization of technology.[2] The conclusions suggest that, although technology was relatively plentiful in most schools, it was used infrequently and almost always at additional cost. We presume, therefore, that there is no urgent need to review empirical evidence on utilization before the Godfrey study.

As a supplement to the available literature on utilization, we did a limited resurvey based on the Godfrey study.* To this end we revisited ten school districts that were included in the earlier study and asked several of the same questions, as well as others, in the light of the new technologies. The original survey included:

- An inventory of equipment and materials.
- Patterns of utilization of equipment and materials.
- The climate of opinion of school personnel concerning technology.
- Changes in inventories from 1961 to 1963 and projections into the future.

The SRI resurvey covered most of these issues and in addition covered:

- The present potential of the new technologies (e.g., computers, cable TV).
- New development in old technologies (e.g., cassette tape recorders, 8mm projectors).

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*Appendix C is a separate detailed report on the resurvey prepared by Eleanor Godfrey. The main points of her report are included in this section.

- The potential of technology in an era of accountability and financial stress.

At the time of the Godfrey Study in 1961-63, there was a fairly standard stable of workhorse technology, which included the 16mm projector, slide-filmstrip projector, record players, and tape recorders. These devices were quite generally available, even in small districts, although the materials to use on the devices were often difficult to obtain and of poor quality and quantity. Godfrey concluded that the technologies were used infrequently and almost always as "add-ons" at extra cost. However, there was general verbal acceptance of the idea of educational technology. Godfrey concluded therefore that the technical or machinery problem was closer to solution than the instructional problem for each grade and for each subject. Godfrey also concluded that the critical element in utilization is the teacher. Our society places high premium on autonomy. If the technology is not compatible with the teacher's philosophy, it will not be used. Godfrey said that in the early sixties the teacher was unconvinced.

The evidence is not available to make such unequivocal statements about utilization today. While all of the districts we talked to had increased their inventories, the patterns of utilization do not seem to have changed greatly over the decade since the Godfrey study. There was a notable decrease in the variability among large and small districts in the type and amount of media and materials in their inventories; the small districts now tend to have the same range of equipment as the large ones.

The inventories of all equipment except radios increased in the schools we resurveyed. The individual filmstrip projector came into common use. Very few of these single purpose machines were reported in the 1963 national survey. By 1973, however, the ten districts we re-visited reported over 1,700 units, or enough to provide, on the average, one for every 1.6 teachers. Also, the overhead projector grew very rapidly and virtually replaced the opaque projector. Ten years ago the work horses of educational technology were the record player, 16mm projector, slide-filmstrip projector, and tape recorder. In 1973, the individual filmstrip viewer and overhead projector had joined this stable.

The newer technologies have been uneven in their growth since the early sixties. In 1960 the language laboratory was considered a glamorous innovation, and 45 percent of the districts in the first study planned to develop the use of this medium in the next few years. In 1973 enthusiasm for the language laboratory had declined drastically; no one interviewed was at all optimistic about its educational potential.

Another inflexible system, the teaching machine, has apparently met a similar fate.

Broadcast educational television was in its infancy in 1961. Today our respondents in the resurvey uniformly complained of poor reception, inadequate programming, inflexible scheduling. Yet five of the eleven districts plan to increase their use of television. This seeming contradiction is resolved when we look at how the medium is used. Direct broadcast television is still the unchallenged instant medium for events of national or local significance, and the increasing availability of cable hookups makes local reception less problematic. But the most promising future for television seems to lie in its adaptability for local production through the use of videotape. Quality programs can be taped off the air and can be used at the teacher's convenience, although copyright problems are beginning to loom large. The increasing portability of television equipment and the use of erasable tapes makes for a very flexible system. Seven of the eleven districts have used video tape recording equipment, and all are enthusiastic about the potential of such use in the future.

A recent survey by NCES of the Office of Education[38] showed apparently remarkable television coverage in public elementary and secondary schools. A few results:

- Eighty-two percent of all students are in schools having TV receivers.
- Ninety percent of public schools in large cities have TV television receivers.
- In suburban areas around large cities, about 50 percent of secondary schools have videotape recorders.
- Only 13 percent of the schools have neither of these forms of TV.
- More than 70 percent of schools having TV receivers use educational TV.
- However, only a few schools have enough receivers to permit simultaneous use of TV by different classes--the median number of receivers is 2.8 per school. This is a very serious limitation. Large scale use of educational TV in the classroom awaits the acquisition by the schools of large numbers of receivers.

It should be observed that the data in the NCES survey was a simple audit of TV equipment. It is dangerous to draw conclusions concerning usage of equipment from these data. Some of the experts who reviewed this report in draft were critical of the NCES survey and concerned that misleading inferences concerning utilization would be made.

The data from our small resurvey indicate that computers are used mainly as an administrative tool rather than as a medium of instruction. More light is shed on this by a recent national survey sponsored by NSF,[37] which is consistent with our own data.

The NSF study, based on a national sample of secondary schools, shows that computers are used for instructional purposes by about 13 percent of secondary schools. The bulk of instructional usage (about two-thirds) is for electronic data processing training and for math course problem solving. It should be noted that this study is about four years old. There are indications that there have been substantial increases in computer assisted instruction (CAI) since then.

Direct CAI applications were much less frequent, about 20 percent of the schools making instructional use of the computer. The study reaches three major conclusions:

(1) Use of the computer for instructional purposes is growing rapidly.

(2) Schools must share information or there will be too much repetition of costly mistakes.

(3) Evaluations should be made of experiments so future applications can be based on a cumulative experience.

The climate of opinion in 1973 is much the same as in the early sixties. The teacher is primary and essential. Educational technology wisely used could improve the quality of education, but only at extra cost. In a budget squeeze, administrators contacted in our resurvey said technology would be one of the first things to go. The first cut would be new equipment, next media center staff and materials, and next new programs such as cable television or CAI.

In the early sixties Godfrey wrote that "educators at all levels encounter problems that hamper the effective use of audiovisual materials. There is never enough money; projection conditions are far from ideal; films do not arrive on schedule; some teachers fail to see the value of audiovisual technology; or the added burden of preparing materials for classroom use is just too much to fit into an already crowded schedule" (Ref. 2, p. 67). According to our respondents on the resurvey these problems still plague the local district. Compounding the situation today are the more frequent breakdown of sophisticated equipment, lack of local production facilities, lack of technical expertise, and the possibility of copyright infringement in reproducing material locally. Apparently things have not changed very much since the early 1960s. However, the resurvey identified several trends which, if confirmed by a full scale study, have important policy implications:

- The apparent turning away from complicated, prepackaged systems in favor of simple devices suited for local production and student manipulation.

- The emphasis on individualized media tailored to the instructional needs of a group of students seen as heterogeneous in talents, interests, and knowledge, rather than as a "fourth grade" of "freshman English class."

- A counter trend toward accountability for the achievement of some minimum standard of proficiency by all, or nearly all of a "class."

- The trend toward individual school autonomy in curriculum and budgeting. This decentralization, coupled with rising taxpayer resistance to continually rising school costs, despite declining enrollments, does not presage a receptive climate for the rapid development of sophisticated technology. Even with massive outside support, such development might be counter to the educational mission as seen at the local level.

- The extension of the concept of autonomy in the teacher's demand to be recognized as a professional capable of directing his own work, without interference from district, state, or federal administrative personnel. Almost all of the respondents alluded to the final decision making power of the teacher in whether and how educational technology will be used. You can "make the bait available," but whether or not it is accepted it's up to the individual teacher.

We repeat that the evidence on present day utilization is scarce. A systematic large-scale study of utilization along the lines of the early Godfrey study is needed in order to permit accurate estimates of current utilization and of changes since that Study. We strongly recommend that such a study be conducted. Federal technology policy designed to aid public schools will almost certainly be flawed without such up-to-date information.

V INVENTORY OF FEDERAL ACTIVITIES AND EXPENDITURES IN EDUCATIONAL TECHNOLOGY RESEARCH AND DEVELOPMENT*

Introduction

One of the early efforts on this project was an inventory of recent (fiscal years 1971 and 1972) federal R&D activities in educational technology.† This information provides a backdrop for the analysis of forward looking federal policy, since past R&D activities reflect implicit or explicit strategies and emphases. Of course, it is evident that much federal activity is in response to a wide variety of influences (legislation, pressure from constituencies, and so on) and does not necessarily, or even probably, reflect calculated programmatic R&D strategies. Nonetheless, patterns of R&D do indeed amount to a federal policy, intentional or not.

For this inventory we relied primarily on the information services of the various agencies concerned with educational technology. In our initial analysis of Smithsonian Science Information Exchange material we discovered that by far the bulk of the R&D activity in educational technology was carried out by three agencies: the National Science Foundation, the Office of Education, and the Department of Defense (see Appendix D). Our analysis is limited to these three agencies. We think we have a reasonably good picture of the R&D activities of these three agencies which, when aggregated, reflect to a reasonable extent the activities of the government as a whole.

Appendix D contains a detailed description of the methodology and procedures used in conducting the inventory. This methodology will be summarized here in order to provide perspective for the analysis of findings and conclusions to follow.

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*Appendix D contains a detailed description of the methodology of the R&D inventory.

†The inventory was limited to R&D funded by "discretionary" federal money. This eliminates R&D funding allocated on a block grant basis.

OE and DoD have computerized systems that accept detailed lists of descriptors or key words and produce output list of ongoing projects tagged with those descriptors. (These descriptors are listed in Appendix D.) In a very real sense, then, the information on R&D activities is conditioned by the descriptors, which are largely oriented to instructional devices or materials.

For the OE we used the Projects and Grants Information System (PGIS), for DoD the Defense Documentation Center (DDC), and for NSF the annual NSF publication listing grants and awards. We performed checks of completeness and accuracy for each of their sources (these checks are reported in more detail in Appendix D). In the case of PGIS, fairly careful checks (in two bureaus) indicated the coverage of R&D projects was about 80 percent complete. Our best information from DDC indicated that its coverage is at least this complete. The NSF data (which is not computerized) is reasonably complete also.

A word is in order concerning our experience with these computerized systems. These systems may be useful for some purposes, but they have serious drawbacks as sources for inventories of educational R&D. Some of these drawbacks are noted here for the benefit of future users of this t e of information system.

First, the data obtained from the computerized systems must be carefully checked. Such checks inevitably reveal errors, inconsistencies, incompleteness, or all of these. In such cases, another pass through a system may be necessary. In our project, several passes were required. In some cases this led to very long waits--our record on some of these experiences is very nearly a chronicle of despair.

Second, each information system has a somewhat different method of obtaining the stored information. Key words and descriptors are not interchangeable. Hence, entry into each system is unique. This leads, of course, to uncertainties concerning the comparability of data between information systems, which can only be resolved by independent checks.

Third, the information systems are not kept up-to-date. Each R&D project is, in some sense, unique and, typically, goes through a complex evolution. As a project nears the contractual stage, changes can be made in problem, scope, approach, timing, and funding; similar changes can be made after the contract is signed. These changes, if reported, find their way into the system sooner or later.

In trying to cope with these and other problems, we arrived at the conclusion that computerized information systems are not suitable for inventory studies like ours. Our experience suggests that telephone surveys of principal investigators or project leaders may be the most effective and inexpensive means of collecting inventory data (assuming a complete list of such persons is available). Such persons seem delighted to discuss their work. They are almost always locatable, though in some cases it is necessary to make several calls. And most importantly, data from the investigator is probably more valid and reliable than from the computerized information systems. This is particularly important on the duration and funding of research, which are highly variable over time.

Findings

Over $44 million was invested in educational technology R&D for the two fiscal years 1971 and 1972. The NSF contribution was largest, at over $17 million. DoD and OE added $15 million and $12 million respectively. This represents about 20 percent of the total federal investment in educational R&D for the same period (about $240 million). Our guess is that $44 million is probably an underestimate of the amount spent on technology, since the inaccuracies found thus far show that we are more liable to miss projects than include inappropriate ones.

What did the three agencies do with this R&D money? NSF's main activity was R&D in computers in education.* Nearly $9 million, or about 50 percent of the total, was spent on computer based instruction. (This includes a variety of computer projects.)

Nearly another quarter of the total, about $4 million, was invested in networks of university based groups to study the applications of computers to instruction. Typically, these networks included a large number of institutions of higher education, led by a few universities or colleges with special computer expertise and hardware. The networks are designed to provide leadership, inspiration, and guidance from centers of excellence to a regional or state group of smaller colleges and universities.

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*The information on NSF's R&D is derived from the annual report on contracts and grants. This report simply lists the investigator, title of project, and level of funding.

NSF's remaining investments (over $3 million) were devoted to a variety of technologies, over ten percent, or nearly $2 million, of which was in films. The remaining investments, all under $0.5 million, ranged over ETV, programmed instruction, simulation and gaming, and so on.

NSF relies largely on universities to perform its R&D, which is oriented primarily to a normal population. Little else can be said about NSF due to the scanty amount of information on each R&D project. More complete data is available for DoD and OE.

The following analysis of DoD and OE activities is based on these variables:*

- Type of technology.
- Type of project (e.g., development, evaluation, demonstration).
- Target audience.
- Performer of R&D.
- Grade level.
- Public law (for OE only).

DoD presents a different pattern of activities, on which it spent a total of nearly $13 million. Almost $6.5 million, or over 40 percent, was devoted to simulation and gaming. The primary focus of this type of R&D was on devices and procedures for military training designed primarily to avoid direct use of actual equipment. These projects ranged from very large simulations of nuclear war to small arms combat situations. About $3.75 million, or 25 percent of the total DoD funds, went into CAI. Two million dollars was devoted to multimedia systems. The remaining funds, all under four percent of the total DoD R&D funds went to ETV, films, programmed instruction, recorders, and the like.

DoD R&D was heavily oriented to development type projects--over 75 percent ($11.5 million) was devoted to this type of activity. Research (11.8 percent) and evaluation (11.8 percent) made up the remaining activities of significance. None of the other types of projects (demonstration and literature review) exceeded one percent of the total.

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*See Appendix D for a detailed description of the variables.

The DoD target audience was overwhelmingly normal (i.e., not handicapped, mentally retarded, or the like)--99.1 percent, a pattern DoD has in common with NSF but, as we shall point out, quite different from OE.

DoD performs nearly 60 percent of its R&D in DoD installations. Universities (17.2 percent), private profit making companies (16.6 percent), and private nonprofit organizations are the other frequent performers.

All of the DoD R&D is focused on the postsecondary grade level, as might be expected of a military organization with a total population of adults.

The Office of Education pattern of R&D activity differs substantially from DoD and NSF. Whereas DoD and NSF were focused narrowly, OE is much more diversified and clearly less concerned with computers. Multimedia Systems is OE's single biggest commitment--almost $3 million, or nearly one-quarter of its total budget. This activity entails the use of two or more media (including computers) for specific instructional purposes, where the various elements are conceived as a system of instruction. OE is also the biggest federal investor in ETV, which took nearly $1.5 million (11.5 percent) of the total OE budget.

OE has a significant amount devoted to computers--over 18 percent ($2.3 million) to CAI and over 6.0 percent (about $0.75 million) devoted to the noninstructional use of computers. The projects involved include pure CAI development as well as the use of computers for the direct and indirect support of instruction.

As with DoD and NSF, OE has small investments in a variety of technologies. These include programmed instruction, film, recorders, radio, and the like. The total amounts for each of these are all under $0.5 million for the two year period.

OE devotes over 50 percent of its R&D to development-type R&D. Other R&D orientations of significance are demonstrations (about 20 percent), research (8.9 percent), literature review (7 percent), and evaluation (5.9 percent). The remainder are "miscellaneous" or "not applicable."

Performers of OE's R&D are highly diversified compared to DoD and NSF. About a third of the projects are performed by universities and a third by public schools. Nonprofits (15.5 percent) and private profits (8.8 percent) account for nearly all the remaining performers.

OE, in contrast to DoD, has a widely varied target audience, with normal being the largest (31.4 percent); bilingual (24.5 percent), handicapped (22.9 percent), disadvantaged (6.4 percent), and retarded (0.6 percent) account for the remaining target audiences. (14.2 percent were "miscellaneous" or not applicable.)

In terms of grade level, OE devotes 34 percent to the postsecondary level, in sharp contrast to DoD and NSF, both of which devote nearly 100 percent to this level. OE has 25 percent directed to elementary grades, 9 percent to general audiences (all levels), over 8 percent to preschool, 5 percent to combined elementary and secondary, and 2.8 percent to secondary levels. "Miscellaneous" and "not applicable" make up the remainder.

OE R&D activities are funded under various pieces of legislation. Prominent among them are the Elementary and Secondary Education Act (54.5 percent), Cooperative Research (24.4 percent), Higher Education Act (11.8 percent), and National Defense Education Act (4.2 percent). A variety of legislation accounts for the remainder, which is under one-half million dollars in all.

Conclusions

One of the most clearcut patterns emerging from the inventory is the high level of investment in the "newer" technologies. For NSF, DoD, and OE aggregated, 76.8 percent (almost 35 million) is devoted to such technologies as computers, television, simulation and games, and multimedia systems. In DoD the newer technologies account for 84 percent, in NSF over 80 percent (all but a fraction in computers), and in OE over 60 percent. This is impressive evidence of a broad federal tendency to stress R&D on the newer aspects of the field.

It is not possible to say definitively whether or not this emphasis on the newer technologies is appropriate, or if more or less R&D funds should be so invested. Certainly one of the important federal roles in technology is to do pioneering R&D that is too risky for, or beyond the resources of, the private sector or of state and local governments. In this sense it seems reasonable that a high proportion of federal R&D funds be devoted to newer aspects of the field.

R&D on the newer technologies varies substantially between the three agencies. NSF's stress on computers is of long standing. NSF is recognized as one of the centers that consistently pushes the computer based instruction state-of-the-art. While its R&D budget for computer based instruction has been declining in recent years, NSF will no doubt continue to be highly influential. NSF is moving out of operational support and more into advanced systems.* The PLATO (programmed logic for automatic teaching operations) system is an example of this trend as is the TICCIT System (time-shared interactive computer-controlled information system). Both of these are advanced systems using computer based instruction. NSF is currently evaluating both systems.

DoD is heavily invested in R&D on simulation and gaming (over 40 percent). This is clearly a military training issue where the simulation affords savings of money, trainee time, and wear and tear on actual equipment. DoD also has significant R&D activities in CAI and in multimedia systems; some of the CAI work now underway at Fort Monmouth is highly advanced.

The OE R&D investments in the newer technologies center around multimedia systems (23.1 percent), CAI (18.1 percent), and ETV (11.5 percent). OE also has very large investments in operational support of ETV. For example, in fiscal years 1971 and 1972 OE invested over $8 million on ETV operations, a large proportion of which went to the well known Sesame Street and Electric Company. While this support is currently rapidly declining, OE has gained important experience in supporting the creation of high quality instructional TV for mass use.

*Personal communication from Dr. Andrew Molnar of NSF.

VI SUMMARY, IMPLICATIONS, AND RECOMMENDATIONS

In each of the preceding sections we have examined the evidence on the four key questions that we set out to answer. In this section we attempt to answer the question, "What does all of this mean?" and, more specifically, "What implications does this have for federal policy?" Let us first quickly review the conclusions of each of the sections. In brief, the answers to each of the four questions were:

(1) How is educational technology used in public elementary and secondary schools?

Educational technology is used for the most part as an addition to, rather than as an integral part of the instructional process, and is almost always an added cost to instruction. Also, high quality up-to-date software is not always available, and local production is expensive and time consuming.

(2) How effective is educational technology?

Virtually all of the educational research on the effectiveness of technology in education finds that technology is not significantly more or less effective than conventional instruction. Generally, technology that is wisely used is effective for almost any instructional task.

(3) How much does educational technology cost?

Adding technology to the present program of a school can cost anywhere from \$0.05 per student-hour (for printed programmed instruction) to \$4.00 per student-hour (for computer assisted instruction). With present knowledge, even a zero-cost technology might save a school system at most 11 percent of the total budget, and current uses of technologies would save considerably less, if anything at all. Other less capital-intensive means of reducing costs appear more attractive than technology.

(4) What have been the federal activities in the field in the recent past (fiscal 1971 and 1972)?

The three federal agencies primarily involved in the field are DoD, NSF, and OE. Most of the federal dollars have gone into R&D on television based instruction, computer based instruction, and simulation. NSF has invested heavily in computer based instruction. DoD has a heavy investment in simulation. OE invests in a wide range of technologies and forms of support, with the largest amount going to multimedia systems.

How does all of this diverse evidence compare with the claims being made for educational technology? Table 2 is a short list of some of those claims and of the evidence concerning them that we have accumulated.

Table 2

CLAIMS FOR EDUCATIONAL TECHNOLOGY

Claim	Counter Evidence
Technology can radically reduce the cost of education.	Technology, at least in uses currently suggested for it, can theoretically save at most 11 percent of the total school budget, and probably less. In no actual case has technology alone reduced the cost of education.
Technology can dramatically increase the effectiveness of education.	The effectiveness of technology has not been shown to be significantly different from that of conventional instruction.
Technology can replace the teacher.	While some redeployment of teachers has accompanied the use of technology, any significant replacement of teachers in public elementary and secondary schools is still a long time in the future. Currently, technology requires more teachers.

Given these doubtful claims, what can we say about the role that technology can, does, and will play in public elementary and secondary education? There are some functions that technology has traditionally performed, and which evidence suggests it can perform effectively; these include:

- Bringing to the limited classroom environment the sights and sounds of the world outside of the classroom. Research shows that a picture is indeed worth a thousand words in making some points; subjects such as art and music are taught much more effectively with the aid of audiovisuals.
- Bringing formal education to an audience that would not otherwise have access to it. The great usefulness and cost-effectiveness of technology in reaching people that would not otherwise be students has been demonstrated by such institutions as Britain's Open University and Australia's correspondence schools that use radio.
- Making available programs of study that are tailored to the learning speed and sometimes the learning style of an individual. Reading laboratories have been used very effectively to tailor the speed of progression through a reading sequence to the abilities of the individual.
- Adding subjects to the curriculum for which specialized teachers are not available. Technology can present a sequence of lessons on any topic, so that any teacher can presen them.
- Saving time. Some technologies, notably programmed instruction and computer assisted instruction, have demonstrated significant time saving over conventional instruction.
- Teaching students about technology. Technology has been shown to be effective in teaching about technology. For instance, computer assisted instruction has been shown to be very effective in teaching computer programming.

These are some of the functions that our study showed technology can and does perform effectively. However, our study was limited to the core curriculum of elementary and secondary education. Some of the research that we examined suggests that the most fruitful applications for technology lie outside of this area.

We now turn to the policy recommendations emerging from our analyses. We have been careful to formulate these recommendations with the perspective provided by other studies in the field. The 1970 report of the Commission on Instructional Technology[1] is the most important recent attempt to analyze the federal role in instructional technology. The Commission concluded that technology had an important contribution to make in education which was not being currently realized. It made a series of recommendations designed to lead to more effective use of technology. These were oriented primarily to massive support of research, development, and demonstration, and seem to have been overtaken by reductions in federal R&D support in education. Only one of the Commission's six recommendations has been implemented--the creation of the National Institute of Education.*

Our recommendations, listed below, differ from those of the Commission. Whereas the Commission was primarily concerned with R&D mechanisms, our concern is with substantive policy recommendations that can be addressed immediately by the Education Division of HEW.

(1) Claims about the power of technology to reform and improve public elementary and secondary education should be moderated and brought into accord with the limited knowledge of the subject.

(2) Initiatives taken by the Education Division should be formulated in the light of other federal activities. Investments in computer applications are an important case in point. Both DoD and NSF have made important gains in computer based instruction which should be built upon.

