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ABSTRACT

This paper examines some of the questions to be answered and some of the problems to be faced if the widespread application of technology in education is ever to be achieved. The paper is not a "how-to-do-it" manual for conducting cost-effectiveness studies; rather it is an argument to be used in support of such studies and of the experimentation in educational organization which is needed to provide the data necessary to support the redesign of public education. Several aspects of the problem which are discussed include: (1) factors inhibiting the adoption of technology in public education, (2) the educational economic crisis, (3) the need to redeploy resources, and (4) the needed database for technology. Sixty-seven references are listed. (LLS)

Occasional Paper Number 2

EDUCATIONAL MEDIA, TECHNOLOGY AND INSTRUCTIONAL PRODUCTIVITY

A Consideration of Cost and Effectiveness

by

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Preface

American education is in the midst of a crisis of major proportions. Recession, inflation, and taxpayer revolt are leading to severe problems in finance. At the same time, there is reduced confidence in the effectiveness of public education. There is a feeling that education is not sufficiently productive. A potential solution to the problem of educational productivity lies in technology. However, in spite of continuing demonstrations of the effectiveness of the systematic application of media and technology in education, technology has not been used to achieve its potential. Until the advocates of media and technology face up to the high cost of technology and propose that it be used, not as something to be added to conventional instruction, but as a means of redesigning the structure and redeploying the resources of public education, its potential to enhance the quality and economic efficiency of public education will never be realized.

This paper examines some of the questions to be answered and some of the problems to be faced if the wide spread application of technology in education is ever to be achieved. While opinion leaders in the field of media and technology are the immediate intended audience, a more important audience comprises the gatekeepers of public education--the school board members, superintendents, and principals whose support is necessary if education is ever to move from a labor intensive to a capital intensive organization. The paper is not a "how-to-do-it" manual for conducting cost-effectiveness studies; rather it is an argument to be used in support of such studies and of the experimentation in educational organization which is needed to provide the data necessary to support the redesign of public education.

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Definition of Terms

There are two common definitions used for the term educational or instructional technology (Tickton, 1970). One of these definitions...

> the media born of the communication revolution which can be used for instructional purposes alongside the teacher, textbook and blackboard (p. 21)

refers to machines and materials. These elements are a sub-element of what the Association for Educational Communications and Technology (1977) defines as the Domain of Educational Technology. When this narrow meaning is intended, the term educational media will be employed in this paper. The term technology will be reserved for Tickton's second definition...

> 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. (p. 21)

In other words, technology will imply process and not just devices.

Other terms in the paper, such as productivity, which is defined as the amount of output or results obtained for a given amount of input, are taken from the field of economics. Most of these terms have previously been defined within the field of instructional technology (Wilkinson, 1973; Doughty, et al, 1978). When necessary, such terms as cost-effectiveness or cost-benefit analysis, economic efficiency, etc., will be defined within the context of the paper.

Books will soon be obsolete in the schools. Scholars will soon be instructed through the eye. It is possible to teach every branch of human knowledge with the motion picture. Our school system will be completely changed in ten years.

Thomas A. Edison, Dramatic Mirror, July 9, 1913

The Unfilled Promise of Media

The history of educational media is a story of unfilled promise and unrealized potential. Edison, in 1913, predicted that motion pictures would totally change education. But, although motion pictures were soon proven to be effective in increasing student achievement (Freeman, 1924), education did not significantly change. Then radio was going to change education. Then television would change it, or programmed instruction would change it. Today videodiscs and microcomputers are being proposed as the means to an educational revival. Yet, public education continues to be largely as it was when Edison made his prediction. As Stakenas and Kaufman (1977) point out, "applications of educational technology in the United States have been primarily add-on inputs to enrich student experience. There are few, if any, examples where applications of technology have improved school system productivity" (p. 76). Yet increasing productivity is an area where media has demonstrated its greatest potential effectiveness. The ability of media to increase the amount of student learning, to reduce the time required to achieve a given level of learning, or to reduce costs while maintaining student achievement at a set level is well demonstrated in the literature. For these potential benefits to be realized in practice, however, will require a basic change in attitudes and/or organization within the schools.

The Effectiveness of Educational Media

The relative effectiveness of media within instruction is one of the most thoroughly researched areas within education. This research has been reviewed and summarized by a number of writers (e.g., Moldstad, 1974; Jamison, et al, 1974; Schramm, 1973; Stakenas & Kaufman, 1977). Wilkinson (1980), when summarizing sixty years of research on educational media, states that...

