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ABSTRACT

The current educational system is based on a class progression model, whose purpose the goals of American education have far exceeded by attempting to provide universal basic education. Individualized instruction, for which a teacher as tutor is not essential, aided by some technological system, can bring the educational model into a better balance between the expense demands of capital and labor. Recent technological developments of possible service to education include the following: audio cassettes, holography, microfiche, miniature electronic calculators, one-half inch video tape equipment, broadband communication (cable TV), and electronic data processing (for student records and also for possible linkage with cable TV to produce a multidimensional mass communication system). In the school of the future, the teacher may no longer be clerk, disciplinarian, and presenter of subject matter, but rather may attempt the tasks of subject matter monitor, psychologist, recreation specialist, librarian, and creator of instructional software. Gradual preparation of teachers for the pluses and minuses of technological systems will ease us over any such transition that may occur. (JA/CL)

PREPARATION OF SCHOOL PERSONNEL FOR THE USE OF INSTRUCTIONAL TECHNOLOGY

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I would like to clarify the intent of this paper at the outset. It is not my intention to present a summary of research or a detailed survey of new teacher training programs. Instead, I would like to present some personal thoughts on the development of educational technology. I hope to clarify the reasons for my own view that the increased use of instructional technology is inevitable, discuss important aspects of the teachers role that I feel will be changed by technology and to explore some ways of preparing for that change. I am convinced, after a decade of observation, that the massive use of communication and data processing technology for the purposes of instruction is inevitable. It is inevitable unless American society turns its back on its historic commitment to equal educational opportunities for every citizen without regard to his race, religion, or economic status.

It is a noble goal that American education is striving toward, one that is without precedent in any previous period or society in history. But American education is on the verge of collapse in its attempt to achieve that goal with an organizational and an instructional model that was designed for a different and much more limited purpose. The model, though greatly modified in its current usage, was developed over centuries of experience when the educational system served basically as a social filter or screening device. It is still used for that purpose in most other countries in the world today. In its basic aspects the model divides the student population into barely manageable sized groups called "classes", and assigns a "teacher" to each class whose duty is to present an organized body of concepts called a "curriculum" and set tests and examinations for the class to deter-

mine which members may proceed to the next higher level. Those students who pass the tests or screening devices proceed through the system until they achieve a reward for their luck and endurance in the form of a baccalaureate or more advanced degree. Those who do not pass through all the filters are shunted off at the point of failure to a commercial or trade school or are dropped out of the system entirely.

The model works perfectly well for the purpose for which it was designed. American education however, has goals that far exceed the purpose of the model. We attempt to provide a basic education for everyone regardless of background and the definition of what constitutes a basic education is being continuously upgraded. More importantly we deny both by law and by economic pressure the right of the individual to withdraw from the system until they have endured ten years of it. Economic if not legal pressures are continuously increasing the period of required tenure in the system. Fifty years ago it was eight years. Now it is legally ten years and economically twelve years and the economic push is toward fourteen and sixteen years.

In addition, American education is attempting to remove the screens and filters and make the kind, quality and extent of education a matter of choice by the individual concerned. The removal of barriers and screens is coming about through social pressure. The filters work very well for the white middle and upper class students. They were designed to allow continuous progress for the upper two-thirds of that population. They also work very well to assure failure of the economically and socially deprived youngster. Any doubts of their efficiency in assuring failure are quickly dispelled by examining the IQ scores, achievement scores, reading levels and dropout rates of the blacks, the chicanos, the Indians, (and incidentally the bottom one-third of white middle class children).

There are two segments of American society that are forcing change in the model: the economically and socially underprivileged, those who by accident of birth are irretrievably handicapped at the start of the race and a growing group of the winners who do not accept without critical analysis the very system in which they were successful. Both groups are making the same points in their criticism of the model, points that are gaining acceptance because of their common sense validity. The first point is that a race in which a considerable fraction of the runners are untrained, crippled, and must run barefoot against a field that is in the best of health, training and equipment is not a fair race.

The second, and even more fundamental point is that there is no real reason for having a race in the first place. It is only by tradition, a tradition maintained by the winners, that we must compete over the same course to achieve our common goal. There are, after all many roads to Rome. Further, it is even suggested that Rome is not necessarily the goal of all the runners.