(3) The information about federal R&D projects in education is inadequate. Since this type of information is essential to policy evaluation and reformulation, steps should be taken to improve the appropriate federal information systems. The Project and Grants Information System (PGIS) is the Education Division's Computerized information system. This system is apparently inadequately financed and lacks the authority to obtain inputs from all sources.

(4) There is no recent systematic information concerning utilization of technology in public schools. Since coherent federal policy should depend heavily on such information, a utilization survey along the general lines of the Godfrey Study[3] of the early 1960s is a high priority.

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* Personal communication from Dr. Sidney Tickton.

(5) There is a need for some form of consumer (i.e., teacher) information on available materials (films in particular). Information is needed that would enable a user to identify materials suitable for a given instructional objective along with an evaluation of effectiveness. The Educational Products Information Exchange (EPIE) has made a valuable start in this direction for hardware. The Education Division should explore the dimensions of the demand for this type of information for software and means of supplying it.

A related problem is that hardware is often of poor quality and durability. Incompatibility is more the rule than the exception. The Education Division should analyze the interaction between the technology industries and public education with a view to encouraging improved quality and standardization. Examination of the incentives for industry to improve products and services seems a particularly high priority issue.

(6) Education Division technology R&D expenditures were targeted mostly on "normal" populations in both fiscal years 1971 and 1972. This is inconsistent with the broad mandate for emphasis on the "disadvantaged" at the federal level. Analyses of these expenditures should be made to determine whether heavier investments in technology for special problem areas, especially the disadvantaged, are appropriate.

(7) Education Division policy should stress technology for special applications and not as a substitute for conventional instruction. There are a number of promising areas of special applications. These include:

- Intensive instruction for the disadvantaged
- Technology for higher education
- New opportunities in adult and continuing education.

There is not a sufficient basis in knowledge and experience to permit the development of an integrated federal policy on such special applications. The Education Division should explore these applications with a view to conducting policy analyses.

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Appendix A, Part 1

AN EVALUATION OF THE EFFECTIVENESS OF INSTRUCTIONAL TECHNOLOGY

by

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Prepared for the

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A1/A2

Appendix A, Part 1

AN EVALUATION OF THE EFFECTIVENESS OF INSTRUCTIONAL TECHNOLOGY

Introduction

The emphasis in this discussion on the effectiveness of instructional technology is on the use of four different media forms: radio, television, programmed instruction, and computer assisted instruction. These technologies have been widely used in many countries at all educational levels, including the use for continuing education. Useful information may be obtained from studies of all educational levels, but the major concentration will be on the use of technology for primary and secondary education in the United States. The research in this field has been voluminous, and the conclusions discussed in this paper will draw heavily on the conclusions of many surveys of this literature and some selected studies.

To determine the cognitive effectiveness of instructional technology, comparisons are usually made with conventional instruction. Unfortunately, there is no clear definition of the components of conventional instruction. It is also difficult to specify precise experimental controls for the studies. For example, in a comparison of televised instruction, should we use the same instructor with the same materials in both media? Or, should we allow total flexibility in course construction in order to utilize the differences in the media? As a broad overview of the effects of the various media on cognitive measures, one is struck with a general finding of "no significant differences." Or, as Chu and Schramm (1967)* have stated:

> Given favorable conditions, pupils can learn from any instructional media now available.

What are some of these favorable conditions? Armsey and Dahl (1973) stressed organizational variables to help insure the success of a technology project. These organizational objectives include: the existence

*References are listed at the end of Part 1 of this Appendix.

of a recognized and generally agreed upon need and the desire to meet the need through the use of technology, the participation and support of teachers in the project, and adequate resources for the duration of the project.

The project must also be analyzed to determine the best form of technology to use and the manner in which to use it. Forsythe (1970) mentioned a highly successful creative arts program that was originally broadcast on radio and later transferred to television. The program was returned to radio when it was discovered that its effectiveness had diminished, since students were copying the artist. Chu and Schramm (1967) concluded:

> The use of visual images will improve learning of manual tasks, as well as other learning where visual images can facilitate the association process. Otherwise, visual images may cause distraction and interfere with learning.

It is possible that the technologies must be adaptable to particular abilities, knowledge bases, or personalities of the students. There is little evidence in the literature to draw any firm conclusions on this basis. The one possible exception is the high degree of success of computer assisted instruction for compensatory education (e.g., Wells, Whelchel, and Jamison).

One might feel that a successful use of technology would take advantage of the unique capabilities of the various media (e.g., color television, animation). Chu and Schramm analyzed a variety of program formats for instructional television and generally concluded that

> ... effective use of television grows out of attention to the basic requirements of good teaching, rather than to any fanciness that might be peculiar to television.

Chu and Schramm also suggest that good use of television depends, like all instruction, on

> ... qualities like simplicity, good organization, motivation, practice, knowledge of results, rest pauses at appropriate points, cues that direct the pupil to the essential things he is to learn.

These general considerations can probably be applied to the other media forms.

However, this does not mean that there are no unique advantages to the use of technologies. Radio and television can extend schooling to areas that receive no schooling and can provide a wide variety of auditory and visual experiences and demonstrations that might otherwise be unavailable. Programmed and computer assisted instruction allow for scheduling flexibility and individuality in progression to specified goals. Several studies have demonstrated the savings in time resulting from programmed and computer assisted instruction, even when there are no significant differences in cognitive performance on a comparison with conventional instruction.

Time is a scarce economic resource, and the possibility of time savings should be considered in an anlysis of the relative effectiveness of the media. The analysis of the costs of the instructional technologies is an obvious part of the process of assessing the relative effectiveness of the technologies.

The attitudes of students and teachers toward the various media seem to be favorable. Although as Dubin and Hedley (1969) found, the students are more interested in the quality of instruction rather than in the form of instruction. They found that college students tended to prefer small discussion classes to television classes, and television classes to large lecture classes. Dubin and Hedley also concluded that the students would choose a televised course with the guarantee of a superior instructor rather than face the uncertainties in registering for a conventional class.

Zoll (1969) and Schramm (1962a) reported that students were generally favorable to programmed instruction, although they became bored with long programs and programs that continually used short steps.

The Wisconsin Research Project in School Broadcasting (1942) did not find any differences in interest or appreciation of students who received a course over radio and students who received the course without radio. However, the investigators did find significant effects on social attitude changes in a curriculum on community living. Willis (1940) also uncovered significant changes in attitudes of high school and college students as a result of short (15 minute) radio programs.

Wells, Whelchel, and Jamison did not find any differences in self-expectation between students who received computer assisted instruction (CAI) and students who did not, although they did uncover an association between self-expectation and increased CAI use. Smith and Hess (1972) used a variety of measures of student attitudes and could find no differences between CAI and non-CAI groups.

The most interesting study of attitudes of CAI students was undertaken by Hess and Tenezakis (1970). They attempted to measure the students' attitudes toward the computer and the classroom teacher to assess the use of the computer as a socializing agent. The students seemed to have realistic attitudes about the capabilities of the computer. They felt that the computer had more expertise than the teacher and would be more neutral in evaluating the students. They also felt that the computer was more responsive to student abilities but less responsive to student desires.

The four media forms are discussed separately in the next four sections. In each section there is an attempt to assess the effects of the media on cognitive outputs, effects of alternative program formats, and changes in student social attitudes and attitudes toward the media. The section on television also contains a discussion of the evaluation of Sesame Street. This well publicized project has attracted vociferous acclaim and criticism. The statistical evidence on one of the major program goals--to increase the readiness of poverty children entering the first grade--has been mixed (Ball and Bogatz, 1970; Bogatz and Ball, 1971; and Sprigle, 1971, 1972). There is also widespread criticism on program content: wrong directions for reading and mathematics readiness (Holt, 1971), adult dominated discussions (Sprigle, 1972), and the lack of appropriate learning models (Meichenbaum and Turk, 1972).

Radio

Instructional radio has declined in use in the United States since the 1930s and '40s. However, radio has not completely disappeared from American education; Forsythe (1970) mentions several projects in Portland, St. Louis, Des Moines, Newark, and Washington providing compensatory education for disadvantaged children. For the St. Louis project, Kottmeyer (1970) reported substantial gains in IQ and spelling for students who listened to the broadcasts as a supplement to regular instruction as compared to students in previous years who did not have access to the radio programs.

The attraction of the newer and more glamorous media may have contributed to the decline in interest in radio in the United States, but the effectiveness of instructional radio is amply demonstrated by the widespread use of radio in many other countries and by the results of the early studies in the United States. Forsythe (1970) mentions the use of radio in Sweden (166 hours of instruction per year to 12,000 participating schools), Korea, England, Canada, Cameroon, Sudan, and Nigeria. Jamison, Suppes, and Wells discussed the use of radio in England (63 radio series with illustrated pupil pamphlets and coordination between classroom and radio teachers), Australia (6,000 students enrolled at the Radio University of New South Wales in 1965), Japan (47 percent of the primary schools, 37 percent of the lower secondary schools, and 27 percent of the upper secondary schools used radio in 1958), and Thailand (students received instruction in English, social studies, and music between 1957 and 1965). Chu and Schramm (1967) mentioned the effectiveness of radio in teaching literacy to villagers in Malaya (see Entwisle, 1955), in teaching English to elementary school children in Ghana (see Kinross, 1961), and in teaching French to elementary school children in Tahiti (see Medard, 1962).

Xoomsai and Ratamangkala (1960) compared radio instruction with conventional instruction in music for grades two and three and in English for grades six and seven in Thailand. For the music lessons, the radio group performed significantly better than the control group. The radio groups scored significantly higher in reading and writing tests for English, but did not score higher on the aural tests. The results on the aural tests are surprising, since one might expect radio to be advantageous in areas requiring only auditory stimulation.

Examples of Learning from Instructional Radio

Carpenter (1937) used radio for science for students in the fourth through the twelfth grades and found that these students performed as well as conventionally taught students.

Brewer (1939) used radio for teaching science to elementary school children and concluded that the radio group performed significantly better than the nonradio group and had more favorable attitudes and a higher interest in science.

Miles (1940) also used radio for teaching elementary science and concluded that the radio group performed significantly better than conventionally taught students.

Constantine (1964) in a more recent evaluation of the effectiveness of radio for science instruction of elementary school children demonstrated a gain of 14 months on a standardized test of science information and a gain of 15 months in work study skills in one school year (the norm gain is 12 months).

Lumley (1933) investigated the use of radio for high school foreign language instruction. The radio students excelled in pronunciation over nonradio students.

Wiles (1940) compared the performance of junior high school students listening to news broadcasts with the performance of nonradio students and found that the radio students learned more.

Nelson (1957) found no significant differences in the performance of groups listening to an interview program on radio with groups watching the interview on television.

Barrow and Westley (1959) also compared the effectiveness of radio and television for news broadcasts. The programs were used for sixth grade students. The television group performed better on a test of immediate recall, but there was no difference in a test of retention six weeks later.

The Wisconsin Research Project in School Broadcasting (1942) provides one of the more extensive analyses of the use of instructional radio. Programs were produced for music, nature studies, geography, social studies, English, the encouragement of reading good books, and the improvement of speaking ability. A wide variety of tests were used for assessing the performance of the students in the various programs. The music course was the most successful. Radio students scored significantly higher than control groups on several tests of music ability. For most of the other courses no significant differences were reported between control and radio groups. The researchers attributed this negligible effect to the possibility that teachers of the control groups were stimulated to their best efforts; all teachers had received course outlines and lesson materials for the radio courses. Since the radio students outperformed the control students in music and tended to do better (although not significantly) in English and speech, the researchers also concluded that radio lessons might have an advantage in those areas where auditory illustrations were important.

Noncognitive Effects of Instructional Radio

The report of the Wisconsin Research Project also provides useful information about student interest, organization, and attitude change. Information on teacher reaction was obtained from voluntary responses to questionnaires (approximately one-third of the teachers responded).

Generally, there were no significant differences in interest or appreciation between radio and control groups for most of the courses. The most interesting result was the change in student attitudes in the social studies curriculum. The radio groups had significantly higher changes in the direction of the program goals; the goals were to increase

(1) Tolerance toward the interests of various economic groups.

(2) Cooperation with the members of one's own group in solving common problems.

(3) Cooperation with other groups in solving common problems.

(4) A sense of responsibility in furthering the interests of one's own group.

In related work on attitude change, a study by Willis (1940) was cited. Willis compared the relative effectiveness of three forms of radio presentations: straight talk, complete dramatization, and a combination of talk and dramatization. The subject areas treated were: the treatment of criminals, freedom of speech and press, and the attitudes students should hold toward the German people. An attitude test was administered to high school and college students before the program, at the conclusion of the program, and after two weeks. There were non-listening control groups for each education level. The following general conclusions were noted.

- A 15-minute radio program significantly shifted the attitudes of high school and college students.
- The attitude changes were still significant after two weeks, although there was more of a tendency for the attitudes of the high school students to return to original attitudes.
- For high school students, the dramatization was most effective, the combined form next, and the talk the least effective in changing attitudes (all methods produced significant attitude changes).
- For college students all three methods were equally effective.
- In terms of preference the high school students ranked the combined form first, the dramatization second, and the talk third. College students ranked the combined form first, the talk second, and the dramatization third.

The use of radio for producing changes in attitudes seems to be highly effective. Radio has also been successfully used to inculcate socially desired values in Thailand (Jamison, Suppes, and Wells) and Korea (Forsythe, 1970).

In terms of organization, the Wisconsin Research Project reported the following conclusions from the teacher responses.

(1) Wisconsin teachers think that all of the programs make valuable contributions to school curricula.

(2) Teachers need less help in teaching fundamental school subjects than in teaching enrichment subjects.

(3) Curriculum content in some schools was affected by the radio program.

(4) Most teachers used the materials supplied for the radio programs and found them useful.

(5) More use should be made of teachers in planning the radio programs.

(6) The use of radio programs for high school subjects presented a greater scheduling problem at the high school level than at other levels.

Televised Instruction

The research into the use of television for educational purposes has been voluminous. There have been several excellent surveys of this literature (Schramm, 1926; Stickell, 1963; Chu and Schramm, 1967; and Dubin and Hedley, 1969) and large scale experiments (Pflieger and Kelly, 1961; and Kelley, 1964). This section will draw heavily on the results of these studies. The major conclusion that one reaches is that educational television is as effective as conventional instruction.

As Chu and Schramm point out, the advantages of television include: the possibility of using a good teacher for many students, the accessibility of a variety of experiences and demonstrations, the extension of schooling to areas that receive no schooling, and the freeing of time for classroom teachers. The disadvantages include: the lack of adequate two-way communication and feedback channels, and a difficulty in merging the television program with regular work.

The general conclusions regarding the effectiveness of televised instruction as derived from the survey papers will be discussed in the next section. This will be followed by (1) a discussion of some of the conclusions reached by Chu and Schramm regarding program format, (2) an in-depth discussion of a long-term, extensive local use of television (Hagerstown) and a nationally broadcast educational series (Sesame Street), and (3) a brief discussion of some of the conclusions regarding student attitudes toward television.

The Effectiveness of Educational Television

Pflieger and Kelly (1961) reported the results of a three year study that involved over 200,000 students in 800 public schools. Most of the comparisons resulted in no significant differences; there were significant differences favoring the TV-taught students in 119 cases and the conventionally taught students in 44 cases.

Kelley (1964) evaluated over 300 matched achievement test comparisons from 1956 to 1961. He found significant differences in favor of television in 25 percent of th cases.

Schramm (1962b) evaluated 393 studies and found no significant differences in 255 of the studies, significant differences favoring television in 83 cases, and significant differences favoring conventional instruction in 55 cases.

Chu and Schramm (1967) evaluated 207 studies that involved 421 separate comparisons. Of these comparisons there were no significant differences in 308 instances. Significant differences favoring televised instruction were found in 63 comparison and 50 cases favored conventional instruction.

Stickell (1963) analyzed 250 comparisons. He applied strict restrictions on experimental design and determined that 217 were not interpretable. Of these 217, significant differences occurred in 59 cases and were evenly divided between televised instruction and conventional instruction. Twenty-three studies were only partially acceptable (usually because of nonrandom assignment) and of these there were significant differences in favor of television in three cases.

Ten acceptable studies were all undertaken by Carpenter and Greenhill (1955, 1958) at Pennsylvania State University and resulted in no significant differences. The restrictions were:

- Experimental and control groups consisted of at least 25 students.
- The students had been randomly assigned from the same population.
- The students were taught by the same instructors, either by two instructors exchanging classes in the middle of the term or by seating one group in the room from which the class was being televised to the other group.

- The results were measured by a testing instrument judged to be valid and reliable.
- The results were evaluated by acceptable statistical procedures.

Dubin and Hedley (1969) surveyed research in college instruction by television. In order to be included in their survey the study (1) had to be of an American college course for credit of at least one term duration and (2) had to include a report of group mean scores on identical tests for students in a televised course compared with students in a conventional course. On this basis they found 102 studies that favored televised instruction, 89 that favored conventional instruction, and two with no significant differences. Dubin and Hedley felt that a more accurate conclusion could be obtained by using a "t-value" for the statistical comparison of mean scores. Positive values were assigned to "t-values" that favored televised instruction, and negative values were assigned when conventional instruction was favored. The distribution of "t-values" was then analyzed to determine if the mean of the distribution was significantly different from zero. Ninety-three studies were included in this analysis, and conventional instruction was favored over televised instruction. When experiments using two-way television (systems employing audio feedback to the television studio) were excluded there were no significant differences.

Dubin and Hedley used this result to conclude that two-way television was a particularly poor use of technology. However, in their survey 25 of the 26 studies in two-way television came from the same college. This might be indicative of poor organization in this particular college rather than a deficiency in the use of two-way television. Wolgamuth (1961) found no significant differences on attitudes, learning, or retention (after four weeks) for college students divided into four groups: (1) a studio class, (2) a class with talk-back facility, (3) a class that could signal for pace of instruction, and (4) a class with no feedback. Almstead and Graf (1960) found two-way televised instruction to be superior for reading for 4th and 6th grade students.

With respect to two-way television, Chu and Schramm (1967) concluded that student learning was not impaired by the lack of two-way communication, although a talk-back facility might be more important for more complex subject matter. They also concluded (on the basis of research by Gropper and Lumsdaine, 1961, and Gropper, Lumsdaine, and Shipman, 1961) that showing, testing, and revising an instructional program might help substitute for the lack of feedback facilities.

Television was also demonstrated to have a differential impact by grade level. Schramm (1962b) and Chu and Schramm (1967) stratified the studies in their respective surveys by grade levels. Table A-1 shows that television tends to be more effective at lower grade levels. At upper grade levels there is more of a tendency for the finding of "no significant difference."

Table A-1

COMPARATIVE STUDIES OF TELEVISION INSTRUCTION VERSUS TRADITIONAL INSTRUCTION AS A FUNCTION OF GRADE LEVEL

Grade Level	Number of Studies Showing that TV is Superior	Number of Studies Showing that Conventional Instruction is Superior	Number of Studies Showing No Significant Difference
According to Schramm (1962b)			
3rd to 6th	50	16	86
7th to 9th	18	5	28
10th to 12th	12	21	57
College	3	13	84
According to Chu and Schramm (1967)			
Elementary	10	4	50
Secondary	24	16	82
College	22	28	152
Adults	7	2	24

Program Format

The conclusions drawn by Chu and Schramm (1967) regarding program format are often based on the results of very few studies. However, these results do provide some insight into successful program format. Chu and Schramm's numbered conclusions with respect to programming are listed below--with no discussion of specific research studies that they cited to justify them.

7. There is no evidence to suggest that either visual magnification or large-size screen will improve learning from television in general.

8. There is insufficient evidence to suggest that color will improve learning from film or television.

9. Where learning of perceptual motor skills is required, a subjective angle (from point of view of performer) presentation on television is more effective than an objective angle (from point of view of observer) presentation.

10. There is no clear evidence on the kind of variations in production techniques that significantly contribute to learning from instructional television. However, students will learn better when the visuals are presented in a continuous order and are carefully planned both by the television team and the studio teacher.

11. Attention-gaining cues which are irrelevant to the subject matter will most probably have a negative effect on learning from instructional television.

12. There is no consistent evidence to suggest that either humor or animation significantly contributes to learning from instructional television.

13. Subtitles tend to improve learning from instructional television, particularly when the original program is not well organized.

14. There is insufficient evidence to suggest that dramatic presentation will result in more learning than will expository presentation in instructional television.

15. Inserting questions in a television program does not seem to improve learning, but giving the students a rest pause does.

16. Whether a television program is used to begin or end a daily lesson by the classroom teacher makes no difference in learning.

17. Repeated showings of a television program will result in more learning, up to a point. But a teacher-directed

follow-up, where available, is more effective than a second showing of the same program.

19. There is no clear evidence to suggest whether eye-contact in television instruction will affect the amount of learning.

21. The students are likely to acquire the same amount of learning from instructional television whether the materials are presented as a lecture, or in an interview, or in a panel discussion.

25. Instructional television appears to be equally effective with small and large viewing groups.

35. Practice, whether by overt or covert response, will improve learning from instructional television if the practice is appropriate to the learning task, and if the practice does not constitute an interference.

36. Note-taking while viewing instructional television is likely to interfere with learning if time for it is not provided.

These conclusions indicate precisely the general findings of Chu and Schramm; that effective teaching on television is more a result of attention to the basic requirements of good teaching than the use of fancy production techniques. Of the numbered conclusions, there seems to be an inconsistency between 15 and 35. However, conclusion 15 is based on experiments that inserted questions before or after a program segment, but did not allow for time for considering responses. The rest pause experiments frequently instructed the students to consider the facts that were presented (a form of covert response).

Hagerstown and Sesame Street

Television has been in use in the Washington County Schools System in Hagerstown, Maryland, for over ten years and is used for teaching core courses at all grade levels. Wade (1967) discussed some of the successes of the curriculum as measured by standardized tests. These results indicate the reasons for the continued use of television in Hagerstown:

(1) Classes at all elementary grade levels using television for mathematics improved.

(2) Junior high school students in urban schools moved from the 31st percentile to the 84th percentile on concepts

after four years of televised instruction. For problem solving abilities the increase was from the 33rd percentile to the 68th. On the same test, rural students moved from the 14th to the 38th percentile on concepts, but gained very little in problem solving abilities.

(3) Significant gains were also reported for 10th grade mathematics, 6th grade science, 8th grade science, United States history, and 12th grade English.

Sesame Street was probably the most publicized nationwide experiment in the use of educational television in many years. As a result of the publicity and the large expenditure of funds ($8 million for two years from the Carnegie Corporation, the Ford and Markle Foundations, Operation Headstart, the Corporation for Public Broadcasting, and the U.S. Office of Education) a great deal of analysis and criticism has been directed at the programs. Meichenbaum and Turk (1972) reviewed the literature on teaching disadvantaged children and suggested several methods for improving the programs. Holt (1971) and Sprigle (1971) had criticized the program for having the children in a passive learning environment and giving children an answer rather than having them figure it out. Meichenbaum and Turk concluded from their research that models could be used to stimulate attention and scanning activities and to influence the manner in which a child would act on his environment. They also suggested that children on the program think "out loud" to demonstrate the steps by which a problem is solved rather than being given answers by adults.

Holt's (1971) criticisms were more extensive. He felt that the program reinforced the belief that all learning must be deliberately taught, and that condescending tones were used to the children. He also suggested that the program should emphasize (1) writing as an extension of speech and (2) the use and properties of number rather than simply counting.

Rogers (1972) in a summary of literature on Sesame Street also mentioned several criticisms aimed at the noncognitive aspects of the show. However, all of the criticism seems to be directed at program content rather than the usefulness of television as an educational medium.