> When they are carefully selected and/or produced--taking into account both media attributes and student characteristics--and systematically integrated into the instructional program, educational media have a significant impact on student achievement. (p. 39)

The studies on media effectiveness made use of a wide variety of measures and have amply demonstrated the value of media as tools within the instructional process. The findings of these studies show not just statistically significant gains but obvious and impressive gains in raw scores.

The most commonly employed measures of media effectiveness deal with student achievement. It is in this area that the most significant research results have been obtained. Rulon (1933) compared text-plus-film with text-only instruction in science and found that on factual items the text-plus-film group scored 14.8 percent better on a recall test. On application items, the experimental group scored 24.1 and 41 percent better than the text only group. Romano (1955) found 26.2 to 63.9 percent gains in vocabulary due to the incorporation of various projected media in fifth through seventh grade science classes. In an evaluation of the Hagerstown, Maryland, experience with instructional television, Wade (1967) reported that there were major gains in the percentile rankings of students on standardized achievement tests in a wide variety of academic areas. The percentile rankings showed gains of 53 points in science concepts, 35 points in problem solving, 17 in mathematics, and 22 in United States history. These, and several hundred other studies of such educational media as motion pictures (Carpenter & Greenhill, 1956), instructional radio (Woelfel & Tyler, 1945), television (Chu & Schramm, 1967), programmed instruction (Lumsdaine & Glaser, 1960), and computer assisted instruction (Suppes & Morningstar, 1972), provide strong support for Moldstad's (1974) initial general conclusion from his survey of significant media research that "significantly greater learning often results when media are integrated into the traditional instructional program" (p. 390).

A second common measure of media effectiveness relates to learning efficiency--the speed with which material is learned. In a study of the use of transparencies in the teaching of descriptive geometry, Chance (1960) found not only that students in the experimental class did significantly better on the final examination but that the use of transparencies resulted in an average savings of 15 minutes per class period. In comparing the effectiveness of a one-semester world history class which employed 54 carefully selected motion pictures with a two-semester course using traditional teaching methods, Wendt and Butts (1960) found that students in the one-semester course learned 86 percent as much as the two-semester students in half the time. In an experiment with programmed instruction, Price (1963) found it possible to teach content in arithmatic in 86 class periods which took 130 class periods using conventional instruction. These studies, and a wide variety of other studies in such areas as military and industrial training, computer-assisted instruction, and auto-tutorial instruction, where student time was allowed to vary, strongly support Moldstad's (1974) second general conclusion from his survey that "equal amounts of learning are often accomplished in significantly less time using instructional technology" (p. 390).

A third area of media effectiveness relates to student attitudes. Studies such as those by Edwards, et al (1968), on the use of multimedia in typing and office practices; Chance (1960), on the use of transparencies; and Suppes and Morningstar (1972), dealing with the effects of computer assisted instruction on student retention in elective courses, among others, support Moldstad's conclusion that mediated instruction is "usually preferred by students when compared with traditional instruction" (p. 390).

A major portion of the efforts in media research have been directed toward finding the "best" medium to present instruction. This effort has produced ambiguous results. Schramm (1973), when reviewing media research for the Agency for International Development, made the statement that...

> Motivated students learn from any medium if it is competently used and adapted to their needs. Within its physical limits, any medium can perform an educational task. Whether a student learns more from one medium than from another is at least as likely to depend on <u>how</u> the medium is used as on <u>what</u> medium is used. (p iv)

For example, Manduley (1967) identified a number of teacher practices which had an impact on the effectiveness of instructional radio in Washington, D.C., public schools. These practices included preparatory activities, such as the development of student readiness through preliminary discussion of why the broadcast was to be used and the planning of follow-up activities; active interest by the teacher during the broadcast; and follow-up activities which would fill in gaps, clarify misunderstandings, and extend learning to related areas. Manduley's finding corresponds to Carpenter and Greenhill's (1956) findings in regard to U.S. Navy film utilization research. The focus on how the medium is used as opposed to what medium is used represents a shift from educational media to educational technology--from machines to technique. The shift to technology has grown out of the "systems approach" to instructional design and is part of the basis for another of Moldstad's (1974) conclusions from media research, that "multimedia instructional programs based on a 'systems approach' frequently facilitate student learning more effectively than traditional instruction" (p. 390).