A statistical evaluation of Sesame Street was conducted by Ball and Bogatz (1970) for the first year of Sesame Street and by Bogatz and Ball (1971) for the second year of production. The evaluations were undertaken under the auspices of the Educational Testing Service. The sample for the first year consisted of 943 children from a variety of backgrounds--inner city disadvantaged, suburban advantaged, rural, and Spanish speaking. The students were subdivided into quartiles depending on viewing frequencies. For all groups, significantly higher gain scores were reported for students who watched the most frequently. However, as Ingersoll (1971) pointed out, these results were based on nonrandom sampling of groups based on individual viewing patterns, and gain scores may not be a reliable comparison measure (Cronbach and Firby, 1970). There was an obvious correlation between viewing frequency and pretest scores. This correlation would confound the ability to attribute gains purely to the frequency of viewing. There may be other factors that influenced the higher pretest scores, the viewing patterns, and the gains in test scores.

To correct these inadequacies Bogatz and Ball (1971) encouraged viewing during the second year of the program for approximately half of the students in the sample, which consisted of 566 disadvantaged students. Twenty-nine goal areas were tested with 214 questions constructed by the Educational Testing Service. The pretest scores of the encouraged-to-view students were slightly lower than pretest scores for the nonencouraged groups. Comparisons were again based on gain scores. There were no significant differences on six of the items. The encouraged-to-view students gained significantly more on 13 items and had positive but insignificant differences on the remaining ten items.

No significant differences were uncovered in pretest or gain scores for black or white disadvantaged children in each viewing quartile.

The results also indicated larger gains for disadvantaged students than advantaged students. Disadvantaged students in the highest viewing quartile had scored lower on the pretest than all viewing quartiles of advantaged children. However, on the posttest these students scored higher than the lower two viewing quartiles of advantaged students.

Sprigle's (1971, 1972) criticism of Sesame Street is on more scientific grounds than other critics. He conducted several tests to determine the abilities of Sesame Street graduates compared with other students. He generally concluded that the programs failed to prepare poverty children for the first grade and failed to narrow the gap in achievement between poverty and middle-income children. In his first study, he compared the scores on various subtests of the Metropolitan Readiness Test and found significant differences favoring middle-income children for each test as compared with children who had watched Sesame Street and attended a class where the teacher made use of all materials suggested by the Children's Television Workshop (the coordinators of Sesame Street). There were no significant differences reported between the Sesame Street students and students who attended a kindergarten where instruction was undertaken in groups of four using the game format and where a high emphasis was placed on emotional and social development.

Sprigle's second study was more extensive and equally critical. The same groups were compared at the end of the first grade on several subtests of the Stanford Achievement Test. As in the first study, there were significant differences favoring the middle class children over the poverty children who viewed Sesame Street and no significant differences between the two groups of poverty children.

The Metropolitan Readiness Test was again used to compare new groups of students; in this instance the experimental groups had viewed Sesame Street for two years. There were no significant differences in any of the subtests for the students who had viewed Sesame Street for two years compared with students in the previous study who had viewed the program for only one year. The students who viewed the program for two years scored significantly lower than middle-income children and poverty children who attended a well organized Head Start kindergarten.

Sprigle also attempted to obtain evidence on the relationships of adults and children on the program to determine the types of interactions that occur on the program. Fifty programs were viewed from October, 1971 to January, 1972. From these programs there were 36 small group activities between an adult and a child that were recorded. Of these, 12 were randomly selected for further analysis. Adults spoke for 90 percent of the time in these groups. Of the conversations, all were initiated by adults, 88 percent were controlled by adults, and 12 percent were dominated by adults. Of the 21 child-initiated comments that involved either the use of the pronoun "I," a personal reference, a spontaneous comment, or a "why" or "how" question, the pronounced tendency of the adult was to ignore or interrupt the statement.

This type of behavior is the antithesis of the suggestions made by Meichenbaum and Turk (1972) to improve the learning of disadvantaged children. The sharp contrast between this study and the results reported by Ball and Bogatz points to the need for further research in this area.

Attitudes Toward Instructional Television

Attitudes of students and teachers are generally favorable to the use of instructional television, and become more favorable with increased experience. The attitudes of upper education levels are less favorable.

In a survey of attitudes of teachers in the Hagerstown (1965) project attitudes were decreasingly favorable from primary to intermediate to junior high to senior high school teachers.

Dubin and Hedley (1969) listed many studies that reported an increased favorability toward television after experience with it. They also reported that students at the college level preferred small discussion classes to television classes and television classes to large lecture classes.

In an interesting study, Carpenter and Greenhill (1958) compared students' stated preference for television with their actual preference when given a choice. For business law students, 42 percent claimed a preference for televised courses, although 47 percent went to a televised course when the choice was available. The difference was even more pronounced for political science students. Of these students, 51 percent stated a preference but 70 percent chose the televised course.

Chu and Schramm (1967) summarized the conditions that affect student and teacher attitudes toward television.

44. Among the factors that determine teachers' attitudes toward instructional television are (a) how they perceive the degree of threat to the classroom; (b) how they estimate the likelihood of mechanized instruction replacing direct contact with students; (c) how they estimate the effectiveness of instructional television; (d) the difficulties they see in the way of using modern techniques; (e) how conservative they are, and whether they trust or distrust experimentation.

45. Among the factors that determine students' attitudes toward instructional television are (a) how much contact they think they will have with a teacher; (b) how they compare the relative abilities of the studio and classroom teachers; (c) whether they find instructional television boring or interesting; (d) the nature of the televised programs they have seen; (e) the conditions of viewing.

Programmed Instruction

Programmed instruction is a general description for a type of instructional process and may entail the use of books, teaching machines, radio, or television. The use of a computer allows for much more complicated branching programs. The effectiveness of computer assisted instruction is discussed in the following section. The programmed material usually allows for individual learning of a subject by presenting the subject in a well-ordered sequence of steps, allowing for student responses, and reinforcing those responses. Schramm (1962b) reviewed over 180 studies in programmed instruction.

Approximately 75 percent of the studies tested various aspects of the forms of programmed instruction, including ordered sequence, size of steps, response mode, prompting and confirmation for responses, knowledge of results, and pacing.

Along related lines, Gagne (1965) has theorized that learning proceeds according to a hierarchy of learning tasks from signal learning (a general, diffuse response to a signal) to problem solving (the ability to use two or more chains of concepts to produce a new capability that can be shown to depend on a "higher-order" chain). In a variety of experiments (Gagne, 1962; Gagne, Mayor, Garstens, and Paradise, 1962) and Gagne and Paradise, 1962) the advantage of dividing a task into a hierarchy of learning sets was demonstrated.

Peterson (unpub.) surveyed twenty-eight experiments in mastery learning and found twenty-four cases with significant differences in favor of mastery learning. Mastery learning is a general term used to describe a programmed instructional process in which a subject is subdivided into many smaller units. Each student attains a mastery of a given unit before being advanced to the next unit. The experiments discussed progression from simpler to more complex tasks, but the subdivisions were not necessarily along the lines of Gagne's learning hierarchies.

Learning from Programmed Materials

The general conclusions from several recent surveys of programmed instruction are: programmed instruction is as effective as conventional instruction and usually takes less time. For example, Wells (1973) mentioned an analysis of programmed instruction for college economics (Lumsden, 1967) that found no significant differences in economics knowledge between programmed and conventionally taught students. However, students with the programmed books spent only three weeks (an average of 12 study hours) compared to seven weeks in the lecture.

Schramm's (1962b) annotated bibliography also included 36 studies that compared programmed and conventional instruction. He reported no significant differences in 18 studies, 17 differences significantly favoring programmed instruction, and only one favoring traditional instruction.

Silberman (1962) reviewed 15 experiments in programmed instruction and found significant differences in nine of the cases for programmed instruction and no significant differences in the remaining six cases. He also reported a time saving in each of the experiments with the use of programmed materials.

Lange (1972) reported the results of 112 studies of programmed instruction that were undertaken between 1960 and 1964. No significant differences were reported in 49 percent of the cases, significant differences favoring programmed instruction were reported in 40 percent of the studies, and the remaining 10 percent of the cases favored traditional instruction.

Zoll (1969) reviewed the use of programmed instruction for mathematics instruction in 35 studies (mostly doctoral dissertations). Thirteen of the studies compared programmed and traditional instruction, with no significant differences in seven of the studies. Of the remaining six, three favored programmed instruction and three favored traditional instruction.

Wells (1973) surveyed the use of technology in economics education (mostly at the college level). Of the 36 studies included in his survey, seven analyzed the use of programmed instruction. Programmed instruction provided significantly higher performance in two of the cases, and there were no significant differences in the remaining five studies.

Examples of Specific Studies in Programmed Instruction

Attiyeh and Lumsden (1965) analyzed the performance of students in high school economics on a standard economics examination. On the pretest, the students ranked in the 62nd percentile of the national norm (students without economics). On the posttest (after using programmed materials for ten weeks) the students ranked in the 82nd percentile of the national norm (students with economics).

In studies of mathematics for different student ability levels, no significant differences were reported by Tanner (1966) for seventh grade low achievers, Bobier (1965) for twelfth grade low achievers, and Meadowcraft (1966) for seventh graders at all ability levels.

Barcus, Hayman, and Johnson (1963) used programmed instruction for reading and writing Spanish for sixth grade students. When the programmed material was introduced after a year of conventional instruction, the students in the control group performed significantly better. When the programmed material was introduced after one-and-a-half years of conventional instruction, there were no significant differences, indicating that the time of introduction might significantly affect performance.

Reed and Hayman (1962) found no significant differences between control and experimental groups in tenth grade English grammar and usage. However, when students were subdivided by ability groups it was found that high-ability students did significantly better with programmed instruction, and low ability students performed significantly better with conventional instruction.

Attitudes and Program Construction

The surveys and studies analyzed did not contain any information on social attitude changes. Attitude data in these studies only measured student attitudes toward programmed instruction. Zoll (1969) reported that ten of the mathematic studies he surveyed reported favorable attitudes toward programmed instruction, and in three of the studies interest decreased with time spent on the program. Schramm (1962b) reported that students were generally favorable, although they were more often bored with long programs than with short ones and with programs that used short steps than with programs that increased step size or used longer steps.

While little information was obtained on the coordination of programmed materials with conventional instruction, the value of improving the quality of the material is evidenced in two of the studies surveyed by Wells (1973). Fels and Starleaf (1963) reported significant differences favoring the lecture students in their first experiment but no significant differences in the second experiment when the materials were revised. Attiyeh, Bach, and Lumsden (1969) conducted one of the largest studies of programmed instruction to date, covering over 4,100 students at 48 colleges. Two different programmed books were used, and the students were divided into three groups: programmed book only, conventional instruction supplemented by the programmed book, and conventional instruction only. Students using one of the programmed books as the only source of instruction performed significantly worse than all other groups, indicating a difference in quality of programmed material.

Two studies reported on the relationship of performance on programmed instruction with various student characteristics. Doty and Doty (1964) used a programmed unit for psychology students and found a significant negative relationship between social need and performance on programmed instruction. There was no significant relationship with achievement need.

Shrabel and Sassenrath (1970) performed an experiment with college upperclassmen. They defined an easy program as one in which the probability of success of a response was nearly 100 percent; a hard program had a probability of success of less than 60 percent. Basing their results on quicker completion times, lower error rates, and higher retention rates, they found that easy programs were better for persons with low need for achievement and high fear of failure. Hard programs with longer steps were better for persons with high need for achievement and low fear of failure. They concluded that the easy program provided insufficient motivation for students with high need for achievement.

MacPherson (1967) reported that persons with high anxiety levels required significantly less time to complete the programmed material.

The research on program construction is summarized by Schramm (1962b). The majority of these studies were short duration experiments with college students. While many of the results are interesting, the applicability of the results to primary and secondary students might be limited. Some of the studies cited by Schramm will be mentioned below to give an indication of typical experimentation.

Ordered Versus Random Sequence

Levin and Baker (1963) tested the differences between ordered and scrambled sequencing of one-third of the frames in a 180 frame geometry program for second graders. They found no differences in acquisition or retention of knowledge. However, the program was rather short and it is reasonable to assume that longer programs would require more order.

Size of Step

Size of step is measured in three forms: the reciprocal of the number of steps, the amount of material covered in a frame, and the number of errors.

In a series of experiments using college students and measuring step size by frame content Maccoby and Sheffield (1958), Margolius and Sheffield (1961), and Weiss, Maccoby, and Sheffield (1961) demonstrated that performance was better in programs with gradually increasing steps. In experiments in which the student was able to vary the step size, the programs resulted in gradually increasing steps.

Shay (1961) measured step size by number of errors for fourth grade students and found no relationship between step size and intelligence level.

Smith and Moore (1962) measured step size by the number of steps required to complete a unit and found no significant differences for fifth grade spelling.

Overt and Covert Responses

Schramm reported that the majority of the studies report no significant differences between overt (written or oral) and covert (thinking) responding. Keislar and McNeil (1962) reported no significant differences in primary grade science for overt and covert responding. Lambert, Miller, and Wiley (1962) reported no significant differences in ninth grade mathematics between the two response modes. Campbell (1961) reported no significant differences between overt, covert, and reading responses, although the reading group performed significantly better on a retention test after ten weeks.

In a related experiment, Goldbeck and Campbell (1962) found that the overt group performed below covert and reading groups at low difficulty levels and above the other groups at intermediate difficulty levels.

Suppes and Ginsburg (1962) found that a group of five- and six-year-olds performed significantly better when they were required to repeat a correct response after each error rather than merely being told the correct response.

Knowledge of Results and Pacing

Schramm reported that the majority of the studies favored immediate knowledge of results. Although individual pacing would appear to be preferable, there was no evidence in the experiments to support this contention.

Moore and Smith (1961) found no significant differences between groups of sixth graders (1) who received immediate knowledge of results and those who did not and (2) who worked at their own pace and those who completed a fixed amount of material each week.

Confirmation and Prompting

In the confirmation format, the student responds when appropriate and is then told if the response is correct. In the prompting format the stimulus and response are presented simultaneously and the student then repeats the response. Most of the studies have shown a superiority for prompting formats. It should be emphasized that the studies where prompting was successful usually did not deal with concepts or problem solving.

Briggs (1961) found prompting superior for the learning of map symbols by high school students. Campbell (1961) found no significant differences for prompting or indirect cueing in a short program on static electricity for junior high school students. Angell and Lumsdaine (1961) found prompting to be advantageous for high school students in pairing English words with digits and English and French words.

Computer Assisted Instruction

Computer assisted instruction is a relatively new and expensive technology that allows for more individuality in progression toward program goals than other technologies. Research into the effectiveness of CAI is recent and has amply demonstrated its effectiveness. The CAI programs for elementary students have usually been drill-and-practice mathematics or reading programs and have been supplemental to regular instruction. The student receives several sessions per week on a computer terminal. (Wells, Whelchel, and Jamison, to appear, found a range of 3 to 159 sessions, with a mean of 80 sessions, on a yearly basis for students in their study.) At the college level, CAI has been used as a substitute for conventional instruction and the results have been favorable.

Jamison, Suppes, and Wells (to appear) have provided an extensive analysis of CAI experiments at the elementary and college level, and the discussions on the effectiveness of CAI in this section closely follows their discussion. The discussion of the effectiveness of CAI for cognitive outputs will be followed by an analysis of noncognitive effects of CAI presented by Hess and Tenezakis (1970) and Smith and Hess (1972).

College Level CAI

Hanson, Dick, and Lippert (1968) reported on the use of CAI for physics and found that a group receiving CAI instruction performed significantly better than groups receiving (1) traditional instruction only and (2) a combination of CAI and traditional instruction.

Adams (1969) and Morrison and Adams (1969) reported on the use of an hour of CAI instead of an hour of language laboratory as supplements to the lecture class in college German. CAI students were superior in reading and writing ability. No significant differences were uncovered in listening or speaking abilities.

Suppes and Morningstar (1969) reported on the use of CAI as a replacement for the normal classroom hours of an introductory college Russian course. Five hours of lectures were replaced with five CAI hours each week. The dropout rate for the CAI section was less than half the dropout rate of the regular section. In addition, the CAI students performed better on the final examination.

Three studies demonstrated the reduction in time that occurs for CAI usage. Axeen (1967) used the Plato system for teaching library use and found no significant differences in test scores, but found that CAI students took less time.

Bitzer and Boudreaux used the Plato system for a nursing course and found that the average student using CAI completed the materials in 50 hours compared with 84 lecture hours.

Homeyer (1970) used CAI for computer programming. Although he found no significant differences on examinations or grades for programs written by the students, he did find a significant time savings. CAI students used an average of 13.75 hours compared with 24 hours for the lecture group.

Elementary Level CAI

Vinsonhaler and Bass (1972) recently surveyed ten studies in CAI effectiveness. These ten studies included 30 separate experiments and involved over 10,000 students. Vinsonhaler and Bass concluded that there was strong evidence that CAI was effective where effectiveness was measured by standardized test scores.

Suppes and Morningstar (1969) reported the results of the evaluation of a drill-and-practice program in mathematics, which was used at four schools in California and 12 schools in Mississippi. CAI programs were used for all grade levels. To evaluate the effectiveness of the programs, they administered the Stanford Achievement Test (SAT) using different forms for the pretest and posttest examinations.

The four California schools were matched in two pairs according to school district, and in each case one school used CAI and the other did not. For schools A (experimental) and B (control) there was a significant advantage for CAI students in grade 3 but a significant disadvantage in grades 4 and 5 (there were no significant differences in grade 6). For schools C (experimental) and D (control) CAI students were favored in grades 4 and 6 with no differences in the grade 5. At the end of the school year, the investigators learned that the teachers and administrators at school B had added 25 minutes per day to mathematics instruction fo the 4th and 5th grades. This increase in instruction caused the apparent disadvantage for CAI and demonstrated that an increased effort along other dimensions could be as effective as CAI in supplemental instruction.

The 12 Mississippi schools were divided into eight schools with CAI and non-CAI students, three schools with CAI students only, and one school with non-CAI students only. The CAI students performed significantly better for all grades (1-6), and in most cases gained one-half grade or more above the gain of non-CAI students.

In a further study Suppes and Morningstar (1972) analyzed the performance of students according to subtests of the SAT. The subtests were: computation (grades 1-6), concepts (grades 2-6), and applications (grades 4-6). Mean gain scores were compared for students in seven California schools and for two groups of students: mixed classes (CAI and non-CAI students in the same class) and separated classes (CAI and non-CAI students in different classes). Of the 40 test comparisons, CAI students outperformed non-CAI students in 29 cases. The difference was significant in only 10 cases listed below:

Mixed classes
- Computation: grades 3, 4, and 5
- Concept: grade 3
- Applications: grades 4 and 5

Separated classes
- Computation: grades 2, 3, and 5
- Applications: grade 6

Non-CAI students had significantly higher scores in grade 4 in the separated classes for the concepts and applications subtests.

Weiner (1969) evaluated the use of CAI for mathematics in New York City schools and used the Metropolitan Achievement Tests for measurement of CAI effectiveness. In grades 3, 4, and 5 the CAI students scored significantly higher gains, even though they had significantly lower pretest scores. In grade 2 the pretest score was higher (insignificantly) for the non-CAI students and higher (significantly) for the CAI students. In grade 6 the gains were insignificantly higher for CAI students.

Atkinson (1968) reported on an experiment in CAI for reading. Students in the experimental group received CAI for remedial reading, while students in the control group received CAI for remedial mathematics. The experimental and control groups had similar characteristics and were all in the 1st grade. Scores were significantly higher for the experimental group on the Hartley Reading Test and all subtests of the California Achievement Test, with the exception of the comprehension test. The computer system used in this experiment was an expensive one; each student station had not only a cathode-ray tube and a keyboard terminal, but also an audio and visual display unit and a light pen for the cathode-ray tube.

Wells, Whelchel, and Jamison (to appear) evaluated the effectiveness of a mathematics program in CAI for grade 5 and 6 in California schools. The students were stratified by grade and sex for the statistical analysis. Although the non-CAI students had higher scores on the pretest of the California Test of Basic Skills, the CAI students had significantly higher gains in three out of four cases. Interestingly enough CAI students in two of the groups also scored significantly higher on reading tests. The result for the reading test should eliminate any concern with decreasing performance in other subject areas when CAI is introduced for supplementary work in one subject area. A regression analysis was also used to determine the amount of the effect and to control for variations in individual abilities and teacher characteristics. For 5th grade boys, an additional session of CAI resulted in an increase of 0.004 grade equivalents on the test. This result seems numerically small, but if linearity was maintained for 100 sessions of CAI the gain would be 0.4 grade equivalents.

Noncognitive Effects of CAI

Two of the studies reported below analyzed the effects of CAI on the attitudes of students toward themselves, and the third study attempted to measure the use of the computer as a socializing agent.

Wells, Whelchel, and Jamison (to appear) found that there were significant differences in the self-expectation of CAI and non-CAI students. However, when CAI students were considered separately, a positive association was uncovered between self-expectation and number of sessions of CAI.

Smith and Hess (1972) used the Sears Self-Concept Inventory, Coopersmith Self-Esteem Inventory, Crandall Locus of Control Instrument, and items from the questionnaires used in the Coleman (1966) report. All of these measurement instruments are based on student responses; they question the student's attitudes relating to general control over environment, responsibility for mathematics failures and successes, aptitude in mathematics, and social relations. The sample used for the analysis consisted of 159 students with CAI and 161 without in grades 7, 8, and 9. The general result observed was no significant difference between CAI and non-CAI groups, and no difference in means on pre- and post-test measurements for the CAI group.

Hess and Tenezakis (1970) used extensive questionnaires to determine the attitudes toward computers and other instructional media and the possibility of using the computer as a socializing agent. CAI in this case was used for mathematics instruction of 7th, 8th, and 9th graders who received CAI for remedial work.

The effectiveness of a communicator was measured in three dimensions:

- Expertise--Amount of information, validity of information, ability to answer all questions, and likelihood of making mistakes.
- Trustworthiness--Inferred from items dealing with motivating power of computer.
- Charisma--Infallibility, limitless endurance, unpredictability, and unresponsiveness.

The majority of the students felt that the computer gave the right answers, had large amounts of information, could answer all questions, would make few mistakes, and was smarter than textbooks. The students were divided on the relative intelligence of computers and people. In terms of expertise, the computer was also rated higher than the teacher on all items.

In terms of trustworthiness students were generally satisfied with the computer for use in math and were satisfied with the problems chosen by the computer and the scores they received from the computer. The computer was ranked higher than the teacher on those items and was also considered to be fairer and clearer than the teacher. The students were also more favorable to the computer than to textbooks or television.

For the measurement of charisma, students felt that the computer was unresponsive, unpredictable, not infallible, and had unlimited endurance. Teachers were ranked as unpredictable as computers but more responsive.

In terms of comparing the computer with teachers on task related items, Hess and Tenezakis found that the computer was more responsive to the student's abilities but less responsive to the student's desires. Students also had a greater understanding of computer assigned tasks. In criteria for evaluating task performance of students, the computer and teacher were judged equivalent in correctness, completeness, and neatness. Speed was ranked more important in the computer evaluation and the teacher was seen as using nontask items for evaluating student task performance.

While a large amount of information was analyzed by Hess and Tenazakis in an attempt to uncover undue reverence of the computer, one is forced to conclude that students have favorable but realistic attitudes toward the computer. The students realize that the expertise of the computer is derived from the expertise of the person or persons who programmed it. This expertise is ranked higher than that of the classroom teacher. To the extent that people rely on authority figures for information and values, the computer may have magnified effects.