Patterns of Media Utilization

If media have, in fact, been demonstrated to be effective in improving student performance, why have media had such a small impact on what takes place within the schools? Partially this lack of impact is due to the ambiguous nature of media research. There have been a large number of studies showing the effectiveness of media. There have been a larger number of studies which show no significant difference. One reason for the conflicting research results is that much of the research has been poorly designed (Hartley, 1966; Stickell, 1963). Another reason for the conflicting results relates to the way in which the media were employed. As early as 1924, Freeman pointed out that the effectiveness of motion pictures depends upon the characteristics of the material being taught. If motion is necessary to the development of the concepts, motion pictures will be more effective to present the material. If motion is not necessary, motion pictures are no more effective, and sometimes less effective, than other forms of presentation.

Media can be used in an instructional setting in a wide variety of ways, each of which have different effects on teacher behavior, student performance, and school costs. Three clearly delineated types of media utilization can be identified (see Table One on page 8). The most common way in which media is currently used in the United States is as an additive, enrichment experience. Such use of media is dependent on the teacher. This type of media utilization--typified by the tradition that "Friday is movie day" or the use of filmstrips to mask a lack of lesson planning on the part of the teacher--does not make a significant impact on student achievement and merely represents an added expense for the educational system. In such cases, media is often viewed as an educational "frill" which can be omitted with little loss when budgets are tight.

The second form of media utilization, the integrated use of media, is based on the principles of educational technology. The materials and devices to be employed are carefully selected and/or produced to provide an essential element of the instruction that is to be presented, taking into consideration the needs and abilities of the learners, the requirements of the content to be mastered, and the characteristics of the media available to the teacher. Under the integrated pattern of media utilization, the media and the teacher are mutually dependent--neither can function effectively without the other. This type of utilization represents

ADDITIVE	INTEGRATED	INDEPENDENT
Materials are added to regular instruction as supplementary or enrichment activities and, as such, are not necessary for the achievement of basic instructional outcomes.	Carefully selected and/or prepared materials are integrated into regular instruction and provide an essential element leading to the achievement of basic instructional outcomes.	Instruction is redesigned so that basic instructional outcomes are achieved through the active or passive interaction of students and instructional materials without the classroom teacher.
Use of media is dependent on the classroom teacher.	Media and the teacher are mutually dependent.	Media is independent of the classroom teacher.
<u>NOT</u> cost-effective	effective but costly	cost-effective

TABLE ONE: Media Utilization Patterns

additional cost for the school system and requires extensive planning and preparation on the part of the teacher but will have a significant impact on student achievement.

Independent utilization, the third variation, has the greatest potential for increasing school productivity and for demonstrating the cost-effectiveness of media in education. In its weakest form, the independent use of media might involve putting the classroom teacher in front of a television camera and duplicating such traditional instruction at remote locations. This type of media-transmitted instruction has been found, in most cases, to be as good as, but no better than, face-to-face instruction in terms of student achievement. However, by increasing greatly the number of students handled by a single instructor, the cost per student can be significantly reduced. Significant gains in student achievement can be obtained through the independent use of media if the principles of educational technology are applied to the design of materials so that the specified instructional outcomes are obtained. Such use of media represents a major initial cost to the institution or school system, however, it should reduce the long-term operational costs of providing quality instruction.

Little justification, other than "it's nice if you can afford it," can be provided for the additive use of media. The potential value of both integrated and independent media use should be so obvious that little active persuasion would be needed for its widespread adoption. Yet, the technologically based forms of media use are rare in formal education.

Factors Inhibiting the Adoption of Technology

A number of factors act to inhibit the adoption of any innovation in any setting (Rogers, 1962; McClelland, 1968) and in education in particular (Bowen & Douglass, 1971). These factors range from a lack of knowledge of the innovation to a simple fear of change in any form. A few of these have a direct bearing on the adoption of technology in education.

One major factor inhibiting the widespread adoption of technology in education is cost. Many authorities (Ross, 1968; Havelock, 1969) have pointed out the effects of tight budgets on the adoption of innovations. Lyons (1966) states that the lack of funds and personnel required is one of the major characteristics of unsuccessful efforts to implement innovations within the military training system. However, the availability of additional funding does not necessarily mean that technology will be adopted. Sieber (1977) points out that "money is not invested in new education practices until after needs defined as more pressing have been met" and that "school personnel are often more concerned with their organizational quality of life than with the improvement of educational practices" (p. 34). For example, the National Education Association is currently pressing for a reduction to a one-to-fifteen ratio of teachers to students. Even when there is a willingness on the part of teachers and administrators to adopt technological solutions to institutional problems, legal barriers exist. As Scanlon and Weinberger (1973) have pointed out...

> the regulations involving how school districts receive and allocate funds force them to make artificial distinctions between modes of instruction. An economist would say that the financial structure of the schools biases the mode of production; it tends to force schools to pivot instruction around the person physically present in the classroom and tends to make educational technology a peripheral and marginal part of the process. (p. 343)

School funding formulas that are based on the number of teachers or teaching stations act to prevent the implementation of instructional strategies that will increase the ratio of students to teachers and therefore increase the productivity of education.

Another major argument that is raised against the adoption of technology in education is that technology is de-humanizing--that a machine cannot cuddle and comfort a child. Forgetting, for a while, the fact that technology as it is defined in this paper refers to techniques of designing instruction rather than machines, the other side of this argument needs to be examined. Just how humane is traditional instruction? In spite of the fact that education is one of the most labor intensive enterprises in American society, students receive little personal attention in the classroom. To a large extent, education is not hand craftsmanship but rather batch processing. Presentation of information is, in most cases, aimed at the average child. The amount of individual time which a teacher can give to any one child is limited. The typical classroom teacher with 25 to 30 students is exceptional if, after completing administrative duties, grading papers, making assignments, and making group presentations, he or she is able to devote one or two minutes a day to each child. The thing that is necessary is a means of improving the quality of time that a teacher spends with children, however basic instruction is delivered.

Educational Economic Crisis

If the cost of educational technology is a problem, so is the cost of traditional education. Education is expensive. In 1972-73, 47 billion dollars were spent on public elementary and secondary education alone (Rogers & Jamison, 1973). According to the most recent figures from the National Center for Educational Statistics (1979) the yearly cost of education has grown to over 81 billion dollars. This rate of growth is faster than the increase in inflation and the increase in Gross National Product. Frankly, public education is facing an economic crisis. If expenditures for education continue more rapidly than the Gross National Product (GNP), we face the absurd prospect that by the year 2020 the costs of education will exceed the GNP (Stakenas & Kaufman, 1977). The problem has been clearly stated by William Baumol (1967), an economist at Princeton, as what has become known as the "Baumol crunch." His argument basically is that no one part of a system can indefinitely increase its consumption of resources at a greater rate than the rate of increase in income of the total system. If it does, at some point in time that part's consumption will become equal to the total income of the system.

The constant increase in educational expenditures is no longer automatically supported by taxpayers. As early as 1971, the Board of Directors of the United States Chamber of Commerce declared that the American economic system could not continue to support an educational system that was "demanding an ever greater portion of the nation's wealth without producing a proportionate increase in learning."[1] The grim toll of public revolt and governmental cutbacks on education read like signposts on the road to Doomsday. Proposition 13 in California, and similar actions in other states, is passed to limit, or cut back on, local property taxes. School bond issues are defeated regularly, or are not submitted because defeat is certain. Entire programs and departments are being eliminated in public schools and universities because of funding cutbacks at the state level. Federal funds for education are being consolidated and reduced through block grants to the states which can be diverted away from educational support. The U.S. Department of Education stands a good chance of being eliminated.

At the same time that the cost of public education is being resisted, the quality is also being questioned. The daily papers deplore dropping SAT scores. State legislatures are passing minimal competency requirements for high school graduation. Books are published on the topic that "Johnny Still Can't Read" or that Schools of Education should be abolished. The

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[1] Newsnotes. Phi Delta Kappan, February, 1971, P. 386.

public cry is for a return to "basics," for the teacher on one end of a log and the student at the other.

In the midst of the crying over educational cost and quality, media and technology do not receive a high priority. A very small percentage of the current educational budget is devoted to media (see Table Two, below).