Other advantages of a computer to the students is its neutrality compared to a teacher, and the increased feedback they receive from the computer. The major disadvantage seems to be the lack of control the student has over the direction of a computer.

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Appendix A, Part 2

INSTRUCTIONAL FILM RESEARCH

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Appendix A, Part 2

INSTRUCTIONAL FILM RESEARCH*

More research has been done on film than on any other single medium. Instructional film research began in the United States near the end of World War I. Since then, research has been supported by all sectors--from commercial concerns to universities and foundations to various branches of government. The research evaluates the effectiveness of film in meeting many diverse educational objectives, such as:

- Motivating the student to learn.
- Imparting factual knowledge.
- Teaching perceptual motor skills.
- Stimulating student participation in the learning process.
- Changing student attitudes, opinions, and behavior.
- Reinforcing (or rewarding) the student's acquisition and use of knowledge.

This review of the effectiveness of instructional films relies almost exclusively on three other reviews of the literature: Hoban and van Ormer (1950),† Lionberger (1960), and Saettler (1968). All of the specific studies to be cited here are also cited in those sources.

In this review we are primarily interested in the effectiveness of instructional film along cognitive dimensions. For this reason, we will first discuss the effectiveness of film in teaching facts, concepts, and skills. We will then briefly examine the evidence on noncognitive goals, such as motivation and attitude change. Instructional film research goes beyond the model for most research on the effectiveness of educational technology, since the model is only the comparison of one medium (further

*This analysis of film research was prepared by SRI to augment the analysis by Wells in Part 1 of this Appendix.

†References are listed at the end of this Appendix.

unspecified) to conventional instruction (further unspecified). However, instructional film research is still not very sophisticated. For instance, in looking at film effectiveness in conveying factual knowledge, little distinction is made between acquiring facts and accepting them, or acquiring facts and using them. The lack of such distinction may account for the variation in results of different studies.

Studies of Cognitive Effectiveness

One of the best-known studies dealing with the teaching of facts with film was done by Holaday and Stoddard (1933). They concluded that the general information of both children and adults is increased by information shown in motion pictures, and that retention of specific incidents is high. They also concluded that incorrect information presented in films is usually accepted as valid unless the errors contained are glaring.

Three studies of the Army orientation films Why We Fight done by Hovland, Lomsdaine, and Sheffield (1949) showed that these films had a sizeable effect on increasing the factual knowledge of trainees on the subjects covered. The group of trainees shown the film learned from 14 to 22 percent more than the control group, on the average. When the results were compared on the basis of the years of education of the trainees, the studies concluded that trainees with more education learned significantly more from the films.

Two studies of the Yale Chronicles of American Photoplays, Wise (1939) and Knowlton and Tilton (1929), showed that film plus conventional instruction is more effective in teaching historical facts than conventional instruction alone. Knowlton and Tilton found, however, that the Photoplays interfered with, or at least did not facilitate the teaching of time relationships.

Two reports on the Nebraska study of the enrichment effects of motion pictures, Wise (1949) and Scott (1949), suggest that films are very specific in their effects. The superiority of film-supplemented instruction in the specific areas covered by the films was reliable and appreciable. On the other hand, on standardized tests administered before and after the semester, no such uniform reliable effect was found.

The conclusions reached by Hoban and van Ormer (1950) on the effectiveness of films in imparting cognitive knowledge were:

- Films can be good communicators of information that can be presented visually, but film presentation may sometimes result in the distortion of some facts, such as time relationships, during learning.

- The effectiveness of films depends on how well their content is related to the instructional objective. There is nothing in the motion picture presentation, per se, that guarantees better learning.

- Research does not bear out the notion that film learning is passive. Some studies show that the contribution of good instructional films to the comprehension of understanding of facts is greater than their contribution to the rote memory of details presented in the films.

- The force of motion pictures in communication seems to be of such a nature that the influence of certain films on factual knowledge may persist over a long period of time.

Comparison Between Films and Other Media and Methods of Instruction

Although the result of all the research is not consistent, most studies suggest that the addition of films to conventional instruction increases the amount learned. This effect seems consistent when the film and the other instruction are designed to reinforce each other. Studies that compare the use of film alone to conventional instruction suggest that for certain topics and for limited objectives in teaching information and concepts, suitable instructional films may be more effective in the instructional process than poor instructors, and at least as effective as average instructors. In many studies comparing film presentation with lecture or demonstration, the films reduced the instructional time required (sometimes as much as one-half to two-thirds) with little or no sacrifice of instructional results.

Noncognitive Effects of Films

The motivational effectiveness of films has not been well researched. Research presents no evidence that motion pictures reduce academic motivation; that is, that they result in less voluntary reading, less voluntary participation in classroom recitation, or greater avoidance of a specific course of study. The scanty experimental results do suggest that audiovisual demonstrations in general may have some fairly long-lasting motivational effects, but we know too little about motivation in this area to use it with consistent effectiveness.

We do know some factors that do not increase the motivational effects on films. For instance, a study by Vandermeer (1950) found that a technically "slicker" version of a film did not increase its effectiveness. Other experiments--e.g., May and Lumsdaine (1958)--found a negative correlation between how much students liked a film and how much they actually learned from it. Attempts to incorporate motivational sequences or perspectives are not successful; studies by Beck, Van Horn, and Gerbner (1954) and by Peterman and Bouscaren (1954) bear this out. In one experiment by Feshback and Janis (1951) the film that produced the highest degree of anxiety about dental health was actually counter productive: viewers found that ignoring the issue of dental health altogether was a much faster way of relieving the anxiety than taking better care of their teeth.

The evidence on the effects of films on attitudes is summarized by Hoban and van Ormer (1950):

- Specific attitude changes can result from certain motion pictures whose content is closely related to the object of the specific attitude.
- The effect of films on specific attitudes can be cumulative for two or more pictures on the same social theme. The cumulative effect may result even though some films in the sequence may be individually ineffective in reliably influencing a specific attitude.
- When the initial influence of one or more films on a specific attitude is large, it may persist for weeks or months, generally with some diminution.
- Few, if any, specific attitude changes will result when the film bias is strongly contradictory to the social norms. In the case of contradictory influences, film bias may actually reinforce the existing attitude, rather than modify it.
- Films may not exert the same attitudinal influence within a nonuniform population, such as one in which different occupational, social, or educational backgrounds are represented.

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Appendix B

BUDGETARY COST ESTIMATES FOR FIVE INSTRUCTIONAL TECHNOLOGIES

Appendix B

BUDGETARY COST ESTIMATES FOR FIVE INSTRUCTIONAL TECHNOLOGIES

Intensiveness and Extensiveness

Details of the cost estimates summarized in Section III of the main body of the text of this report are presented herein. The estimates are for five instructional technologies, or media: (1) broadcast, cable, and video cassette instructional television; (2) 16mm film; (3) programmed text; (4) computer based instruction; and (5) audio cassette sound-filmstrip. The approach here is to define two variables and to compute the costs of using each of the above five technologies over the range of those variables. One variable, which we will call "intensiveness," relates to the number of minutes per day or per week that the instruction is given; the other variable, which we will call "extensiveness," relates to the number of students and the geographical area concerned. Changes in each variable permit consideration of media use in widely different circumstances, while maintaining comparability of the estimates. However, the reader should be aware that the normal uses of a given medium might not be compatible over the entire range assigned (e.g., sound-filmstrips used one hour/day by each student), or the student population might be too large or too small for the cost-effective operation of the medium.

Since information on the effectiveness of different systems in either instructional or organizational terms was not included in the cost study, the effectiveness dimensions of different system scales will not be evident in the cost figures obtained here. What will be determined is the extent of cost advantages or disadvantages at different levels of use, both in the amount of time each student uses the media system per week and the number of student users.

In addition, the lack of empirically based evaluation standards for learning materials means that the costs of such materials for each system cannot be developed in reference to precise specifications of comparable learning tasks across the media. In some ways this makes a cost study easier, in that instructional "tasks" will have to be neutral with respect to subject material; the "tasks" will relate only to one common dimension, intensiveness. In this study the single "task" dimension used is simply the amount of time per week, on the average, that a student would receive instruction from the media system. This means that the real differences among the media and their relative appropriateness for different tasks and the different instructional results obtained will be masked in the cost figures.

Instructional Tasks and Environments

General expressions for three instructional tasks were chosen that would provide to each student, on the average, sufficient material to occupy different amounts of his total instructional time, as shown below:

Task	Intensiveness
I	20 min/week/pupil
II	20 min/day/pupil
III	60 min/day/pupil

If the total instructional time (excluding lunch periods, recess or exercise periods, and study halls) of each student is five hours per day, Tasks I, II, and III correspond to 1.3, 6.7, and 20 percent of the student's total instructional time, respectively. In reality, some students will use only a few of the media and not others; some will use no media; still others may use a given medium more than these percentages of instructional time. The instructional task is general in nature so that it may be applied to any media system. Twenty-minute segments were chosen because this corresponds to (1) the average length of films, sound-filmstrips, and instructional television programs and (2) two 10-minute or one 20-minute lesson on a computer based system. The range of times chosen is sufficient to cover the spectrum from typical present uses of film to extremely intense uses of each medium. The reader familiar with the General Learning Corporation study,[1*] from which the basic approach described here is derived, will note that it used only one

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*References are listed at the end of this Appendix.

instructional task, which corresponds roughly to Task II above. Variations in cost with extensiveness and intensiveness of use will yield a measure of the economies of scale of each of the media examined.*

Four environments were chosen to represent a variety of geographical areas and population densities actually found in urbanized parts of the United States. State and regional areas were omitted from the calculations to make the task more manageable; interested readers can find a discussion of the costs of instructional television systems at the state and regional level in Linvill et al.[3] The characteristics of the four environments are summarized in Table B-1.

Local District I represents an exurban area having an enrollment slightly under the 1971 national median. The district has an irregular shape, but all schools lie within a circle whose radius is five miles. In Table B-1, this is called the radius of the smallest encompassing circle. The area and population may actually be made up of two or more smaller administrative units joined in a cooperative effort to share the costs of some of the more elaborate media systems (e.g., television). Local District II represents a joint undertaking by two adjacent, developed suburban school districts, each approximately the size of the Palo Alto Unified School District in California. The City and Metropolitan models are modified to fit a K-8/9-12 configuration from the General Learning Corporation's 1968 study (Ref. 1, pp. 5-7, summarized in Ref. 4, pp. 3-4). In the Metro† model it is assumed that school districts in the area would cooperate on large media projects where economies of scale of operation could be achieved.

The elementary schools in each configuration are intended to represent a K-8 configuration, and the secondary schools include senior and vocational high schools. Throughout the modeling process, an elementary school will have between 500 and 700 students (with a mean of 600) and 20 or more classrooms. The secondary schools will have between 1,000 and 1,500 students and 50 or more classrooms. The totals for each configuration are rounded to form convenient numbers.

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*Schramm (Ref. 2, p. 79) has termed media use of the order of Task II "a very heavy use of instructional media, not ... [the use of] a few films in a course or presenting supplementary materials by filmstrip or tape." Task III, three times this level, was included to represent the upper boundary on media use with present knowledge.

†In this report, the words "metro" and "metropolitan" are synonymous.

Table B-1

ENVIRONMENTS, OR EXTENSIVENESS OF MEDIA USE

Local District I model parameters	
Student population (K-12)*	10,000
Total population (approximate)	40,000
Area	53 square miles
Population density (average)	750/square mile
Approximate shape	irregular
Radius of smallest encompassing circle	5 miles
Number of elementary schools	10
Number of secondary schools	3
Local District II model parameters	
Student population (K-12)	30,000
Total population (approximate)	110,000
Area	50 square miles
Population density (average)	2,200/square mile
Approximate shape	rectangular
Radius of smallest encompassing circle	5 miles
Number of elementary schools	34
Number of secondary schools	7
City model parameters	
Student population (K-12)	150,000
Total population (approximate)	800,000
Area	70 square miles
Population density (average)	11,500/square mile
Approximate shape	rectangular
Radius of smallest encompassing circle	6 miles
Number of elementary schools	169
Number of secondary schools	35
Metropolitan Area model parameters	
Student population (K-12)	600,000
Total population (approximate)	2,100,000
Area	1,500 square miles
Population density (average)	1,400/square mile
Approximate shape	irregular
Radius of smallest encompassing circle	30 miles
Number of elementary schools	677
Number of secondary schools	139

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*(K-12) = kindergarten to 12th grade.

Courseware Time Requirements

The three tasks must be treated further in order to determine the number of hours of unique programming required of the instructional courseware. The most critical factor affecting the amount of unique programming required is the number of students who use (or interact with) a specific instructional sequence in any given year. A convenient descriptor of such patterns of use is in terms of joint use among grade levels in an elementary setting or among different courses in a grade level in a secondary school setting. Since the trend in education is strongly away from such rigid organization, this description is somewhat archaic. For the purposes of this cost study, on the other hand, what matters is the requirement for courseware and the scheduling of courseware distribution, rather than the particular mode of use in the learning setting. Thus if the term "grade level" is used, it can equally well be interpreted as the equivalent number of students at the equivalent learning level, while allowing flexibility in the organization of learning at each specific site.

With this understanding, the number of hours of unique programming required for the two local district environments can be selected. Guidance in these decisions was obtained from the 1972-73 instructional television schedules for schools in (1) the Anaheim City Elementary District,[5] (2) the Santa Ana Unified School District[6] (both in California) and (3) Washington County (Hagerstown, Maryland).[7] The final form of the programming types at the secondary level was developed from Appendix C of Ref. 3, with a substantial reduction in the number of vocational education options offered. The resulting programming requirements are shown in Table B-2 for an intensiveness of 20 min/day for each pupil.

If one proceeds sequentially through the various grade levels in Table B-2, it will be evident that this configuration implies a significant use of media techniques in delivering core instruction to each student. More importantly, the intensiveness of use is designed to be the same for each student over all twelve grade levels. An increasing number of options is available in the higher grades to satisfy the student's more heterogeneous subject and treatment requirements, especially as between academic and vocational preparation.

Generally speaking, programming is represented as common to all students in each of the first six grades, with options available at the seventh and eighth grades for one-third (20 hours) of total programming received by each student. In grades 9-12, programming is divided for each student into three equal portions. One-third is common to all

Table B-2

TOTAL REQUIREMENTS FOR ELEMENTARY AND SECONDARY PROGRAMMING IN LOCAL DISTRICTS
(Intensiveness: 20 Min/Day/Pupil)

Grade Level	Student Group	Type of Programming	Hours for Each Student	Number of Options	Programming Hours/Year
Elementary					
K,1,2	All	Joint, grades 1 and 2	20	1	60
3-6	All	Common to grade levels	60	1	240
7-8	All	Common to grade levels	40	1	80
	All	Options at grade levels	20	2	80
Subtotal programming hours, K-8					460
Secondary					
9	All	Common to grade level	20	1	20
	College Prep.	Common to grade and course	20	1	20
	Voc. Ed.	Common to grade and course	20	1	20
	College Prep.	Options for grade and course	20	2	40
	Voc. Ed.	Options for grade and course	20	2	40
10-12	All	Common to grade level	20	1	60
	College Prep.	Common to grade and course	20	1	60
	Voc. Ed.	Common to grade and course	20	1	60
	College Prep.	Options for grade and course	20	2	120
	Voc. Ed.	Options for grade and course	20	5	300
Subtotal programming hours, 9-12					740
Total					1,200

students, a second third is specialized as to academic or vocational preparation but is taken by all students in each specialization, while the last third consists again of options available within each specialization.

There is nothing sacred about the structure of these programming requirements. What is important, particularly for the costs of television systems, is the uniformity of coverage of grade levels and the fitting of the medium to the program of the secondary schools, rather than trying to fit the schools to the medium.

Programming Requirement for 20 Min/Day/Pupil in Local Districts

The total unique programming requirement at 20 min/day/pupil is the sum of the elementary and secondary figures. As shown in Table B-2, this is 1,200 hours.

Programming Requirements for 20 Min/Wk/Pupil and 60 Min/Day/Pupil in Local Districts

Programming requirements for 20 min/wk and 60 min/day average intensities are respectively one-fifth* and three times the 20 min/day intensiveness. Dealing with the totals only (the reader can readily compute the corresponding elementary and secondary requirements) we have:

$$\text{Requirements for 20 min/wk} = 1/5 \times 1{,}200$$

$$= 240 \text{ hours/year}$$

$$\text{Requirements for 60 min/day} = 3 \times 1{,}200$$

$$= 3{,}600 \text{ hours/year.}$$

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*Assuming a five-day week.

For comparison, the General Learning Corporation study used a total of 1,000 hours of unique programming to occupy ten percent of the total instructional time in grades 1-12 (Ref. 1, pp. 10-11).

At the city and metro levels, the overall unique programming requirements due to curriculum differences across schools in these larger environments are somewhat more than at the local district level. A 25 percent increase in unique programming requirements will be taken to represent this for the city, and a 50 percent increase for the metropolitan area. The summary figures are given in Table B-3.

Table B-3

REQUIREMENTS FOR COURSEWARE UNIQUE PROGRAMMING
(Hours per Year)

	Intensiveness		
Extensiveness	Twenty Minutes/Week	Twenty Minutes/Day	Sixty Minutes/Day
Local	240	1,200	3,600
City	300	1,500	4,500
Metro	360	1,800	5,400

The impacts of increased courseware requirements at the city and metro levels are felt principally for media having centralized production or broadcast distribution systems, such as instructional television. If courseware is leased or purchased in multiple copies (e.g., for instructional film libraries in large cities), the requirements for an increased range of courseware can be met by varying the mix that is purchased rather than increasing the total number.

The Costs Examined*

Costs can be categorized along two dimensions, function and time.

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*Adapted from Ref. 4, pp. 7-10.

Function

Costs can be classified in terms of production (of the instructional content, or courseware, from which the student will eventually learn), distribution (of the instructional content by mechanical or electrical means to the learning site, and the return of learner feedback), and presentation (of the instructional content to the student in a form suitable for learning).

Production

Production costs encompass all expenditures incurred to design the media curriculum and to obtain, evaluate, and update the courseware used in the media system. This includes costs of selecting and acquiring courseware from external sources as well as costs of local courseware creation. Specific examples include planning, writing scripts, and recording programs for television based systems, and writing, debugging, and pretesting programs for computer based systems.

Distribution

Distribution costs are those incurred in converting the instructional content to a transmittable or transportable form, sending it to the learning sites, receiving it there, and returning any learner responses and records required for the media system to operate. These include duplication (if required) and transportation costs of copies of an instructional program and the communications costs of electronic systems. Television transmitters and receiving antennas and computer two-way data communication links between learning sites and central facilities are specific examples.

Presentation

Presentation costs are those incurred in changing the form of the received material to a form useful for learning by the student. For computer based approaches, this includes the cost of processing the instructional program and student responses so as to obtain a sequence of interactive experiences adapted to student needs. Specific examples include costs of computation and memory, student terminals, TV receivers, film projectors, screens, and all communications wiring within the learning site (schools). In-school instructional personnel costs depend on the deployment of staff, which can vary radically within and among districts having otherwise the same media system. For example, Anaheim employs television in a team teaching context,[8] while Santa Ana employs it in self-contained classrooms.[9] Consequently, personnel costs are considered separate from the presentation category in the analysis.

Time

Production, distribution, and presentation costs can be further classified as either capital or recurrent costs. Capital costs are costs incurred to purchase goods and services that have a useful value of greater than one year (the usual accounting period of school systems) or that need not be purchased every year. Recurrent costs are the operating costs of a system, the costs incurred to purchase goods and services that are used up within a year or are purchased every year. The following lists encompass all the cost elements explicitly included in the modeling exercise.

Capital Costs

The activities and facilities listed below come under the heading of capital costs:

- Initial planning--Planning extends from survey of needs to evaluation of alternative proposals.
- Initial training--Production staff and operations and maintenance personnel may need training and, especially important, classroom teachers may need training to effectively utilize the media system. This training depends on system size and complexity, familiarity, intensiveness of use, and desired quality of performance. This item is too frequently omitted in both system adoption and cost estimation.
- Facilities--Where space at least the size of an entire room is required to perform a media function, this space is costed as new construction on a consistent per square foot basis in lieu of a more precise estimate on available space.

- Initial equipment and courseware--The courseware required to implement the system. including test equipment and an initial inventory of spare parts, is included in this item. In practice most courseware (except live television programming) has a useful life of more than one year and will be treated as a capital cost.

Recurrent Costs

The following activities are considered to be recurrent costs:

- Operation of equipment--Operation includes the salaries of system operating personnel, and the cost of utilities and recurrent supplies. This cost will vary with the medium and the system design.
- Maintenance of equipment and facilities--Maintenance is typically ten percent of the initial purchase price per year, or about one percent per month of operation. It includes replenishment of spare parts and stocks, replacement of test and repair equipment, and prorated building maintenance costs.
- Continuing teacher planning and training--Updating of the media system requires additional training, as does courseware and personnel turnover. This activity is subject to wide variation in practice and is very frequently not undertaken, to the detriment of the system's performance. It is costed as the sum of a courseware previewing cost varying linearly with intensiveness and a fixed percentage of the initial training cost.
- Administration--Administration varies with size, character, and use of the media system. Salary costs increase at a diminishing rate as the system size (as well as its extensiveness), increases. For non-electronic systems (audiovisual media), communication costs such as travel, telephone charges, and mail tend to increase rapidly with system size and complexity.

The electronic systems, on the other hand, have the potential to carry a large part of this burden themselves during nonteaching hours.*

- Related materials--Printed material providing directions, schedules, guidelines, lesson plans, and so forth is required. Sovereign, the economic consultant on the GLC study, notes that the cost of this material is closely related to the number of hours of unique programming and to the total number of users of the system (teachers and students). A cost for each hour of unique programming can be assigned and then extrapolated over the number of user-hours as the extensiveness and intensiveness of the media system increases (Ref. 4, p. 9).

- Research, testing, and evaluation for system updating--Evaluative feedback is essential to ensure proper operation and to guide improvements of the system, including the courseware. For each media system this cost increases with student user population, number of subject offerings, and intensiveness of media use. Costs are assigned to this function only for the two high intensiveness tasks (20 and 60 min/day/pupil) inasmuch as few systems would engage in more than administrative feedback at an intensiveness of only 20 min/week per pupil. Unfortunately, none of the three district ITV systems that we contacted--Anaheim, Santa Ana, and Washington County--carry out such an evaluation on a regular basis, even though their programming is on the order of Task II or greater. Only computer based instructional systems, for which feedback and record keeping is integral to the procedure, and for which much lower separate costs need be assigned, appear to perform this function on a regular basis in ongoing systems.

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*This possibility is in evidence in the Santa Ana system,[6] where a staff development informational program is broadcast once a week.

Support Costs and Direct Costs

The various cost elements outlined above can also be classified as either "support costs" or "direct costs." Three of those elements will be designated as support costs; they are:

- Initial planning
- Administration
- Research, testing, and evaluation.

Support costs are incurred to initiate, sustain, and guide improvements in a media system as a whole, rather than for any one function in particular. The remaining costs will be termed direct costs.

Amortization and Equivalent Annual Costs

To compare systems having a different proportion of capital to recurrent costs, it is necessary to convert one of these to the form of the other and then to sum them. "Capitalizing" the operating cost on the basis of some social rate of discount and then adding the initial investment is called the "present value method" and is the approach typically used for single investment projects, such as water resource development. On the other hand, for an ongoing activity such as education, the natural and preferred approach, and the one used in this study, is to convert each capital cost to an equivalent annual cost on the basis of its lifetime and the discount rate (ten percent was used in this study), and then to add these "annualized" costs to the recurrent costs to obtain the equivalent annual cost.