CATEGORY OF EXPENDITURE			Percent of Total
Administration			4.4
Instruction	Media/Audio Visual Materials	.21%	
	School Library Materials	.34	
	Textbooks	.64	
	Teaching Supplies	1.78	
	All other costs	52.83	
		55.80	55.8
Plant Operation and Maintenance			9.8
Fixed Charges			10.8
School Services			8.4
Community Services			1.1
Capital Outlay			7.1
Interest on Debt			2.6
			100.0

TABLE TWO: Breakdown of Current Expenditures for Public Education, 1979

According to the <u>National Comparison of Local School Costs</u> (1977), only .21 of one percent of the educational budget is spent for media and audiovisual materials. This is not an area where major savings can be made. The major item of expenditure within education, which cuts across all program areas, is salaries (NCES, 1979). Education is a labor intensive enterprise. The only real hope to increase the productivity of education is through the widespread application of technology (CED, 1968; Wilkinson, 1972; Scanlon & Weinberger, 1973).

The Need to Redeploy Resources

Any system, if it is to survive, must either adapt to meet the expectations of the environment which it exists to serve or it must convince the environment that what it is producing is of value to the environment (Banathy, 1973). Despite the fact that schools are called upon to serve a wide variety of social change functions in contemporary society, they need to become concerned with both productivity--the amount of output or results obtained for a given amount of input--and efficiency--the attainment of the maximum possible output with a given amount of inputs or the attainment of a given output with the minimum amount of inputs--if they are to survive.

The answer of the National Education Association to the complaint of poor quality of public education is to move toward smaller classes. This move is partially justified by a meta-analysis conducted by Smith and Glass (1978) which shows a steady increase in student achievement as class size is reduced. The Smith and Glass study involved a consolidation and analysis of the results of a large number of previous studies which employed class size as a major variable. From their analysis, Smith and Glass were able to construct a curve which predicted the effects of class size on student achievement (see the Smith/Glass curve on Figure One, page 15).

The Smith and Glass findings have, however, been strongly criticized. Citing the results of an earlier review (ERS, 1978) which found no impact of class size on academic achievement of most pupils in most subjects above