The standard formula by which to convert an initial capital cost to an equivalent annual cost is the following:*

$$\text{annualized cost} = \frac{r(1 + r)^n}{(1 + r)^{n-1}} \times \text{initial capital cost}$$

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*See Ref. 10, and also Ref. 11, pp. 160-167.

where

r = the cost of capital (the interest rate)

n = the useful life of the initial outlay.

The capital recovery factor (or "annualizing" factor) will be denoted $a(r,n)$. Thus

$$a(r,n) = \frac{r(1+r)^n}{(1+r)^{n-1}} \quad .$$

If $K_i(n_i)$, $i = 1, \ldots, I$, represents I different capital costs with different useful lifetimes, n_i, the equivalent annual cost of the sum is given by

$$\sum_{i=1}^{I} a(r.n_i)\ K_i(n_i) \quad .$$

If in addition there are J recurrent costs, R_j, $j = 1, \ldots, J$, the total annualized costs, TC, is given by

$$TC = \sum_{i=1}^{I} a(r,n_i)\ K_i(n_i) + \sum_{J=1}^{J} R_j \quad .$$

This is the general formula used in this study to obtain annual costs for media systems. The value of r used was ten percent. See Ref. 11, pp. 167-173, for a discussion of factors affecting the choice of r).

The useful lifetimes of various fundamental cost components were made compatible across the media systems. The most generally used in the detailed calculations are listed in Table B-4. The lifetime of three years for locally produced courseware is based on the average practice of the major local districts using instructional television;[12]

Table B-4

USEFUL LIFETIMES OF STANDARD COST COMPONENTS

Lifetime (years)	Component	Comments
Variable	Film and filmstrip projectors	Based on hours of use
3	Locally produced courseware	Computer programs may be updated at the third year without complete rewrite and used for three more years
5	Commercially produced courseware and certain equipment	For example, delivery trucks, film inspection machines, TV sets, videotape machines
10	Initial planning	
10	Initial teacher training	
10	Installation costs	
10	Most major equipment	For example, computers and outfitting of facilities
25	Buildings	

it reflects obsolescence of content rather than wear and tear.* Five years for commercially produced courseware is a reasonable assumption widely used and explicitly quoted for several of the media (Ref. 1, p. 206 and Ref. 13, pp. 482 and 486). Ten years' lifetime for initial planning, training, and equipping facilities reflects the commitment to the use of media that each district is assumed to make in this study. The lifetime of buildings is based on convertibility to alternative uses, rather than an assumption of duration of the media program in its original form.

Five major types of media listed on the first page of this appendix were examined using the above methodology. Each of the media was costed for separate operation. The use of two different technologies simultaneously (e.g., 20 min/week each of a television based system and 16mm film) in a specified environment would cost approximately the sum of the separate media costs, perhaps lessened by sharing of certain initial and recurrent costs such as planning, training, facilities, related materials, and administration. In contrast, savings can result from the joint use of two systems within the same technological group. Thus, for example, sound-filmstrip and 16mm film can share the same distribution system and many features in production and presentation--instructional material centers, classroom equipment, and staff training among others. Santa Ana relays broadcasts of "Sesame Street" and "The Electric Company" from the local UHF television station into the classroom via its instructional television network.[6]

The Sources of Data

Two principal references were used to construct the cost estimates for film and television. For film the reference was the original GLC study,[1] significantly updated with market data and price lists on the costs of hardware and courseware. For television based systems, the reference was a partially updated (to 1972) version of the GLC television estimates contained in a HEW report (Ref. 3, especially Appendix A) and subsequent verification of certain price estimates with equipment suppliers and manufacturers. Further efforts here were directed at improving the estimates for instructional television production, which had not been updated, and at obtaining comparative data and an intuitive understanding of the operation of three local district instructional television

*The importance of this point was stressed in private conversations in November 1973 with Mr. John M. Sweeney of Education Turnkey Systems, Inc., Washington, D.C.

networks. As stated above, these were at Anaheim and Santa Ana, California, and in Washington County, Maryland. It was during these activities that the extent of districts' unwillingness or inability to spend time and resources to keep accurate data on costs and effectiveness of instructional systems, even when such data might be favorable or lead the way to further improvements, became fully apparent.

For the three remaining technologies (programmed text, computer based instruction, and sound-filmstrip) no such comparable estimates were available. Thus it was necessary to calculate them in full detail, using a wide array of journal literature (inside and outside of education). We used (1) market reports such as the 1972 survey of the Educational Media Producers Council;[14] (2) catalogs and directories such as the 1973-74 Audio-Visual Equipment Directory,* which was also used to update some GLC estimates for film and television; and (3) extensive telephone and personal discussions with media producers such as Science Research Associates, Chicago (for printed programmed instruction), Coronet Instructional Media, Illinois, and Guidance Associates, Inc., New York (for film and sound-filmstrip prices). Finally--and most necessary and rewarding in that rapidly moving field--we employed telephone contacts and personal interviews (often multiple interviews) with officials of eight computer companies (including IBM, San Jose; Sperry, Chicago; Computer Curriculum Corporation, Palo Alto; and Hewlett-Packard, Palo Alto) and four user organizations (including the SRI Computer-Assisted Instruction Group).

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*See Ref. 15--sound-filmstrip, pp. 46-57; 16mm film, pp. 4-22.

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Appendix C

THE USE OF EDUCATIONAL TECHNOLOGY IN THE PUBLIC SCHOOLS, 1973--A PILOT STUDY

by

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Appendix C

THE USE OF EDUCATIONAL TECHNOLOGY IN THE PUBLIC SCHOOLS, 1973--A PILOT STUDY

No matter how revolutionary the potential of educational technology is for the development of public education, it remains just that, a potentially revolutionary force, until it is integrated into the philosophy and curriculum of the local school. In a preliminary effort to assess the impact of technological developments in the last ten years, a small subsample of the 238 districts studied intensively from 1961 to 1963[1] was revisited during late August and early September by Harry Kincaid, Norman McEachron, and Dorothy McKinney of SRI and Eleanor Godfrey, formerly of the Bureau of Social Science Research (BSSR), and now at Northern Illinois University. Eleven school systems at ten locations were visited. Because time and funds were short, they were all located in two states, seven in California and four in Illinois. Ten of the eleven systems had participated in all three phases of the original BSSR study; the eleventh is a sister secondary district for one of the elementary districts in the original California sample. The subsample included systems that were large and small, single level or K to 12, stable or growing, rich and not so rich, and covered the range of previous attitudes toward educational technology from indifference to innovative. A summary of district demographic characteristics is given in Table C-1.

Although the districts differ widely in size, type, location, wealth, growth, and previous experience with educational technology, there are marked similarities in their current audiovisual programs and plans. This similarity within diversity suggests that findings from the pilot study may be indicative of some important general themes in public school education. However, a full scale restudy is advisable to test our hunches. One further caution is in order. Both California and Illinois are relatively wealthy states, ranking fifth and sixth in per capita personal income in 1970. Both also have a history of strong support for education. With the possible exception of New York and Connecticut,

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[1] Eleanor P. Godfrey, The State of Audiovisual Technology: 1961-1966 (National Education Association, Washington, D.C., 1967).

Table C-1

RANGE OF DEMOGRAPHIC CHARACTERISTICS AMONG THE SAMPLE DISTRICTS

Characteristic	Range
Size	450 to 18,200 students
Number of schools	1 to 45
School organization	Elementary* only (5),† secondary only (2), unified (4)
Locations	Sparsely settled mountainous county, rural farm, small town, university city, small city, suburb, metropolitan
Student growth	From an 8 percent decline to an 88 percent growth in enrollment from 1963 to 1973
Current expenditure per pupil	\$675 to \$2,100
Instructional materials expenditure per pupil	\$5.50 to \$66.00

*One of the original elementary districts has become a unified district since 1963. However, for the purposes of inventory comparisons in this study, only the current elementary figures were used.

†Numbers in parentheses indicate number of schools visited.

interest in and use of educational technology should be greater in these two states than in the nation as a whole.

Each of the eleven districts was visited by one or more persons. Interviews were conducted with superintendents, assistant superintendents, audiovisual directors, and librarians. A flexible interview guide was used aimed at:

- Updating the inventory of audiovisual equipment, materials, and facilities.
- Assessing the present and potential use of the more sophisticated educational innovations--specifically, the language laboratory; broadcast, closed circuit, and cable television; and computer managed and computer assisted instruction (CAI).
- Gathering information on usage of new developments in "older" media, particularly the cassette tape recorder, single concept filmstrip viewer, and 8mm projector.
- Ascertaining general administrative attitudes toward the place of technology in education, the problems encountered in media use, and the role governmental agencies should play in the development of educational technology.

Our findings in each of these four areas are discussed in this report.

Change in Audiovisual Resources, 1963 to 1973

Our first task was to measure inventory changes since 1963. Before we did this, however, it was necessary to compare the inventory holdings of the subsample with the larger national sample studied in the sixties. This comparison supports the caution that California and Illinois districts may be more richly endowed than the "typical" school system. In all instances except the opaque projector, the teacher/equipment ratios for the subsample in 1963 were well below the average for the national sample at that time.

Our analysis of inventory change addressed itself to two questions. Have the districts visited this summer increased the amount of audiovisual equipment available for classroom use? Which devices are currently most widely distributed? Data on these questions, as well as a comparison of teacher/equipment ratios for the national sample and the subsample are summarized in Table C-2.

The answer to the first question above is clearly yes. Taking the ten districts for which 1963 inventory figures were available as a whole, there has been a substantial, even spectacular, reduction in the number of teachers per unit of equipment for seven of the eight items included in the 1963 survey.* The only exception is radio, which has virtually disappeared as a standard educational tool. As half of the districts did not carry radios on their inventories, no 1973 teacher/equipment ratios were computed for this medium.

Dramatic as increases in total inventories may be, the increasing uniformity of teacher/equipment ratios across districts has more far-reaching implications for instruction. Increasing homogeneity of holdings was most notable for the tape recorder, overhead projector, and record player. Another important finding was the emergence of the individual filmstrip projector. Very few of these single purpose machines were reported in the 1963 national survey, and only three of the sample districts reported any of this equipment at that time. By 1973, however, these ten districts reported 1,765 units, or enough to provide, on the average, one for every 1.6 teachers, with a district range of 1.1 to 10.0.

Further evidence of the increasing leveling out of resources is provided by a district-by-district comparison of inventory increases. There were 53 instances in which we had inventory figures for both 1963 and 1973. There was a decrease in teacher/equipment ratios in 43 of these 53 possible comparisons. The ten instances in which there was an increase in the number of teachers served by a piece of equipment were 16mm projectors (2), combination slide-filmstrip projectors (4), radios (2), television sets (1), and opaque projectors (1). For all other items, each of the districts, regardless of size or organization, had been able to improve the relative amount of equipment available to the teacher.

Comparison of the subsample with the national sample shows why these districts should not be taken as representative of the "typical" school system. In all instances except the opaque projector, their average 1963 teacher/equipment ratios were well below the average for the national sample.

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*While the term "teacher" is used throughout the report, the ratios are computed from figures for "certified personnel" which may include principals, supervisors, librarians, and psychological and guidance personnel. Ratios computed on this base are a conservative estimate of the number of teachers served by a piece of equipment.

Table C-2

NUMBER OF TEACHERS PER UNIT OF EQUIPMENT: 1963 AND 1973
For National Sample and Subsample

Equipment	National Sample 1963	Subsample* 1963†	Subsample* 1973‡
16mm projector	10.4	8.0 (4.5-15)§	4.9 (2.9-17.3)
Slide-filmstrip projector	11.2	7.0 (3.9-13.2)	6.0 (2.2-20.8)
Filmstrip (only)	--	--	1.6 (1.1-10)
Record player	3.4	1.7 (1.2-13.2)	2.0 (1.2-5.3)
Tape recorder	12.0	5.6 (3.0-30)	1.6 (0.9-5.7)
Opaque projector	30.3	30.8 (26-61)	18.6 (9.7-52)
Radio	17.5	5.2 (2.7-31)	--
Television set	19.0	10.5 (4.6-72)	6.2 (1.8-52)
Overhead projector	37.6	28.9 (14-299)	3.2 (1.6-5.3)
8mm projector	--	--	26.5 (6.2-233)

*Subsample inventory figures are based on reports from ten districts for each year, nine of which are the same. One elementary district that supplied inventory figures in 1963 could not do so in 1973 because the audiovisual program had been decentralized to the individual schools and there was no time to develop a composite inventory for this report. The tenth district for the 1973 inventory figures was the additional secondary district that had not been included in the 1963 sample.

†Ratios are figured for 2,309 teachers in ten districts.

‡Ratios are figured for 2,755 teachers in ten districts.

§Figures in parentheses are the highest and lowest values recorded.

Ten years ago the workhorses of educational technology were the record player, 16mm projector, slide-filmstrip projector, and tape recorder. In 1973 the individual filmstrip viewer and overhead projector had joined this stable. The most popular type of tape recorder was also changing, from the large reel-to-reel model to the small portable cassette type.

Acceptance of More Technologically Sophisticated Media

Three of the more sophisticated technological systems available for educational use are the language laboratory, the television set (open broadcast, cable, or closed circuit), and the computer. A review of the experiences and plans of the 11 districts visited this summer suggests several common themes about the good and bad instructional points of each of these systems.

Language Laboratories

The language laboratory was "the" educational technological innovation in 1960. Forty-five percent of the 2,927 districts participating in the first BSSR study planned to develop the use of this medium in the next few years. Respondents in our small subsample were not quite so convinced of the potential value of a language laboratory, particularly the elementary districts, but even so four of the ten districts planned to install them, and by 1963 five districts had done so. (Comparison of the rank order of desirability for selected media for each of the three survey years is given in Table C-3. This table will be referred to throughout the ensuring discussion.) In 1973, enthusiasm for the language laboratory had declined to the point that two of the systems had been destroyed; three other districts were planning to deemphasize their use; and no one interviewed was optimistic about their educational potential. Why? In the words of one superintendent, the language laboratories had "phased themselves out." Critical reasons given for their demise were technical problems in operation, expense, overselling, and inflexibility.

Another inflexible, precoded system, the teaching machine, has met a similar fate. A third of the national sample and half of the subsample were interested in this innovation in 1961; interest held through 1963, particularly for programmed text materials; but in 1973 the only programmed materials mentioned as desired were graded reading programs--a very distant cousin of the original implementation of Skinnerian learning theory.

Table C-3

RANK ORDER OF DESIRABILITY OF SELECTED AUDIOVISUAL MEDIA: 1961, 1963, AND 1973
For National Sample and Subsample

1961		1963		
National Sample	Subsample	National Sample	Subsample	1973 Subsample Only
Language lab	Overhead projector	Overhead projector	Tapes	Tapes
Overhead projector	Teaching machine	Tapes	Overhead projector	8mm Projector
Records and tapes*	16mm film	Filmstrip	Filmstrip	Gaming
Teaching machine	Records and tapes*	Programmed text	Language lab	Closed circuit and cable television
Filmstrip	Filmstrip, broadcast television	Records, television instruction†	Programmed text, broadcast television†	Overhead projector
Broadcast television	Closed circuit television	16mm film	16mm film	Video tape
16mm film	Language lab	Language lab	Teaching machine	Filmstrip
Closed circuit television	8mm projector	Teaching machine	Opaque projector	Broadcast television
Radio	Radio	Opaque projector	Closed circuit television	CAI
8mm projector			Records, radio	16mm film, graded material, radio, teaching machine, opaque projector, language lab, dial access, telephone instruction

*These two materials were not separated in the 1961 survey.
†These media were tied in rank.

Television

Broadcast television was literally hovering over the educational horizon in 1961. Midwest Program on Airborne Television Instruction (MPATI) was about to become airborne. Educational television stations were operating in most of the metropolitan areas. And Hagerstown heralded the future technological age. Today, MPATI is gone and the Hagerstown experiment collapsed with the withdrawal of outside funds. Respondents uniformly complained of poor reception, inadequate programming, and inflexible scheduling on educational television; yet, five of the eleven districts plan to increase their use of television in the future. The seeming contradiction is resolved when we look at how the medium is used. Direct broadcast television is still the unchallenged instant medium for events of national or local significance, and the increasing availability of cable hookups makes local reception less problematic. But the most promising future for television seems to lie in its adaptability for local production through the use of video tape. Quality programs can be taped off the air to be used at the teacher's convenience. More importantly, television can be used as one respondent put it, essentially "as a mirror--a way of seeing ourselves." The increasing portability of television equipment and the use of erasable tape means teachers filming themselves, learning from the film, and destroying the evidence; students filming a play, a role-playing situation, a class discussion, whatever the needs of the moment; filmed laboratory demonstrations that bring each student up to the microscope; individualized visual instructions and personalized examinations to be studied in the privacy of a student carrel. Seven of the eleven districts have used television in such ways, and all are enthusiastic about the potential of such use in the future.

The Computer

All of the districts, except two small single school elementary districts, have access to a computer. Seven have used it, with varying degrees of satisfaction, for scheduling, printing audiovisual catalogues, and general bookkeeping chores. Six have experimented with computer assisted instruction. While it is too early, and the data are too meager, to forecast the extent to which the computer will be incorporated into the instructional life style of the public schools, certain similarities and dissimilarities with other machine oriented learning systems should be noted.

CAI is a complicated system requiring elaborate supporting machinery, highly trained personnel, and specialized materials. The drawbacks of cost, technical problems, inflexibility, and oversell were cited by several of the respondents, both those who had and those who had not experimented with CAI. Sequential programmed learning is currently held in disdain as the best method to teach most subjects. As a Director of Curriculum Planning put it, "If the content is logical, the computer can facilitate instruction, but much instruction is not of this character. It is best used in special applications, such as the expansion of a motivated gifted student's knowledge in a logically organized subject area such as mathematics or science."

The theme that the computer is most suitable for challenging and motivating the gifted student in mathematics and science ran throughout the interviews. Only one administrator spoke of its utility as a patient tutor for the slow learner. Only one made a case for its use with the "middle 3/4" of the student body (except to teach them computer usage). His district uses the computer to teach mathematics, reading, and driver education.

The grade level at which the brilliant student should be introduced to the computer was somewhat at issue. Some advocated CAI for the elementary student, who could then go as far as his interest and ability would take him, without surpassing his impersonal "teacher." Others felt it was most suited to the secondary curriculum, where there is less need for drill and practice and where the subject matter is more logically structured.

The computer has been welcomed cordially as an administrative slave, and used as such wherever access could be arranged without too much technical difficulty or cost. Some districts have experimented with the computer as a data managing device; e.g., hooking into data retrieval systems or preparing a data bank of examination questions from which to draw individualized tests. They do not seem as sanguine, however, about its direct instructional capabilities. The computer can provide a myriad of individualized instructional programs, a capability not present in previous machine systems; nevertheless, the cost, elaborate support network, and limited envisioned target audience suggest caution. Once burnt by highly touted sophisticated instructional media, twice shy.

The other trends, one related to the structure and governance of education and the other related to instructional emphases, can seriously influence the development of CAI. First, there is a groundswell for individual autonomy for each school in a system in various parts of the country. Several of the subsample districts have delegated, or are in the process of delegating, curriculum <u>and</u> budgeting decisions to the individual schools. The large investment of money and personnel required for a viable CAI program demands a high level of commitment from all parties to the agreement. Whether or not individual principals and faculties, who have just begun to taste the fruits of independence, will be willing to make any such large scale commitment to computer instruction is questionable. A case would have to be made for how such an investment, rather than one in higher salaries or more personnel, would benefit the teacher as well as the student. A resurrection of teacher fear of displacement, kindled earlier by the post-Sputnik emphasis on master television teaching, filmed courses, and expert designed sequenced programs would be disastrous not only for CAI but other forms of educational technology. And teacher militancy has given teachers courage to voice their opposition to any threat to their autonomy and primacy in the educational structure.

The second development is related to the current emphasis on teacher accountability, but accountability for the progress of a different group than that foreseen as the primary target population for CAI. The predicted oversupply of scientists and college graduates and the demands of the disadvantaged for an adequate education relevant to their life situation have dampened the enthusiasm for special programs for the gifted, which was never as robust as that for programs for the handicapped. Individualized instruction is advocated not so much for how it can challenge the gifted, as for how it can meet the needs of the "forgotten 20%" who currently find education irrelevant or incomprehensible. The maxim of the day is success for every student, meaning success for the student who previously has failed. Accountability objectives are written in terms of <u>minimal</u> acceptable levels of achievement for all or a large portion of the students. Perhaps there is a lesson here for those who would promote CAI. Currently it is viewed as an effective teaching device for the gifted mathematician or scientist. Unless its utility as a tool for the masses can be demonstrated and emphasized, it may well run into both teacher and taxpayer resistance. Failing that, its widest immediate utilization appears to be as a data management and retrieval system for the administrator and teacher, not as a medium for direct instruction.

Acceptance of New Developments in Standard Media

Comparison of equipment inventories with earlier years shows substantial increases in the numbers of overhead projectors, cassette tape recorders, individual filmstrip viewers, and 8mm projectors. What hypotheses can our interviews suggest concerning the high popularity of these items?

The Overhead Projector

This device, a spin off from the more cumbersome and less versatile opaque projector, proved to be the most widely accepted technological innovation of the sixties. In 1961, there were an estimated 14,000 in the public schools, or one for every 107 teachers. In 1963, the teacher/equipment ratio had dropped to 37.6, and the overhead projector stood first on the list of most desired equipment. Eighty-two percent of the 238 district administrators surveyed at that time stated that they planned increased use of the overhead projector in the future. Current teacher/equipment ratios for the subsample bear out this intention. The average number of teachers per projector dropped from 28.9 to 3.2, and the range by district shrank from 14.4-299.0 to an amazing 1.6-5.3. A perusal of future plans for the eleven districts suggests that the overhead projector may be approaching a saturation point. It was most desired in 1961, dropped to second place in 1963, and to fifth place in 1973 (see Table C-3). Why did the overhead projector succeed so dramatically when the teaching machine, in second place for the subsample and in fourth place for the national sample in 1961, did not? Differential relative cost per unit of instruction is a facile but, I think, erroneous answer. Teaching machines were getting cheaper and cheaper throughout the halcyon boom days of the early and middle sixties. Both devices were plagued by a dearth of high quality commercially prepared materials; but for one this was a curse, for the other a blessing in disguise.

The ordinary teacher could do nothing about the lack of prepared sequential learning materials for the machines, but he or she could make something to show on the overhead projector. The eleven districts have minimal or nonexistent libraries of prepared transparencies, yet they continue to buy overhead projectors. No one apologized for the use of the machine as a "portable blackboard;" rather, they extolled its versatility and individuality. Ingenious minds discovered acetate rolls, exposed x-ray film, and other inexpensive transparent materials on which to create their own visuals. The teacher, and eventually the student, could be creative, and an apparent anomaly is resolved.

A final note on the teaching machine that may be instructive for the proponents of CAI. One of the eleven districts, a wealthy suburban high school district, had been a demonstration school for both teaching machines and programmed texts. It found not only teacher resistance to programmed learning, but a "tiring factor" for the brighter student, particularly for linear programming. Teacher resistance and student boredom forced them to drop both programs. This district is still antipathetic to any precoded or highly structured instructional program.

Cassette Tape Recorders

In first place in the rank order of desirability in 1973, chosen unanimously for increased use by all eleven districts, is the tape recorder, particularly the portable cassette type. Inventories of this item have mushroomed until there is now an average teacher/equipment ratio of 1.6, with a range of district ratios of 0.9-5.7, and much larger inventories are anticipated in the future. Tapes were ranked fourth in desirability for increased use in 1961, second in 1963, and first in 1973. In the words of one audiovisual director, interest in tapes is "running wild" with no apparent end in sight.