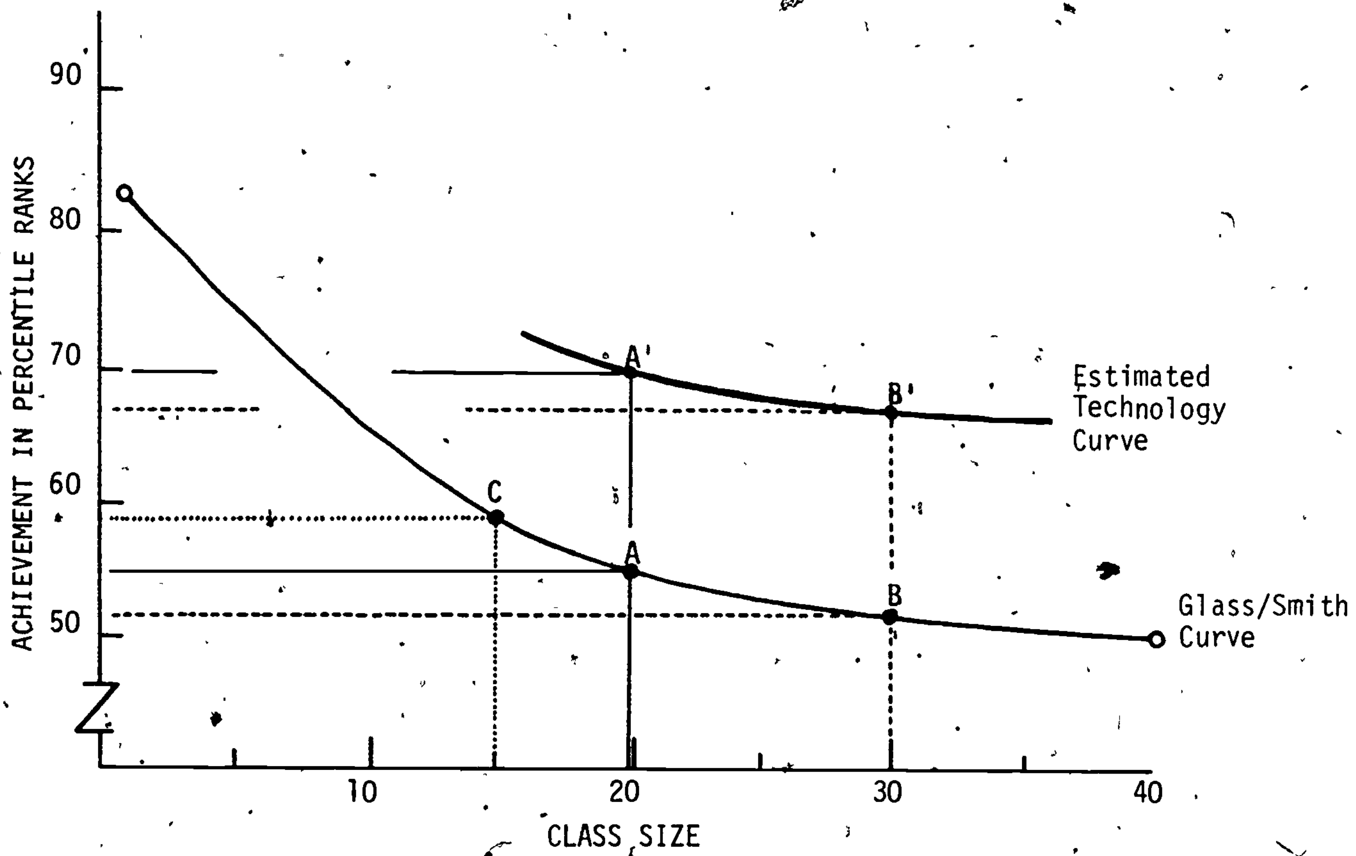

FIGURE ONE: Effects of Class Size and Educational Technology on Student Achievement the elementary grades, the Educational Research Service (1980) stated that "few pupil benefits can be expected from reducing class size if teachers continue to use the same teaching techniques that they used in larger classes and that "many teachers do not take advantage of smaller classes to individualize instruction" (p. 241). ERS is saying, in effect, that there is a need to develop the technology of instruction.

Even if the Smith and Glass findings are correct, however, the benefit of the NEA's proposed reduction from 19.9 students per teacher[2] to 15 students per teacher would be small. On the Smith/Glass curve, this reduction (from point A to point C on Figure One) would result in a gain of less than four percentile ranks, a relatively small gain in achievement, yet it represents a large gain in costs. As Down (1979) points out...

> Class size does, then, make a difference in school budgets. Since teacher salaries typically account for 75 percent of the budgets, school boards should ask if money spent to pay more teachers to teach fewer students could be better spent elsewhere (for example, on materials or teacher training). In a major school system a few years ago, reducing the pupil-teacher ratio by just one pupil per class would have cost 2.8 million dollars in salaries. (p. 22)

The NEA proposal would require an additional 544,000 teachers. With an average salary of $14,244 (NCES, 1979), this would require an additional $7,748,736,000 in salaries alone. The additional classrooms, equipment, etc., required for such a reduction in class size would run over 20 billion dollars per year.

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[2] In the Fall of 1978 there were 2,176,00 full-time-equivalent public school classroom teachers (NCES, 1979). The average number of students per teacher, based on this total, was 19.9. (This number does not equate to class size, which in most systems is 28 students per teacher, due to the number of special teachers who are not assigned to a specific class.)

The major gains on the Smith/Glass curve are achieved at the very small class size (20 or less). It would be unrealistic, in this period of tight governmental finance, to cite achievement in such small classes to support a reduction of from 28 to 25 students per teacher. In fact, the Smith/Glass curve, since there is little apparent difference in achievement between 20 and 30 students per class (from point A to point B on Figure One) could be used in support of increasing the student/teacher ratio and therefore greatly reducing the cost of public education with only a slight reduction in effectiveness.

Those educators who are concerned with both increasing student achievement and reducing the cost of public education--in other words, truly enhancing the economic efficiency of education--can find an answer through a combination of some of the threads woven through this paper. The effects of class size described by Smith and Glass, since they are derived from a large number of studies, are independent of the method of instruction. As hinted by the ERS critique of Smith and Glass and as demonstrated in the previous section on the effectiveness of media, the systematic application of educational technology leads to a dramatic increase in student achievement when compared to conventional instruction. It should be possible, on this basis, to construct a new curve of student achievement related to class size which exhibits the same characteristics as the Smith/Glass curve but which is at a higher level of achievement. Such a curve (the Estimated Technology Curve) has been plotted on Figure One. The Estimated Technology curve follows the same line as the Smith/Glass curve but a a point 15 percentile ranks higher. This is a relatively conservative estimate since the range of gains cited by Wade (1968), for example, was from 53 to 17 percentile ranks.