Several reasons were offered by the respondents for this increasing popularity over a ten-year period. The cassette is ideally adapted to individualized instruction. The units are standardized so that a cartridge fits many player models. Cassettes are relatively cheap, break proof, and erasable. A teacher or student can record a lesson, learn it, and erase it for another. A student can check out and use both the player and the cartridge in the media center and, if he uses earphones, he need not disturb his neighbor.

Talking has always been the teacher's main tool. With a cassette tape recorder, he can record a lesson for later replay at the student's convenience. The fact that the teacher need not be present when the student replays the lesson increases the number of students who can be served in this way without a commensurate sacrifice of teacher time. Thus, the tape recorder provides the remedial tutoring and individual pacing for which the teaching machine was designed. With dual track tape, it also provides the "listen-speak-compare" function of the language laboratory at a fraction of the cost. Indeed, the extant language laboratories are essentially tape recorders with multiple earphone hook-ups, used for small group instruction.

The cassette tape recorder may well replace its grandparent, the record player, as the portable television camera and video tape are replacing the radio. Most of the districts in the subsample are buying more tapes than records, and several are transferring their record collections to the more indestructible cassette as rapidly as resources allow. One district employs a technician to monitor and transfer quality radio broadcasts to tape.

The Individual Filmstrip Viewer

The large single purpose filmstrip projector had essentially been replaced by the combination slide-filmstrip machine in the early 1960s. So few filmstrip projectors were reported in 1963 that they were not discussed as a separate inventory item in the report of that survey. The subsample was no exception to the general pattern at that time; only three districts reported this equipment, and then only in token amounts. In contrast, this summer there were enough filmstrip/projector/viewers in the districts to provide a teacher/equipment ratio of 1.6, with a district range of 1.1-10.0.

The major factor in this reversal of a downward trend seems to be the development of a cheap, simple, portable viewer. Again, like the cassette recorder, we find a machine suitable for individualized learning and simple enough for a small child to operate. Filmstrips can be checked out of the media center for individual study, or children in the classroom can pursue different lessons individually and silently. A reasonable quantity of cheap acceptable materials is available and, if not found in the district library, can be purchased by the individual school or teacher out of discretionary funds. Combination kits of filmstrips, records, or cassettes, and even pictures are available and purchased in increasing numbers. The large districts produce some filmstrips tailored to an individual teacher's needs.

Although locally produced software is not yet available in large quantities, the filmstrip projector/viewer is portable, cheap, and easy to operate, and is suited for small group or individualized instruction.

The 8mm Projector

Both the 8mm sound projector and the 8mm silent film loop machine have grown in popularity since 1960. The superintendents surveyed in 1961 reported very few 8mm sound projectors and little interest in incorporating this projector into their program. The item was carried in the 1963 survey, again with no evidence of any current or anticipated use. Typical of the national sample was the fact that only one 8mm sound projector was reported by ten subsample districts for that year. By 1973, however, there were 54 8mm sound projectors and at least 47 film loop machines among those sample districts. Unfortunately, our interview guide did not ask specifically for film loop machines, so the number recorded for this equipment may underestimate the current inventories.

Again we find, at least within this pilot study, a resurgent interest in a previously quiescent machine. The 8mm projector now ranks second behind the tape recorder in plans for increased use. Our interviews suggest several possible reasons for this renaissance. The single concept film loop, like the filmstrip, is simple to handle and tailored for small group and individual learning. The increased interest in the 8mm sound projector may be coupled with a similar interest in the 8mm camera, which can be used for local production by faculty and students. Commercially prepared films are available for courses, such as career education and driver training.

Administrative Attitudes Toward Educational Technology

Interview Questions

A series of interview questions tried to tap administrative attitudes about the correct use of various kinds of educational technology by asking how and where audiovisual materials had been used most effectively in their school systems; the problems they had encountered in using media; which media were most valuable and which had been oversold; what role federal, state, and county agencies should play in the field of educational technology; and what they would drop in a "budget squeeze" or add if they received a grant.

Productivity, Priorities, and Governmental Role

Most of the administrators and their school boards were concerned with productivity and demands for cost effectiveness, program budgeting, and school and teacher accountability--a concern that was perhaps particularly acute in California where the state has mandated program budgeting and teacher accountability. With possibly one exception, however, these administrators did not look to educational technology as the way to raise productivity without increasing costs. The respondents were unanimously of the opinion that the teacher was primary and essential. Educational technology was "supplemental, but not cheaper." Good technology, wisely used, could increase the quality of the education offered, but not bring about a reduction of costs.

The adjunct status of educational technology was further attested to by the answers given to the question, "If you were in a budget squeeze, what items in order of priority would you drop? Would you increase or decrease the use of instructional materials?" The answers to this query were not as hypothetical as the question wording might suggest. Districts in both Illinois and California have experienced one or more lean years in the recent past, and several of the suggested cuts offered are ones that were actually made when the district was quite literally in a budget squeeze.

Answers to the question substantiated the "add on" nature of educational technology. Noncategorical and deferrable budget items are the first to go in a recession, and educational technology is clearly vulnerable on both counts. The order of priorities for cutting were capital outlay for new equipment and expensive materials, staffing and stocking media centers, and development of new programs such as cable or closed circuit television and CAI. If the cut were deeper, some nonteaching and marginal personnel (e.g., part-time librarians, music, and art specialists) would be eliminated. Hopefully, instructional materials, other than expensive outlays and duplicates, would be the last items to be cut.

Conversely, a special grant would be used first to develop and staff a media center and second to provide more technical support personnel and local production capabilities. Only after these needs are met, would most districts consider initiating expensive new programs such as cable television hookups or CAI.

The federal government, and secondarily the states, were seen as the proper agencies to underwrite expensive program developments like PLATO and those produced by the Far West Regional Laboratory. The federal government should also continue Title I and Title II grants, but reduce the amount of busy work involved in preparing grants and the amount of bookkeeping necessary to account for grant funds. It was also strongly suggested by one district director that the federal government would be well advised to allow more personnel costs in grants and underwrite training programs for technical personnel: "A lot of money was wasted under the National Defense Education Act (NDEA) and Title II because there wasn't the trained personnel in many local districts to see that the equipment and materials purchased with federal funds were used effectively." The desire for more trained personnel was echoed by several district administrators who thought that federal and state agencies would be wise to spend money on consultants, workshops, inservice training programs, and evaluation studies of their own programs and of new products. The respondents envisioned a kind of consumer report service that would test technological innovations in real school settings and report to the local district what works and why.

No one wanted direct participation by either federal or state agencies in local school affairs. These agencies might underwrite, guarantee support levels, develop, test, evaluate, train, and advise as long as "they stayed out of the curriculum" and "allowed the local districts to go off on their own." Like educational technology itself, federal and state involvement should be supplemental.

Even less involvement was wanted from county agencies beyond the provision of a materials library, particularly for small districts. Most of the larger districts would rather go it alone and saw no way in which a county or regional consortium could help them, aside from possible cost sharing for expensive equipment and materials. And these needs would have to be impelling to overcome the serious drawbacks of multiple decision makers, the possibility that their requests would not be honored, and increased bookkeeping chores. Even small districts that must depend on a cooperative library for most of their films complain about inaccessibility of county facilities for preview and production of materials, booking delays, and failure to have their own needs adequately met.

With such an emphasis on local autonomy at the district level, it is not surprising that individual schools are seeking autonomy from their "consortium."

Overall Assessment

Death, taxes, and problems in utilizing educational technology are always with us. In 1964, I wrote that "educators at all levels encounter problems which hamper the effective use of audiovisual materials. There is never enough money; projection conditions are far from ideal; films do not arrive on schedule; some teachers fail to see the value of audiovisual technology (and use it inappropriately); or the added burden of preparing materials for classroom use is just too much to fit into an already crowded schedule . . . and there is a shortage of relevant materials." According to our respondents these problems still plague the local district. Compounding the situation today are the more frequent breakdown of sophisticated equipment, lack of local production facilities, lack of technical expertise, and the possibility of copyright infringement in reproducing materials locally.

Despite these formidable obstacles, the districts are increasing their inventories, experimenting with new media and new uses for old media, and encouraging local production. A few voiced concern that local production by nonexperts would be of inferior quality, but most felt that the creative involvement of both teacher and student in such efforts outweighed the quality defects. They do not advocate that teachers go into the production of feature films, but encourage them to make transparancies, tapes, slides, ephemeral video tapes--anything that will "help the individual child learn." Almost all of the reported examples of effective use referred to individually created materials or novel uses of media.

The enthusiastic see educational technology as a way to reach the child through many senses on many levels and as a way to free the teacher to fulfill the professional role of a manager of learning resources and expert tutor. The less enthusiastic see educational technology as an add on, most useful for supplemental enrichment or motivation. Perhaps a general theme running throughout the interviews can be summed up in the words of one administrator: "Educational technology is always supplementary to the teacher and the curriculum. Technology that is totally preprogrammed seems to be overrated. You can't adapt it to your own needs and special circumstances. Good technologies include: self-instruction and individualized instruction, and those devices which are complete within themselves, and do not have to be used with elaborate supporting machinery equipment, and/or materials. Also, materials and media that allow for the creative inputs of local teachers are very good."

What is the state of audiovisual technology in 1973? What direction might it take in the future? What policy implications can be drawn from answers to these two questions? Eleven cases from two states is much too restricted a sample for any firm conclusions about the current state of affairs. However, certain developments and themes, if confirmed by a broader based study, have important implications for the future:

- An apparent turning away from complicated, prepackaged systems in favor of simple devices suited for local production and student manipulation.
- An emphasis on individualized media tailored to the instructional needs of a group of students seen as heterogeneous in talents, interests, and knowledge, rather than as a "fourth grade" or "freshmen English class."
- A counter trend toward accountability for the achievement of some minimum standard of proficiency by all, or nearly all of a "class."
- A trend toward individual school autonomy in curriculum and budgeting. This decentralization, coupled with rising taxpayer resistance to continually rising school costs, despite declining enrollments, does not presage a receptive

climate for the rapid development of sophisticated technology. Even with massive outside support, such development might be counter to the educational mission as seen at the local level.

- An extension of a concept of autonomy is the teacher's demand to be recognized as a professional capable of directing his own work, without interference from district, state, or federal administrative personnel. Almost all of the respondents alluded to the final decision-making power of the teacher in whether and how educational technology will be used. You can "make the bait available," but whether or not it is accepted is up to the individual teacher.

Appendix D

PROCEDURES FOR THE INVENTORY OF FEDERAL R&D IN EDUCATIONAL TECHNOLOGY

Appendix D

PROCEDURES FOR THE INVENTORY OF FEDERAL R&D IN EDUCATIONAL TECHNOLOGY

Introduction

The inventory of federal activities in the field of educational technology relied largely on the information services that catalog the activities of the various federal agencies and of the research community as a whole. In addition to accessing these information services, an attempt was made to get from the educational literature the patterns and activities of the federal government in this area. However, the literature contains no comprehensive review of federal activities. Scattered papers on the projects involving one or another specific technology exist, and some of the trade journals carry listing of research grants that are noteworthy. So, although the literature provided spot checks of the information we got from the information services, it was not useful as a source of data.

The first information services that we contacted were the Smithsonian Science Information Exchange (SIE), the National Technical Information Service (NTIS), and the Educational Resources Information Center (ERIC). (Descriptions of all of the information services and examples of the information they provide appear later in this appendix.) We did not find NTIS of much use in our task. It provides abstracts of documents, rather than of research efforts, which do not correlate very closely with actual projects. We likewise found that the data we got from ERIC was not much use; a list of reports, most of which came out more than two years ago, does not indicate current research activities. The data from SIE did not include the amount for which each DoD research effort had been funded. Funding was crucial, since the number of projects in a certain area does not reflect the level of effort in that area. We then turned to other sources for funding amounts.

We found that most federal agencies have an internal information system of some sort. Rather than access each of these many information sources, we decided that the best use of our time and effort would be to look for information only from those agencies that the SIE data had indicated were involved to any great extent in educational technology.

The following tabulation indicates the number of projects sponsored by each agency in the area of educational technology, according to the Smithsonian Information Exchange.

Agency	Number of Projects
Office of Education	293
National Science Foundation	70
Department of Defense	39
National Institutes of Health and Public Health Service	25
Social and Rehabilitation Service	6
Veterans Administration	3
Department of Commerce	2
Department of Transportation	2
National Aeronautics and Space Administration	2
Department of Justice	1
Office of Economic Opportunity	1
Executive Office of the President	1
Department of Labor	1
Total	446

The three major supporters of research on educational technology were chosen for closer examination: The Office of Education, the National Science Foundation, and the Department of Defense. While the SIE data is demonstrably incomplete, we assumed that the foregoing distribution was sufficiently accurate for the decision on scope.

Information on the Office of Education's activities was from the Projects and Grants Information System (PGIS); information on the Department of Defense was from the Defense Documentation Center (DDC); information on NSF activities was from the Annual NSF Grants and Awards publication. The latter contains less information on each project than does any other source; therefore, our information of NSF activities is necessarily more scanty. However, there is reason to believe the NSF data is more complete than the data available from OE and DoD.

Procedures for Accessing Information Services

In order to ask these sources for the project listings they had on educational technology, we had to specify key words. Not all of the information systems use the same set of key words, so the list of key words was necessarily different for each information service. Each set of key words was developed in consultation with specialists from the several services. The total list of all of the key words that we used, classified by source, follows:

- Smithsonian Information Science Exchange (SIE)--Audiovisual aids (nonspecific), computer-assisted instruction, films, programmed instruction and teaching machines, television, simulation in education, training devices and aids (includes satellite and radio).
- Educational Resources Information Center (ERIC)--Instructional technology, educational technology, computer assisted instruction, instructional television, educational television, and televised instruction.
- National Technical Information Service (NTIS)--Programmed instruction, teaching machines, computer assisted instruction, computer aided instruction, education or educational television, (education or educational) and television instruction satellites, satellites and (instruction or education or educational) individual, instruction and individual, audiovisual (library or libraries), and (education or educational or instruction) and (library or libraries).
- Projects and Grants Information System (PGIS)--Instructional technology, educational technology, televised instruction, programmed instruction, computer assisted instruction, autoinstructional programs, electromechanical technology, telephone instruction, computer oriented programs, multimedia instruction, media technology, media research, telecommunication, television, radio, educational radio, communication satellites, telephone communication systems, dial access information systems, instructional television, educational television, television curriculum, telecourses, cable television, closed circuit television, airborne television, instructor centered television, fixed service television, video equipment, video tape recordings, films, instructional films, microforms, microfiche, microfilm, sound films, foreign language films, documentaries, single concept films, projection equipment, photographs, filmstrips, slides, transparencies, photographic equipment, electronic classrooms, autoinstructional laboratories, audio video laboratories, language laboratories, audio active

compare laboratories, audio active laboratories, audio passive laboratories, language laboratory equipment, language laboratory use, programmed units, programmed materials, programmed texts, programmed tutoring, mechanical teaching aids, autoinstructional aids, teaching machines, self pacing machines, autoinstructional methods, simulators, games, educational games, classroom games, management games, simulation, tape recordings, phonograph recordings, phonograph records, and audio equipment.

- Department of Defense (DoD)--Computer assisted instruction, instructional films, programmed learning, educational radio, educational games, educational television, educational telecommunications, teaching machines, electromechanical teaching devices, mechanical teaching aids, video instruction, audio instruction, programmed texts, telephone instruction, artificial satellites in education, electronic classrooms, language laboratories, and training.

  Also, for DoD, some specific organizational names within DoD were used to get work units from groups whose work lay largely in the area of educational technology. These included U.S. Air Force Human Resources Laboratories, Naval Training Device Center, Human Resources Research Organization (HumRRO), and Naval Training Equipment Center.

Procedures for Classifying Output of Information Services

The use of these key words gave us a batch of abstracts from each information service. However, not all of these abstracts fell into what we considered our scope. There were two main reasons for this: (1) the abstract was of a project that was not ongoing during fiscal years '71 and '72, or (2) although the abstract was tagged with one of our key words, the research described was not primarily concerned with educational technology. For instance, a research project that concerned the integration of a school and was going to incidentally use a small portion of the grant to buy an item of educational technology was considered out of scope.

Once we had eliminated the abstracts that were not within the scope of our effort, we tried to get as much information as possible from the remaining abstracts. To do this, we asked a series of questions about each research project:

- Which federal agency funded the research?
- At what level of effort was the research funded?

- What type of technology was involved?
- What was the target audience of the research?
- What was the grade level of the target audience?
- Who did the research?
- What type of project was it (e.g., research, development, demonstration, evaluation)?
- In what subject matter was the technology used?

A summary of the coding categories is presented in Table D-1. A detailed description of each code appears below.*

Funding Agency

We found that the great majority of R&D projects on educational technology were funded by three agencies; we are considering only these agencies.

01 DoD: Department of Defense

02 OE: Office of Education

05 NSF: National Science Foundation

Type of Technology

Software and hardware to be used together are often in the same category; exceptions are transparencies (07) and overhead projectors (09).

---

*The following two codes remain fairly constant across all the variables.

09 Miscellaneous/combination. In general, either something that was not common enough to have its own category, or a combination of categories (except for type of technology) such as a project involving both teacher in-service and teacher preservice education. Where one category clearly predominated--e.g., a college course with minor applications to high school students--the project was coded in the major category.

10 Not applicable. Either the variable was not relevant or applicable to the project, or it was in some way not codable; e.g., where there was no information given in the abstract.

Table D-1

EDUCATION TECHNOLOGY CODING CATEGORIES

Funding Agency, 33-34

01 DoD
02 OE
03 NIH or PHS
04 SRS
05 NSF
06 Dept. of Commerce
07 Dept. of Labor
08 Executive Office of President
09 NASA
10 Not applicable
11 Treasury Department
12 Dept. of Agriculture
13 Dept. of Interior
14 HUD
15 Dept. of Justice
16 OEO
17 VA
18 Dept of State
19 Transporation
20 States
21 University
22 Foundation
23 Foreign
24 Congress

99 Misc., comb.

Type of Technology, 35-36

01 CAI
02 ETV (videotape)
03 Film
04 Programmed Instruction
05
06 Tape recorder
07 Slides, filmstrip
08 Other
09 Miscellaneous
10 Not applicable
11
12 Computer, noninstr.
13 Radio
14 Simulation
15 Multimedia system
18 Either 15 or 19
19 Combination

Grade Level, 37-38

01 Elementary
02 Secondary
03 Post-secondary
04 Elem and sec
05
06 Preschool
07 General audience
08
09 Misc., comb.
10 Not applicable

Target Audience, 40

01
02 Handicapped
03 Mentally Ill
04 Alcoholics, drug users
05 Normal
06 Bilingual
07 Disadvantaged
08 Retarded
09 Misc., comb.
10 Not applicable

Performer, 41-42

01 University
02 Private-profit
03 State agency
04 School
05 Fed. govt.
06 Private-nonprofit
07
08
09 Misc., comb.
10 Not applicable

Type of Activity, 43-44

01 Research
02 Lit. review
03
04 Development/design/ production
05 Demonstration
06 Evaluation
07 Operations
08
09 Misc., comb.
10 Not applicable

Fiscal year, 47-48

71 1971
72 1972
73 1973
74 1974

Subject Matter, 49-50

01 English
02 Math
03 Social science
04 Medicine
05 Engineering
06 Physical & natural science
07 Foreign language
08 Arts
09 Misc., comb.--classical
10 Not applicable
11 Nonclassical in school
12 Nonclassical out of school
13 Teaching methods
14 Attitude change
19 Combination, including nonclassical

01 CAI, computer assisted instruction: Computer managed instruction, computer based instruction, computer assisted learning, and so on.

02 ETV, educational, television and videotape: Dial access, closed circuit, and broadcast television, as well as any use of videotape.

03 Film: Films and film projectors.

04 Programmed instruction: Instruction broken into small sequential steps, each of which must be completed before proceeding to the next step. Presentation can be by text or by machine.

05 This code not used.

06 Tape recorder: Tape recorder and tapes, including reel-to-reel, cartridge, and cassette.

07 Slides, filmstrip: Slides and filmstrips and their projectors (may include sound track); also includes transparencies (but not the overhead projectors on which to use them).

08 Other: This includes self-study programs, and anything described only as "individualized instruction."

09 Miscellaneous: Talking typewriters, initial teaching alphabet, overhead projectors.

11 This code not used.

12 Computer, noninstructional: Computers for administration of education--includes keeping records of attendance and grades, scheduling classes, counseling, and so on.

13 Radio

14 Simulation: Simulation and gaming, a technique for imitating a specified situation in which the actions of participants influence situational events. The game may be played with one or several people and may involve a computer. For the military, simulation often means imitating real life military situations that will probably arise in the field; the simulation eliminates the danger to life and equipment and some of the expense.

15 Multimedia system: A single coordinated system design in which several media are employed jointly in the same instructional sequence toward the same instructional goal.

19 Combination: Using more than one medium, but not as an integrated unit. For example, a center that will develop ETV for one group of students, programmed instruction for another, films for another.

Grade Level

01 Elementary: Kindergarten to sixth grade

02 Secondary: Seventh to twelfth grade

03 Post-secondary: Higher education and continuing education. Postdoctoral study, graduate study, or undergraduate study at a university, college, or junior college; adult school; preservice and inservice training. After high school, or after high school age. Basic education for adults (subjects they should have learned in elementary and secondary school but did not) is post-secondary. A 15-year-old enrolled in a college class on a college campus is in post-secondary education.

04 Elementary and secondary: Programs involving both elementary and secondary grades (e.g., music appreciation for third grade, seventh grade, and tenth grade) or any project done in a unified (K-12) school district, where the abstract does not indicate whether it is for elementary or secondary pupils.

06 Preschool: Children through age 5. Sesame Street, directed to 3-5 year olds, is preschool. A program for kindergarten children would be elementary.

07 General audience: The public at large; e.g., television programs for home viewing. Also programs that might benefit several audiences.

Target Audience

01 This code not used.

02 Handicapped: Blind, deaf, mute, disabled; also physically ill (e.g., people recovering from heart attacks).

03 Mentally ill: Neurotics, psychotics, and psychopaths in mental hospitals, schools for emotionally disturbed children, institutions for children with behavior problems, and the like. Individuals threatening suicide.

04 Drug users: Persons who abuse drugs, including alcohol.

05 Normal: Catch-all category for any target group that was not singled out as being in any other category. Most teachers (intermediary target audiences) are coded as normal.

06 Bilingual: People whose native language is not English. (They may or may not speak English.)

07 Disadvantaged: People who come from different cultural backgrounds and so are at an educational disadvantage; e.g., inner-city ghetto residents and Appalachians.

08 Retarded: In general, any target audience classified in the abstract as retarded. Occasionally, we used our own judgment; e.g, a target group called "retarded" because the students were one year behind in reading achievement was coded normal.

09 Miscellaneous, combination: An example is "exceptional," which includes the retarded and the gifted.

Performer

01 University: Any university or college or other institution of higher learning.

02 Private profit: Any company, corporation, or other nongovernmental organization for profit.

03 State agency: Any government agency at the state level, including state boards of education.

04 School: Public and private schools, school districts, and county boards of education.

05 Federal government: Any department or agency of the federal government; e.g., Office of Education, Department of the Navy.

06 Private-nonprofit: Nongovernmental organization not for profit; e.g., Stanford Research Institute, RAND Corporation, the Red Cross, Rocky Mountain Satellite Federation.

07 This code not used.

08 This code not used.

Type of Activity

01 Research: Research on the basic variables underlying the use of educational technology and investigations into the usefulness of certain types of technology. Also other studies, frequently using the methodology of the classical experiment, with subjects randomly assigned to experimental and control groups to examine the effects of different types of technology. The experimental variable may involve technology only incidentally; e.g., research on the effect of discussion groups on learning in an audio-tutorial course.

02 Literature review: State of the art reviews, literature reviews, and conferences where educational technology is the subject.

03 This code not used.

04 Development/design/production: Development of educational technology at any stage from program design to preliminary testing and revision. Development may include some literature review or evaluation of the developed system or product.

05 Demonstration: Putting an already developed educational technology system into practice to a limited extent, for the purpose of modeling or display, with the interest that others will follow the example.

06 Evaluation: The critical testing and review of an existing educational technology program, or the use of educational technology in evaluation; e.g., the use of videotape in "microteaching" for teacher evaluation. Includes only those projects whose main purpose is evaluation.

07 Operations: Financially backing an ongoing educational technology activity; e.g., funding the operation of (and/or the expansion of) an educational radio station.

08 This code not used.

Fiscal Year

We used fiscal years rather than calendar years. A project going on in more than one fiscal year was coded as a separate project for each year in which at least one-half month was spent on the project. For example, a project from June 29, 1971, to September 29, 1971, would be coded once for FY72; a project from June 15, 1971, to September 15, 1971, would be coded once for FY71 and once for FY72. We coded for the fiscal year in which the project was done ("start date" and "end date")--not when the money was allocated. We assumed equal amounts of money were spent each month of the project.

71: Part of the project was done in FY71.

72: Part of the project was done in FY72.

Subject Matter

01 Reading/English/basic: Reading readiness, reading, composition, literature, grammar, punctuation, journalism, speed reading. Also projects to teach "the basics"; i.e., very elementary reading and arithmetic.

02 Math: Arithmetic, algebra, geometry, calculus, trigonometry, statistics, logic, and the like.

03 Social science: The "soft sciences," history, geography, anthropology, sociology, psychology, economics, political science. Also business education, industrial psychology, and other courses leading to a master's degree in business administration.

04 Medicine: Training in treatment and prevention of disease (for doctors, nurses, pharmacologists) as well as other topics related to health care, such as drug abuse.

05 Engineering: Mechanical, civil, electrical, and industrial engineering.

06 Physical and natural science: All "hard sciences" except for engineering and mathematics.

07 Foreign language: Instruction in all languages other than English.

08 Arts: Design and performance of music and other art forms, as well as art appreciation.

09 Miscellaneous, combination--classical: Miscellaneous traditional subject matter or a combination of traditional subject matters. (Traditional subject matters include codes 01 to 08 above.)

10 Not applicable: General purpose work on system not leading directly to work on any specific subject matter.

11 Nonclassical in school: Nontraditional subject matter taught in school: driver education, sex education, counselor education, typing, and shorthand.

12 Nonclassical out of school: General training; e.g., for a job or in the military.

13 Teaching methods: Teaching techniques, methods, discipline, and so on. Teaching teachers to teach a specific subject matter (e.g., math) is coded as that subject matter.

14 Attitude change: The object of the program is for the target audience to change their attitudes and/or behavior--toward integration, for example. (Like "teaching methods," a program to induce people to change their attitude toward a specific subject--e.g., to get over a fear or dislike of reading--is coded as that subject matter--reading.)

19 Combination--including nonclassical: More than one subject matter, including nonclassical and classical subjects.

Determining the Source of Funds

Information on money was obtained from several sources. For the OE, funding was obtained from the PGIS abstract. In three cases where this information was not on the abstract, we called the performer and asked. SRI checked the files of the Bureau of Education for the Handicapped and corrected the dollar amounts for BEH funded abstracts.

For DoD, money was sometimes on the DDC abstract. Where there was no information under the amount of contract or grant, or under "continuing" duration of project, we got information from the performers, contracts and grants offices, and principal investigators.

For NSF we got funding information from NSF Grants and Awards 1970, 1971, and 1972. For the few SIE abstracts not shown in NSF Grants and Awards, we got the funding information from NSFs Contracts and Grants Office.

When a project overlapped fiscal years, we used the following formula to prorate the money:

$$\frac{\text{dollars spent in FY}}{\text{total dollars in project}} = \frac{\text{no. of half-months in that FY}}{\text{total half-months in project}}$$

Where the month but no day of the month was given, we assumed the date was the first of the month.

Data Reduction and Checks for Accuracy and Completeness

Once we had coded the abstracts, we punched the data from each abstract onto cards, and aggregated the data with the aid of a computer. The analysis of that data appears in Section V of this report. Once we had gotten the data, however, we felt that we should check its accuracy and completeness. When we got our first results from the PGIS system, we noticed large discrepancies between it and the data we got on OE from the SIE. At the time, no one was able to explain the discrepancy, so we accepted the PGIS output as being the better representation of what actually occurred, and left it at that. However, before publishing our results, we felt it wise to do some thorough checking.

We checked the accuracy of the information we got from each of the information services by calling a one-in-ten sample of the principal investigators on the projects, and asking them if the information appearing on the abstract was correct. The results of these accuracy checks showed that the data from the information services was better than anyone connected with the information services had led us to believe.

For the Office of Education, we called the recipient institutions--usually a contracts and grants office in a university, or a principal investigator. We made sure we were talking about the right project; we asked if dollars and dates were correct. We verified content of the abstract when it seemed appropriate. The results of this check are tabulated below.

Category	Number of Projects
Completely correct	19
Partially incorrect substance	1
Incorrect dollars	1
Incorrect time	1
Incorrect dollars and time	2
Extension of time only (FY 71-72)	4
Incorrect dollars and extension of time	1
Subtotal	29
Refused to cooperate	5
Total*	34

For the National Science Foundation we called either the performer or NSF Grants and Contracts office to check the accuracy of a sample of SIE abstracts. We verified title, principal investigator, performer, dollars, and dates. The results are tabulated below:

*The reason that we had only 34 abstracts for a one-in-ten sample of 422 projects is that often an abstract counts once for FY71 and once for FY72. The changes in dollar amount in each fiscal year were tabulated and found to be insignificant.

Category	Number of Projects
Completely correct	3
Incorrect dollars	1
Incorrect time	4
Extension of time only	2
Incorrect dollars and time	1
Total	11

Checks of a sample of the entries in "NSF Grants and Awards Annual" that had titles related to educational technology showed that titles were a good indication of project content.

For the Department of Defense, we called several principal investigators and checked all variables. The results were:

Category	Number of Projects
Completely correct	5
Incorrect type of technology	1
Incorrect type of R&D	2
Incorrect time and subject matter	1
No response	1
Total	10

We checked the completeness of the abstracts on each agency by different means. For the Office of Education, we consulted two bureaus and asked for a detailed description of the research projects that they had ongoing during FY71 and FY72. The bureaus that we looked at were the Bureau of Education of the Handicapped and the Bureau of Elementary and Secondary Education.

In the Bureau of Education of the Handicapped, many of the "project officers" responsible for overseeing projects concerned with technology (and other areas) were contacted. These people were able to tell us of nine projects that should have been included in our survey but were not. Of these, seven were in PGIS but were not covered by our list of keywords; the other two had never been entered into PGIS. The addition of the seven that were in PGIS would have caused a 17.5 percent increase in the number of projects sponsored by BEH; the two not in PGIS represent a 4 percent increase. If BEH is one of the best bureaus in the Office of Education as far as record-keeping goes (and most of the people we spoke with both in and out of BEH agreed that it is), this suggests that the best we can hope is that we have 80 percent of all the projects in the Office of Education concerned with educational technology.

Our check of the Bureau of Elementary and Secondary Education showed that in the Office of Equal Educational Opportunity about one-third of the grants for FY71 and FY72 contained some educational technology, but in no case was the amount of technology large enough for the project to be within our scope. In the remainder of BESE, we found a number of abstracts that we did not have, confirming the estimate of completeness we got from BEH--roughly 80 percent.

We checked the completeness of the abstracts that we had on NSF by using their annual publication "NSF Grants and Awards." This publication lists only the title, principal investigator, and amount of each research grant. Judging as best we could by title, the abstracts that we had on NSF from SIE represented only about a quarter of the total number of projects and slightly less than a quarter of the money. This indicated that the Grants and Awards information was a more complete source of data than SIE. In order to verify this we made a check of roughly one-fifth of the projects listed that had titles indicating that they fell within our scope. This check was accomplished through telephone contact with the principal investigators. Although some of these projects proved to be out of scope, the majority were in scope, indicating that the data on NSF from SIE is unreliable in the extreme. As noted elsewhere, we therefore used the Grants and Awards data for the NSF inventory of R&D.

We checked the completeness of the DDC abstracts by looking in detail at one organization: the Air Force Human Resources Laboratory. We found that our key words had failed to get us more than half of the projects with which this laboratory was concerned; of the ones left out, though, only a very small number proved to be in our scope once we had obtained abstracts on them. So it looks as though the DDC system gives us somewhat more complete information on the Department of Defense than we have on OE.

We also did a check of the reliability of our coding. We found that our reliability was about 90 percent; that is, considering all of the questions that were asked about all of the abstracts, there was over 90 percent chance that a second coding of an abstract would produce the same results. This imperfection of the coding system can be ascribed to the lack of sufficient information on all of the abstracts to answer all of the questions. Where insufficient information was available, we were forced to use our judgment.

Annex to Appendix D

CHARACTERISTICS OF INFORMATION SERVICES

Information Source

SIE (Smithsonian Science Information Exchange)

Location

300 Madison National Bank Building
1730 M Street, N.W., Washington, D.C. 20036

Types of Information

SIE has on file abstracts of research in progress under federal contracts and grants, and also a few abstracts submitted voluntarily by other groups.

Methods of Access

SIE offers a computer search that produces a set of abstracts of research projects that are filed under the key words you specify.

Costs

A computer search costs $50 for the search and the first 100 abstracts, and $50 for each additional 100 or part of 100 abstracts. If more than one search is done at a time, the initial cost for succeeding searches is $35 rather than $50.

Notes

SIE provides excellent data on projects in progress. The only notable failing of the system is that SIE depends on the individual agencies to submit data; sometimes these agencies can get a year or two behind in providing SIE with data, and, as a consequence, the usefulness of the system is curtailed. Also, the data for the current fiscal year comes out in the spring of that fiscal year at the earliest, which means that this system cannot be used for "advance warning" analysis. In addition to getting information from federal agencies, SIE gets information from close to 100 foundations, and to a lesser extent from universities. SIE has several people assigned full-time to trying to get information from the federal agencies; all other contributions are just taken as received. SIE takes whatever information is given to it; it does not have a staff to go out and bring data in or check the accuracy of the data received. SIE puts into the system just about everything it receives--its only judgments are made about private foundations; it only inputs research descriptions, not progress reports or general information--some do it several times a year, and others once a year, if that. Contributions are processed as quickly as possible after they are received (the time it takes to get in the system depends on the workload at the time). Information is kept for close to three fiscal years; SIE has the two most recent fiscal years and whatever the data bank will hold of the third. Only administrative data is kept in the computer; subject data is stored on microfilm or microfiche. The main aim of the system is to keep the information on current projects readily available; historical data can be accessed, but the research is more expensive. SIE began in 1949 with two women in NIH; it is now funded by Congress through the Smithsonian Institution. Data goes back to 1949, but is of varying quality because the system has changed. There is a standard form for input data, but only NIH uses it; for the other agencies, SIE translates data into its own form. Other than from NIH (which is very reliable) SIE has no idea how good data from the agencies is. It has formal contacts with NTIS and the Library of Congress.

Typical abstracts are shown in Figures D-1 and D-2.

SMITHSONIAN
SCIENCE INFORMATION EXCHANGE, INC.
1730 M STREET, N.W. PHONE 202-381-5511
WASHINGTON, D.C. 20036

SIE NO.

GY-4072-3

NOTICE OF RESEARCH PROJECT

SUPPORTING AGENCY: | AGENCY'S NUMBER(S):

HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION
NATL. CTR. FOR ED. RES. & DEV.

EP011105
CONTRACT
BR-8-0157

TITLE OF PROJECT:

A SYSTEM FOR INDIVIDUALIZING AND OPTIMIZING LEARNING THROUGH COMPUTER MANAGEMENT OF THE EDUCATIONAL PROCESS

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

S BERTRAM

RECIPIENT INSTITUTION: | PERIOD FOR THIS NRP:

NEW YORK INST. OF TECHNOL.
UNDERGRADUATE SCHOOL
NEW YORK, NEW YORK 10023

7/71 TO 6/72
FY72

SUMMARY OF PROJECT:

A COMPUTER-BASED INSTRUCTIONAL MANAGEMENT SYSTEM WILL BE DEVELOPED AND TESTED. THE SYSTEM WILL BE ADAPTIVE TO PROVIDE AN OPTIMUM INSTRUCTIONAL SYSTEMS DESIGN. ELEMENTS OF THE SYSTEM MODEL ARE (1) CURRICULUM BEHAVIORAL OBJECTIVES, (2) STUDENT CHARACTERISTICS PROFILES AND SELECTION CRITERIA, (3) INSTRUCTIONAL MATERIALS, OBJECTIVES, AND CONTENT, (4) INSTRUCTIONAL STRATEGIES, (5) EVALUATION INSTRUMENTS AND PROCEDURES, (6) INSTRUCTIONAL DECISION MAKING, (7) ORGANIZATION AND FACILITIES, AND (8) FEEDBACK AND RESTRUCTURE MECHANISMS. THE SYSTEM WILL BE USED TO MANAGE INDIVIDUALIZED EDUCATION AND TRAINING. IT WILL BE USEFUL AS A DIAGNOSTIC TOOL, FOR PRESCRIBING INSTRUCTIONAL MATERIALS AND SEQUENCES, AND FOR COST-EFFECTIVENESS EVALUATIONS. ADDITIONALLY, IT WILL PROVIDE AN EMPIRICAL BASE FOR REFINEMENT AND DEVELOPMENT OF CURRICULUM MATERIALS. (WN) ISG

FIGURE D-1 EXAMPLE NO. 1 OF SIE ABSTRACT

SMITHSONIAN
SCIENCE INFORMATION EXCHANGE, INC.
1730 M STREET, N.W. PHONE 202-381-5511
WASHINGTON, D.C. 20036

SIE NO.

3GX-120-3-1

NOTICE OF RESEARCH PROJECT

SUPPORTING AGENCY:

HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
NATIONAL INSTITUTES OF HEALTH
NATIONAL LIBRARY OF MEDICINE

AGENCY'S NUMBER(S):

PE 00040-0351

TITLE OF PROJECT:

COMPUTER ASSISTED INDEPENDENT STUDY - A PILOT PROGRAM

PRINCIPAL INVESTIGATOR, ASSOCIATES AND DEPARTMENT/SPECIALTY:

DR JA PRIOR
JV GRIESEN
RL FOLK

RECIPIENT INSTITUTION:

OHIO STATE UNIVERSITY
SCHOOL OF MEDICINE
190 N. OVAL DR., 102 ADMINISTRATION BLDG.
COLUMBUS, OHIO 43210

PERIOD FOR THIS NRP:

6/71 TO 5/72
FY71

SUMMARY OF PROJECT:

The program is concerned with the application of independent study methods in the education of medical students in the pre-clerkship phase of their curriculum. We have designed, developed, and are now implementing and evaluating this method of instruction for thirty-two medical students under the framework of a separate pilot school within the College of Medicine. The program includes a verticalized curriculum with instructional methods applicable to independent study, computer-assisted self evaluation programs, computer monitoring of student progress and a detailed cost analysis program. The program provides for independent tracts in the curriculum and allows for independent rates of advancement. Evaluation will include comparison of student performance with match control groups in the standard curriculum. ISG

FIGURE D-2 EXAMPLE NO. 2 OF SIE ABSTRACT

Inform ion Source

NTIS (National Technical Information Service)

Location

5285 Port Royal Road, Springfield, Virginia 22151

Type of Information

NTIS has on file the full texts and abstracts of reports resulting from government sponsored research and development and other government analyses prepared by federal agencies, their contractors, or grantees.

Methods of Access

NTIS offers a computer search that produces a set of abstracts of papers that are filed by the key words you specify. NTIS also publishes abstracts (and indices to them) in a series of subscription journals in various areas of interest. NTIS also offers a variety of other information services.

Costs

A computer search costs $50 for the search and the first 100 abstracts, and an additional $25 for each 50 or less abstracts. The cost of documents depends on the cost to NTIS of duplicating and handling them, and ranges from a couple of dollars to over ten dollars.

Notes

NTIS produces essentially a huge annotated bibliography of papers put out with government money. It suffers some of the same problems as ERIC as a source of information for current projects. Over 225 agencies and private industry input technical and scientific information into the NTIS collection. Virtually all federal agencies contribute, especially NASA, the Bureau of Mines, the Department of Labor, and the Atomic Energy Commission. NTIS only handles documents that are submitted to it, and it uses everything submitted. Mainly these are technical reports and journals; few are books. NTIS prints everything word for word. Document input is irregular, since the various agencies just send a document along as soon as it is done. Because of space limitations, some of the older series have been transferred to the Library of Congress, but NTIS does keep the more recent ones. A lot of the publications announced by NTIS are not sold by them--rather, the Government Printing Office sells them. NTIS does make and sell microfiche copies of everything submitted to it. NTIS has an index by title and reference number, which also includes source, author, and price; this is also for sale (at a fairly high price). NTIS is 90 percent self-sufficient, but is part of the Department of Commerce and gets some money from Congress. NTIS began just after World War II (it used to be called the Clearinghouse for Federal Scientific and Technical Information), and its cutoff date for material was 1945; there are no records before that.

Typical abstracts are shown in Figures D-3 and D-4.

Learner Control of Automated Instruction

Florida State Univ Tallahassee Computer-Assisted Instruction Center (405060)

AUTHOR: Brown, Bobby R., Hansen, Duncan N., Thomas, David B., King, Arthur D.
Technical rept. (Final)
A2763C1 FLD: 5I, 56E u7119
30 Aug 70 39p
CONTRACT: N61339-68-C-0071
NAVTRADEVCEN-68-C-0071-3

ABSTRACT: The effects of three variations of learner control and one instructor control condition were investigated. The three types of learner control chosen for investigation were: selection of media-device, and selection of information load; selection of repetition by branching; and selection of topic sequence. The results observed for learner control of sequence in this study, when considered in the light of other studies, strongly suggests that the amount of information presented to guide student decisions in sequencing may be a critical variable and one which should be investigated in more detail. (Author)

DESCRIPTORS: (*Programmed instruction, Control), , Training devices, Computer storage devices

IDENTIFIERS: *Computer aided instruction

AD-728 429 NTIS Prices: PC$3.00 MF$0.95

5

FIGURE D-3 EXAMPLE NO. 1 OF NTIS ABSTRACT

The Design of an Abstract Hierarchical Learning Task for Computer-Based Instructional Research

Texas Univ Austin Computer-Assisted Instruction Lab (406689)

AUTHOR: Bunderson, C. Victor, Olivier, William P., Merrill, Paul F.
Technical rept.
A4922F4 FLD: 5I, 56E u7218
Aug 71 20p
REPT NO: TR-2
CONTRACT: N00014-67-A-0126-0006, ARPA Order-1261
PROJECT: NR-154-282

ABSTRACT: An instructional design model inspired by a cross fertilization between ideas from the different disciplines of system analysis, curriculum design, and computer programming was developed. The paper describes a hierarchical learning task which was designed and developed in accordance with the instructional design model to study questions concerning task structure, sequencing, and other instructional design variables. (Author)

DESCRIPTORS: (*Learning, *Programmed instruction), Design, Simulation

IDENTIFIERS: *Computer aided instruction, Information processing(Psychology)

AD-745 717 NTIS Prices: PC$3.00/MF$0.95

FIGURE D-4 EXAMPLE NO. 2 OF NTIS ABSTRACT

Information Source

ERIC (Educational Research Information Clearinghouse)

Location

There are regional clearinghouses scattered across the United States; the address for requesting documents is:

ERIC Document Reproduction Service
P.O. Drawer O
Bethesda, Maryland 20014.

Type of Information

ERIC keeps on file documents and their abstracts. The documents are all on education and closely related topics, and are all submitted to ERIC by the authors (or others), except for a few that are commissioned by ERIC itself to fill a recognized need.

Methods of Access

ERIC offers several methods of accessing its files: (1) a computer search facility (run by Lockheed) will give you abstracts of ERIC papers that are filed by the key words you specify, (2) ERIC publishes an indexed monthly list of abstracts of new papers, and (3) ERIC has yearly indices that list the titles and accession numbers of documents by key words.

Costs

A computer search costs $35 an hour for computer time plus $0.20 per abstract printed out, so 400-500 copies might cost a few hundred dollars. The document costs run from $0.65 a copy (for microfiche) to hardcopy costs of $3.29 per hundred pages.

Notes

ERIC is excellent for providing background material in any investigation of an educational topic. It includes most of the major publications pertaining to education, with the exception (most of the time) of material published in educational periodicals and books by major publishing houses. As a way to inventory work being conducted in the field, it is less than satisfactory because (1) often papers are entered into ERIC years after they are written, (2) coverage is somewhat haphazard because it depends on submission rather than solicitation, and (3) many of the papers have little or nothing to do with ongoing research and experimentation.

The ERIC Center for Media and Technology (housed at Stanford University) says it gathers two-thirds of its information itself through affiliations with about 25 professional organizations in the field of educational media and technology. It covers conferences and speeches in the field, and also gets material from state and county boards of education and other branches of government involved in education. It subscribes to about 50 journals and newsletters, and sends for bibliographies. Also, it looks at Master's and Doctoral Theses done in the area of educational media and technology. The clearinghouse sends an average of 20-25 documents (some are mere citations) to Central ERIC each week, where they are put on microfiche and hardcover and microfiche copies are made available. Each document is screened for relevance by two or three people--each one is supposed to be relevant to the concerns of researchers and timely (produced within the last year). Once in the system a document is in permanently--no information is ever discarded. Each document takes about three months to be listed. Central ERIC determines the format for inputs to the system; its thesaurus is based on the NTIS thesaurus. It automatically screens all documents that go into NTIS, and puts into ERIC those that are relevant to education (roughly one percent). ERIC is funded by the National Institute of Education, and has been in existence since 1965. The media and technology clearinghouse has been in existence since 1968. Although generally ERIC only inputs current documents, it has gone as far back as 1949 (to pick up Pennsylvania State College's research done for the Navy on flight training films, which was the basis for all later studies of film).

Typical abstracts are shown in Figures D-5 and D-6.