The massive application of technology to public education would be expensive, although probably not as expensive as the NEA proposal for reduced class size. However, with the new curve on Figure One, it is possible to see how to provide the necessary resources. If class size were increased on the technology curve, from 19.9 (point A') to 30 (point B') students per teacher, achievement would show the same decrease of from two to three percentile ranks that was found on the Smith/Glass curve. Since the technology curve, however, is constructed on a higher base than the Smith/Glass curve, total achievement would still be approximately eight percentile ranks higher than the gain in achievement obtained by reducing class size to 15 students per teacher if conventional instruction were retained (point C on the Smith/Glass curve). Such an increase in class size would allow the redeployment of resources from salaries and classrooms to the systematic development and application of educational technology. This move from a labor intensive strategy to a capital intensive strategy could also, through the reorganization of educational patterns, improve the quality of time that the teacher spends with individual students.

An Alternative Organizational Pattern

The sort of educational pattern which might lead to a major increase in school productivity is illustrated in Figure Two on page 19. Students within this pattern spend three out of every four periods receiving information or instruction by means of media, such as television or computers, and the other period in small group, direct interaction with an instructor. This pattern would allow a larger amount of individual attention for

INSTRUCTIONAL PROCESS	TIME BLOCK #1	#2	#3	#4
Presentation via Technology		30	30	30
" " "	30		30	30
" " "	30	30		30
" " "	30	30	30	
Interaction with Teacher #1	10	10	10	
" " " #2	10	10		10
" " " #3	10		10	10
" " " #4		10	10	10

120 TOTAL STUDENTS

4 TEACHERS

1:30 STUDENT/TEACHER RATIO

FIGURE TWO: A Capital Intensive School Organizational Pattern each student while maintaining a high student to teacher ratio. By freeing the classroom teacher from the necessity of preparing and making basic presentations, it would allow the teacher more time to analyze the needs of individual students.

Swanson and Willett (1977) have proposed three major premises as a rationale for the capital intensive reorganization of education:

1. The individual learning needs of students are being poorly met by traditional, labor-intensive educational arrangements.

2. Multimedia approaches to education involving a wide range of subject matter and compared with control groups using traditional instructional methods generally show no statistically significant reduction in learning.

3. The data necessary for preliminary cost comparison of traditional (labor-intensive) education versus man-machine (capital-intensive) education are available.

Although a large number of reports have been written on the potential cost-effectiveness of educational media and technology (see for example, Blaschke & Sweeney, 1977; Gallup, 1977; Heath & Orlich, 1977; Kielt & Spitzer, 1977; Wilkinson, 1976; Burns, 1980) most of these are not based on empirical evidence (Caffarella, 1975). Almost all examples of the use of technology to change the pattern of educational organization have taken place in underdeveloped countries where the lack of a large supply of highly trained teachers does not allow for the development of a labor intensive approach (see, for example, Morgan & Chadwick, 1971; Jamison, et al, 1968). For the development of such alternative patterns in American education, both experimentation and the systematic gathering of detailed cost information is needed.

Needed Data Base for Technology

The technology curve presented in Figure One had to be labeled "estimated" because, as Stakenas and Kaufman (1977) state, "The cost savings potential of educational technology is not well documented as yet" (p. 73). Only one of

14 instructional development agencies surveyed by Alexander and Yelon (1972) was engaged in gathering cost-benefit information on instructional systems as a part of their normal activities. Caffarella (1975) found that only 32 of over 300 references dealing with the cost-effectiveness of educational media were based on empirical data. Many of the most serious questions in the design and organization of instruction are resource allocation decisions. Although a number of general propositions regarding the cost and effectiveness of the application of technology to education can be supported (Caffarella, 1977), the need for a larger information base for such decision making has been pointed out by many different authors.

The use of cost studies in making educational decisions has been widely demonstrated (Cherrington, 1979; Somers; Taylor; Ragsdale, 1978). The methodology for such analysis has been well developed within education in general (Levin, 1975; Rothenberg, 1975), and for the area of educational technology in particular (Beilby, 1980; Doughty, et al, 1978; Wilkinson, 1973, 1978). Although a number of potential problems exist (Doughty, 1979), such evaluations are needed to demonstrate the benefits to be derived from the application of technology to education.

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