ED055429 EM009276
COMPUTER-BASED INSTRUCTION: A BACKGROUND PAPER ON ITS STATUS, COST/EFFECTIVENESS AND TELECOMMUNICATIONS REQUIREMENTS.
Singh, Jai P.; Morgan, Robert P.
Washington Univ., St. Louis, Mo.
Spons Agency-National Aeronautics and Space Administration, Washington, D.C.
Report No.-IM-71-1
Pub Date 10 Apr 71 Note-40p.
EDRS Price MF-$0.65 HC-$3.29
Descriptors-*Communication Satellites/ *Computer Assisted Instruction/ *Cost Effectiveness/ *Educational Technology/ *Program Evaluation/ Resource Allocations/ Rural Education/ Telecommunication/ Telephone Communications Industry
Identifiers-CBI/ *Computer Based Instruction
In the slightly over twelve years since its inception, computer-based instruction (CBI) has shown the promise of being more cost-effective than traditional instruction for certain educational applications. Pilot experiments are underway to evaluate various CBI systems. Should these tests prove successful, a major problem confronting advocates of large-scale CBI utilization is the conflict between the organization of traditional school systems and optimal methods of utilizing CBI. Large-scale and intensive utilization is the key to low per-pupil costs. Some means of low-cost telecommunications must be found if rural communities and sparsely populated regions are to benefit. Communication satellites seem to hold distinct advantages over existing commercial telephone communications for linking remote terminal clusters with a central computer where computer-cluster separation is 150-200 miles or greater. This memorandum includes a discussion of the larger issues involved in CBI and a summary of experiments and costs of a variety of CBI experiments and approaches. (Author/JY)

FIGURE D-5 EXAMPLE NO. 1 OF ERIC ABSTRACT

ED055427 EM009274
INSTRUCTIONAL TELEVISION UTILIZATION IN THE UNITED STATES.
DuMolin, James R.
Washington Univ., St. Louis, Mo.
Spons Agency-National Aeronautics and Space Administration, Washington, D.C.
Report No.-MN-71-6
Pub Date Oct 71 Note-49p.
EDRS Price MF-$0.65 HC-$3.29
Descriptors-Cable Television/ Communication Satellites/ Cost Effectiveness/ *Educational Television/ *Facility Utilization Research / Fixed Service Television/ Instructional Media/ *Instructional Television/ *Material Development/ Programing (Broadcast)/ Teacher Attitudes/ Teacher Education/ Televised Instruction/ Television Research
Identifiers-Appalachia Educational Laboratory/ Sesame Street
Various aspects of utilizing instructional television (ITV) are summarized and evaluated, and basic guidelines are developed for future utilization of television as an instructional medium. The role of technology in education is discussed, and the capabilities and limitations of television as an instructional media system are outlined. A brief review of the state of ITV research is presented. Examples of various ongoing ITV programs are described, and the possibilities inherent in ITV are summarized. The three stages involved in delivering instructional programing to the student via television--production, distribution, and classroom utilization--are described. A summary analysis outlines probable trends in future ITV utilization. (Author/JY)

FIGURE D-6 EXAMPLE NO. 2 OF ERIC ABSTRACT

Information Source

PGIS (Projects and Grants Information Systems)

Location

In the Office of Education, basement of 400 Maryland Avenue, S.W., Washington, D.C.

Type of Information

PGIS keeps on file abstracts of all ongoing projects and all proposals received. Most of the information on the abstract is obtained from the proposal submitted by the (prospective) performer; the information is not always updated if it is changed during the negotiations and the writing of the contract.

Method of Access

PGIS used to offer several methods of accessing its data files, but in the last year or two its budget has been cut to the point where it only offers a key word search. A list of project and proposal titles associated with each key word is produced on request; from this list those projects or proposals desired are chosen. A list of accession numbers of the chosen items is then input to the computer which outputs the abstracts associated with each number.

Costs

Since PGIS was set up solely for internal use, there was no charge for our use. However, any person wishing to access the system who was not working fairly directly for the Office of Education would have to make some special arrangement (which might involve payment) with OE's Office of Public Affairs.

Notes

Information is put into the system continuously; an annual or semi-annual purge is done of all outdated information; proposals that are not funded are dropped from the system as soon as they are rejected. Although an instruction manual and forms are provided for people to input data to the system, the data do not include all of the items about a contract or grant. PGIS is funded almost entirely by the Office of Education, although a small part of its budget is (or was) provided by other agencies. It has institutional ties with ERIC (all reports produced as a result of OE contracts are sent to ERIC); the people we talked to knew of no other formal institutional ties with other information systems.

Typical abstracts are shown in Figures D-7 and D-8.

```
DJH-24-659          DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
02/17/73                      OFFICE OF EDUCATION
M01  HOUSTON, JAMES E.        PROPOSAL/PROJECT RESUME

PRR090401        EP011657
CONTRACT NUMBER: OEG-0-9-140401-4147
    METHODS FOR MAXIMIZING THE LEARNING PROCESS

PROJECT DURATION: 05/01/69  TO  04/30/71
PUBLIC LAW/TITLE/SECTION:
   PL-83-531 COOP RES ACT

BUREAU:              OCO
DIVISION:            OCVR
BRANCH:
PROJECT DIRECTOR:    ATKINSON  RICHARD C                       318263031
INSTITUTION:         STANFORD UNIV
ADDRESS:             VENTURA HALL
CITY, STATE:         STANFORD        CA    94305  CONG DIST: 10
PROJECT OFFICER:     GOEBEL L
PROGRAM:             R01010002
          GENERAL EDUCATION - OCVR

          FY   START     END        OBLIGATED
               DATE      DATE        AMOUNT

          69 06/01/69  05/31/71   $   68,862

PROPOSAL DATE:
DESCRIPTORS:
#04 COMPUTER ASSISTED INSTRUCTION       #05 EVALUATION
#06 INSTRUCTIONAL TECHNOLOGY            #07 LEARNING THEORIES
#08 EDUCATIONAL RESEARCH                #09 EXPERIMENTAL PROGRAMS
#10 LEARNING PROCESSES                  #11 MATHEMATICAL MODELS
#12 TEACHING PROCEDURES                 #13 TESTING
#14                                     #15

DJH-24-659          DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
02/17/73                      OFFICE OF EDUCATION
M01  HOUSTON, JAMES E.        PROPOSAL/PROJECT RESUME

PRR090401        EP011657

#03 THIS PROJECT SUBMITS FOR CONSIDERATION A THREE-YEAR PROGRAM OF
#04 THEORETICAL AND EXPERIMENTAL RESEARCH DEALING WITH THE GENERAL
#05 TOPIC OF OPTIMIZING THE LEARNING PROCESS. THE PROBLEM CAN BE IN
#06 VESTIGATED IN MANY WAYS, BUT THE APPROACH ADOPTED HERE IS TO LI
#07 MIT CONSIDERATION PRIMARILY TO SIMPLE LEARNING TASKS FOR WHICH
#08 ADEQUATE MATHEMATICAL MODELS HAVE ALREADY BEEN DEVELOPED AND HA
#09 VE BEEN SHOWN TO BE REASONABLY ACCURATE. FOR THESE MODELS, THE
#10 PROJECT WILL DERIVE OPTIMAL OR SUITABLE SUBOPTIMAL INSTRUCTIONA
#11 L STRATEGIES. THE BASIC IDEA IS TO SOLVE FOR STRATEGIES THAT EI
#12 THER MAXIMIZE THE AMOUNT LEARNED IN A FIXED TIME PERIOD OR MINI
#13 MIZE THE TIME NECESSARY TO ATTAIN A PRESCRIBED LEVEL OF PERFORM
#14 ANCE. ONCE SUCH STRATEGIES HAVE BEEN FORMULATED, EXPERIMENTS WI
#15 LL BE CARRIED OUT TO EVALUATE THEIR RELATIVE EFFICIENCY. TO THE
#16 EXTENT THAT PARTICULAR STRATEGIES PROVE EFFECTIVE, THEY WILL B
#17 E INCORPORATED INTO COMPUTER BASED INSTRUCTIONAL PROGRAMS IN IN
#18 ITIAL READING CURRENTLY IN OPERATION AT THE UNIVERSITY. (JL)
```

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DJH-24-659          DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
02/17/73                      OFFICE OF EDUCATION
M01  HOUSTON, JAMES E.        PROPOSAL/PROJECT RESUME

PRR090401

                    TAXONOMY AND PPB CODES
```

TAXONOMY CATEGORY	CODE	TAXONOMY DECODED
PHASE	KC	
TYPE GRANTEE/CONTRACTOR	G200	INST OF HIGHER ED (UNSPEC)
STATE/CONGRESSIONAL DISTRICT	S0610	
PROJECT FOCUS	F10000	LEARNING/DEVELOPMENT/BEHAVIOR
TYPE ACTIVITY	T900	ALL OTHER ACTIVITY (SPEC)
SUBJECT MATTER	M542	ED PSYCHOLOGY & LEARNING THEORY
PROPOSED OBJECTIVES	B000	OBJECTIVES -- NOT APPLICABLE
UTG NUMBER OF PARTICIPANTS	N0000	
UTG DEMOGRAPHIC CHARACTERISTIC	D100	URBAN AREA (UNSPECIFIC)
UTG INCOME	I001	UTG INCOME -- NOT AVAILABLE
UTG SPECIAL CHARACTERISTIC	H00000	UTG SPECIAL CHAR -- NOT APPLICABLE
UTG EDUCATIONAL LEVEL	E90000	OTHER EDUCATIONAL LEVEL
UTG ETHNIC CHARACTERISTIC	R52000	CROSS-SECTION OF POPULATION
UTG AGE	A00100	UTG AGE -- NOT AVAILABLE
ITG NUMBER OF PARTICIPANTS	U0000	
ITG SPECIAL CHARACTERISTIC	Z001	ITG SPECIAL CHAR -- NOT AVAILABLE
ITG EDUCATIONAL LEVEL	C001	ITG EDUC LEVEL -- NOT AVAILABLE
ITG ETHNIC CHARACTERISTIC	J001	ITG ETHNIC -- NOT AVAILABLE
ITG TYPE	K 00	EDUCATIONAL PERSONNEL (UNSPECIFIC)
PROGRAM CATEGORY:		
PROGRAM BUDGET:		
ORGANIZATION:		
LEGISLATIVE AUTHORITY:		
TARGET GROUP:		
RACIAL/ETHNIC:		
ACTIVITY CODE:		
FINANCE CODE:		

FIGURE D-7   EXAMPLE NO. 1 OF PGIS ABSTRACT

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OJH-24-659 OFFICE OF EDUCATION
05/29/73 PROPOSAL/PROJECT RESUME
M16 CLARKE, CAMILLE A.

PARD2C01
CONTRACT NUMBER: OEG-3-72-0016
DEVELOPMENT OF AN AUTO-INSTRUCTIONAL APPROACH FOR
THE INDIVIDUALIZATION OF INSTRUCTION IN A COLLEGE
PHYS SCIENCE COURSE FOR PROSPECTIVE ELEM TEACHERS

PROJECT DURATION: 01/?/72 TO 07/30/73
PUBLIC LAW/TITLE/SECTION:
PL-83-531 COOP RES ACT

BUREAU: DCD
DIVISION: DR
BRANCH:
PROJECT DIRECTOR: GLENN R MCELHATTAN 203240383
INSTITUTION: CLARION STATE COLLEGE
ADDRESS: 1801 W FIRST STREET
CITY, STATE: OIL CITY PA 16323 CONG DIST: 23
PROJECT OFFICER: ALBERT CRAMBERT
PROG PM: P01023018
REGIONAL RESEARCH - PHILADELPHIA

FY	START DATE	END DATE		OBLIGATED AMOUNT
72	01/17/72	07/30/73	$	10,000

PROPOSAL DATE: 07/28/72
DESCRIPTORS:

#04 AUTOINSTRUCTIONAL METHODS	#05 COLLEGE SCIENCE
#06 PHYSICAL SCIENCES	#07 INDIVIDUALIZED INSTRUCTION
#08 ELEMENTARY SCHOOL TEACHERS	#09 CHEMISTRY INSTRUCTION
#10 STUDENT ATTITUDES	#11 ELEMENTARY SCHOOL SCIENCE
#12 PRESERVICE EDUCATION	#13 PROGRAM DEVELOPMENT
#14 LABORATORY EXPERIMENTS	#15 SCIENCE TEACHERS

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OJH-24-659 OFFICE OF EDUCATION
05/08/73 PROPOSAL/PROJECT RESUME
M16 CLARKE, CAMILLE A.

PARD2C012

#03 SEVERAL REQUIRED OR CORE AUTO-INSTRUCTIONAL UNITS IN CHEMISTRY
#04 WILL BE DEVELOPED. EACH UNIT WILL CONSIST OF SEVERAL LESSONS
#05 ACCOMPANIED BY GUIDE SHEETS WHICH WILL GIVE BEHAVIORAL OBJEC-
#06 TIVES, REQUIRED ACTIVITIES, (READINGS, PROBLEMS, SCIENTIFIC
#07 ARTICLES, LABORATORY EXERCISES, ETC.) AND SUGGESTIONS FOR OP-
#08 TIONAL ACTIVITIES. STUDENTS WILL HAVE A LARGE AMOUNT OF
#09 FREEDOM BOTH IN SELECTING ACTIVITIES WITHIN A UNIT AND IN
#10 SELECTING OPTIONAL UNITS. EMPHASIS WILL BE PLACED ON DEVELOPING
#11 POSITIVE ATTITUDES TOWARD SCIENCE, SCIENTIFIC PROCESS SKILLS,
#12 AND THE ABILITY TO CARRY ON SELF-DIRECTED LEARNING, AS WELL
#13 AS GIVING AN ADEQUATE CONTENT BACKGROUND FOR THE CHEMICAL TOPICS
#14 TAUGHT IN THE ELEMENTARY SCHOOL. THE MATERIALS WILL BE
#15 USED WITH AN EXPERIMENTAL GROUP DURING THE JANUARY-MAY
#16 SEMESTER. ON A BASIS OF THE RESULTS OF THE
#17 EVALUATION INSTRUMENTS AND STUDENT SUGGESTIONS, THE
#18 MATERIALS WILL BE REVISED AND MORE OPTIONAL ACTIVITIES
#19 INCLUDED. ANOTHER EXPERIMENTAL GROUP WILL RECEIVE THE
#20 TREATMENT WITH REVISED MATERIALS DURING THE SEPT.-DEC. SEMESTER.
#21 BASED ON PAST EVENTS AN EXPERIMENTAL GROUP OF 25-30 IS PREDICTED
#22 FOR EACH SEMESTER. A CONTROL GROUP OF 40-50 WILL BE AVAIL-
#23 ABLE. FINDINGS OF THE STUDY, INCLUDING ANY MATERIALS
#24 DEVELOPED, WILL BE MADE AVAILABLE FOR USE IN OTHER
#25 INSTITUTIONS.(MBB)

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
OJH-24-659 OFFICE OF EDUCATION
05/08/73 PROPOSAL/PROJECT RESUME
M16 CLARKE, CAMILLE A.

PRR02C012

TAXONOMY AND PPB CODES

TAXONOMY CATEGORY	CODE	TAXONOMY DECODED
PHASE		
TYPE GRANTEE/CONTRACTOR	G210	PUB INST OF HIGHER ED
STATE/CONGRESSIONAL DISTRICT	S4223	
PROJECT FOCUS	F34435	INDIVIDUALIZED PROGRAMS
PROJECT FOCUS	F30835	AUTOINSTRUCTIONAL PROGRAMS
PROJECT FOCUS	F51930	OTH SPEC PREP PROG FOR ED PERSONNEL
TYPE ACTIVITY	T210	PLANNING STUDIES
SUBJECT MATTER	M690	PHYSICAL SCIENCES-INCL GEN PHYS SCI
PROPOSED OBJECTIVES	B000	OBJECTIVES -- NOT APPLICABLE
UTG NUMBER OF PARTICIPANTS	N0000	
UTG DEMOGRAPHIC CHARACTERISTIC	D000	UTG DEMOGR CHAR -- NOT APPLICABLE
UTG INCOME	I000	UTG INCOME -- NOT APPLICABLE
UTG SPECIAL CHARACTERISTIC	H00000	UTG SPECIAL CHAR -- NOT APPLICABLE
UTG EDUCATIONAL LEVEL	E20000	ELEMENTARY ED LEVELS (UNSPECIFIC)
UTG ETHNIC CHARACTERISTIC	R00000	UTG ETHNIC -- NOT APPLICABLE
UTG AGE	A44000	6-12
ITG NUMBER OF PARTICIPANTS	U0050	
ITG SPECIAL CHARACTERISTIC	Z000	ITG SPECIAL CHAR -- NOT APPLICABLE
ITG EDUCATIONAL LEVEL	C320	GRADUATE LEVELS
ITG ETHNIC CHARACTERISTIC	J000	ITG ETHNIC -- NOT APPLICABLE
ITG TYPE	W13100	TEACHERS (FULL TIME)
PROGRAM CATEGORY:		
PROGRAM BUDGET:		
ORGANIZATION:		
LEGISLATIVE AUTHORITY:		
TARGET GROUP:		
RACIAL/ETHNIC:		
ACTIVITY CODE:		
FINANCE CODE:		

FIGURE D-8 EXAMPLE NO. 2 OF PGIS ABSTRACT

Information Source

DDC (Defense Documentation Center)

Type of Information

DDC has on file (if received) "work units" covering every project funded by the Department of Defense--past, present, and some future--including both in-house and contracted work. The information includes classified information, and a need to know must be established to access the data. As far as we can tell from talking to people, the information we received does not represent the full amount of information on file; apparently we got only as much as our need to know seemed to justify.

Method of Access

DDC offers a computer search on key words that produces a list of work units (i.e., ongoing projects) and reports in the areas of the key words.

Costs

There is no cost to a qualified user.

Notes

DDC seems a complete and up-to-date service. As far as we could tell, the amount of information not included in the system due to lack of input was very small. However, since the military operates toward different goals than do any of the agencies operating the other information sources that we accessed, a more inclusive set of key words was needed (we are still not sure that we have all the relevant abstracts).

Typical abstracts are shown in Figures D-9 and D-10.

UNCLASSIFIED
DDC REPORT NUMBER CR1179, JUL 03, 1973
DDC FORMAT 80075

TITLE: (U) PROVISION OF PLASMA PANEL TERMINALS AND COMPUTER SERVICES

PERFORMING ORGANIZATION
ILLINOIS UNIVERSITY OF URBANA ILL

RESPONSIBLE GOVT ORGANIZATION
AF HUMAN RESOURCES LABORATORY
TT LOWRY AFB, COLORADO 80230

PRINCIPAL INVESTIGATOR
PROPST

ASSOCIATE INVESTIGATOR

TELEPHONE NUMBER

CONTRACT/GRANT NUMBER
F41609-72-C-0050

PERFORMANCE METHOD
CONTRACT

CONTRACT/GRANT AMOUNT
$ 77,133

DATE OF SUMMARY	START DATE	ESTIMATED COMPLETION DATE
20 MAR 73	JUN 72	JUN 73

KIND OF SUMMARY	SUMMARY SECURITY	WORK SECURITY
CHANGE	UNCLASSIFIED	UNCLASSIFIED

SCIENTIFIC AND TECHNOLOGICAL AREAS
012500 PERSONNEL SELECTION TRAINING AND EVALUATION
012400 PERSONNEL SELECTION TRAINING AND EVALUATION
004200 COMPUTERS

KEYWORDS:

OBJECTIVE: (U) TO OBTAIN FOUR PLASMA PANEL CONSOLES 'TERMINALS' WITH REMOTE TIMESHARED COMPUTER SUPPORT IN ORDER TO DEMONSTRATE AND EVALUATE THE CONSOLES AND THE COMPUTER HARDWARE/SOFTWARE CAPABILITY FOR POSSIBLE USE IN TECHNICAL TRAINING AND FOR THE AIR FORCE ADVANCED INSTRUCTIONAL SYSTEM (AIS).

APPROACH: (U) THE INITIAL APPROACH WILL CONSIST OF THE DELIVERY AND INSTALLATION OF TWO PLATO IV (PROGRAMMED LOGIC FOR AUTOMATIC TEACHING OPERATIONS) STUDENT CONSOLES. THESE WILL CONSIST OF PLASMA PANEL DISPLAY, KEYSET, AND COMPUTER CONTROLLED IMAGE PROJECTOR. INSTALLATION OF THE REMAINING TWO CONSOLES WILL BE ACCOMPLISHED DURING THE FIRST SIX MONTHS OF THE CONTRACT. FOUR TOUCH INPUT SYSTEMS AS AUXILIARY EQUIPMENT TO THE STUDENT CONSOLES (ONE FOR EACH CONSOLE) WILL ALSO BE INSTALLED DURING

THIS PERIOD. INCLUDED IN THIS EFFORT ARE THE ESTABLISHMENT AND MAINTENANCE OF AN INTERFACE TO THE GOVERNMENT COMMUNICATION LINKS, ACCESS TO THE PLATO IV COMPUTER, TUTOR LANGUAGE (A SOFTWARE INNOVATE OF THE PLATO IV WHICH IS ORIENTED TO EDUCATIONAL NEEDS), AND PLATO IV SYSTEMS PROGRAM TO ALLOW AUTHORING OF UNCLASSIFIED COURSE MATERIALS. PROGRAMMING ASSISTANCE WILL ALSO BE PROVIDED AS REQUIRED BY COURSE AUTHORS.

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ACCESSION NUMBER: DF220960

FIGURE D-9 EXAMPLE NO. I OF DDC ABSTRACT

UNCLASSIFIED
DDC REPORT NUMBER CW1179, JUL 03, 1973
DDC FORMAT BC075

TITLE: (U) CSP/EOST TRAINING IMPROVEMENT

PERFORMING ORGANIZATION
SYSTEM DEVELOPMENT CORPORATION
2500 COLORADO AVENUE, SANTA
MONICA, CALIF 90406

RESPONSIBLE GOVT ORGANIZATION
DEFENSE CIVIL PREPAREDNESS
AGENCY WASHINGTON, D.C. 20301

PRINCIPAL INVESTIGATOR
MECOZZI, J

ASSOCIATE INVESTIGATOR

TELEPHONE NUMBER
213-393-9411

CONTRACT/GRANT NUMBER
DAHC20-71-0288

PERFORMANCE METHOD
CONTRACT

CONTRACT/GRANT AMOUNT
$ 60,000

DATE OF SUMMARY	START DATE	ESTIMATED COMPLETION DATE
5 NOV 72	APR 71	NOV 73

KIND OF SUMMARY	SUMMARY SECURITY	WORK SECURITY
CHANGE	UNCLASSIFIED	UNCLASSIFIED

SCIENTIFIC AND TECHNOLOGICAL AREAS
011700 OPERATIONS RESEARCH
004900 DEFENSE

KEYWORDS: (U) EMERGENCY OPERATIONS ;(U) SIMULATION EXERCISE ;(U) TRAINING ;(U) NUCLEAR ATTACK ;

OBJECTIVE: (U) TO UPDATE AND MODERNIZE THE MATERIALS AND METHODS USED IN SIMULATION TRAINING FOR NUCLEAR ATTACK. TO PREPARE THE MATERIAL FOR SIMULATION OF ACTIONS BY THE EMERGENCY OPERATING SERVICES, FIRE POLICE, PUBLIC WORKS, ETC. DURING SUCH AN ATTACK. THE MATERIAL AND METHODS ABOVE SHOULD BE GEARED TO INCREASE THE QUALITY OF TRAINING OF COMMUNITY OFFICIALS, DEPARTMENT HEADS, CITY LEADERS AND ALL PARTICIPANTS IN CIVIL DEFENSE OPERATIONS FOR A NUCLEAR ATTACK.

APPROACH: (U) TO REVIEW THE STATE OF THE ART OF NUCLEAR WEAPONS OF THE LATE 1960'S AND ADAPT THE SIMULATION TRAINING TO THESE, TO MULTIPLE WEAPONS DETONATIONS, TO AIR AND GROUND BURSTS AND TO THE MECHANISMS OF DEFENSE RECENTLY DEVELOPED OF SHELTER PLANNING AND UPGRADING, HOME FOLLOW SHELTER PROTECTION, BLAST PROTECTION IN BELOW GROUND SHELTERS IN ADDITION TO SUPPRESSION OF IGNITION SELF HELP IN FIREFIGHTING, REMEDIAL MOVEMENTS AND DECONTAMINATION.

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FIGURE D-10 EXAMPLE NO. 2 OF DDC ABSTRACT