Aspects of the model have been revised over the years in America to adapt to the pressures of changing purpose. However, when enough aspects of a model are revised drastically enough one is no longer talking about the same model. We are at that stage today. The point of all this discussion is that there are major social pressures to move from a group instruction model of education to an individualized model. Individualized instruction has been discussed by educators as a desirable goal for decades. The pressure for individualization is now coming, not just from educators, but from the society that education serves. We are being told by that society that students are individuals who have different needs and different goals. A group oriented model of education cannot meet the diversity of needs and goals.

Individualization of instruction is no longer just a nice idea, it is a demand being voiced by our society. Technology can help us respond to the demand for individualization. It is my opinion that technology is not only helpful; it is the only practical way that individualization can be achieved in a massive scale.

Another problem with the current model is that it is labor intensive. The fact that a large percentage of our educational expenditures is in the form of salaries is well known and requires no elaboration here. However, one point about the labor intensive aspect of the model does deserve comment.

There was an earlier model of education that had strong elements of individualized instruction. That was the tutorial model of classical times. The purposes of the tutorial model were narrow, to be sure. It was designed for the education of the nobility. Within that limited purpose however, it relied heavily on the interaction of a teacher with one or a very few students.

From that tradition has come the notion that only through a teacher could learning take place. The notion persisted after the first revolution in educational technology: the widespread use of printed books. It was only grudgingly admitted by the educational establishment of the time that students could learn from books. That the proposition is still not completely accepted in modern times is evident by the ways in which textbooks are used in the classroom from elementary school through college. Reading assignments are made, but many teachers still feel compelled to follow the reading with a detailed verbal explication of what was read.

There is mounting evidence compiled in recent times that if books are properly designed students can indeed learn from them with little or no help from a teacher. Going even further, it is becoming clear that, given well designed software,

students can learn by interacting with a computer program, by watching TV, by viewing slides and films, and in many other ways; none of which require the intervention of a teacher.

Of course it is nonsense to say that students do not need teachers. The successful software alluded to above is the result of a number of skilled and experienced teachers working with a variety of other professionals. The students learning from such softward are benefiting from the work of teams of top quality teachers. The interesting point is, however, that in many cases the physical presence of a teacher is not required for extended periods of time.

By shifting the burden of presentation, drill, and similar activities from the classroom teacher to some technological system the educational model can be brought into a better balance between capital expense and labor expense. To the degree that this can be accomplished, the less labor intensive the system becomes and greater cost effectiveness can be achieved. Pressures for greater cost effectiveness need no documentation here. They are obvious to everyone even remotely concerned with educational finance.

The parallel pressures of our society for individualized education and greater cost effectiveness are the foundation for my opening statement that the massive application of technology to instruction is inevitable. While I am certain that the application of technology is an irreversible trend, I am not at all certain about the quality of the result. There is a potential in this movement for a quality of education that exceeds our present dreams. There is also a potential for producing and, even worse, accepting, highly automated mediocrity. The extent to which we attain greatness or settle for mediocrity is dependent upon the extent to which educators

focus their knowledge and talents on the design of the software and train their membership in its proper use. Technology can produce unbelievably sophisticated and flexible hardware: the delivery systems, the computing systems, and the storage and retrieval systems. Unfortunately, technology can be of only minimal help in designing the softward: the content to be delivered, computed, stored and retrieved. The softward is the responsibility of educators.

Before we move to a discussion of the problem of preparing school personnel for the creation and use of instructional software for advanced technological systems it might be well to spend a moment reviewing the current state of development of the hardware. When we speak of instructional technology we mean a range of devices that fall into three functional categories: communication, data storage and retrieval, and data processing. The categories are not mutually exclusive. Most devices can be considered as performing at least two, and often all three functions. For example, computers must store and retrieve data in order to process it. Computers also play an important role in the communication of information.

One technological system is already in widespread use at all levels of instruction. Audio cassettes combined with slides, film strips and single concept films are found in classrooms from the primary grades through college. Listening posts and study carrels utilizing some combination of audio-tapes and films are an increasingly common aspect of the educational landscape. Community colleges have been notable pioneers in the development of audio-tutorical systems. Oakland Community College in Michigan and Golden West Community College in California are two examples of schools that have received national attention for the extent to

which they have developed and used audio-tutorial systems.

Holography is a visual presentation technic that has an interesting potential for instruction. By recording an interference pattern of light on a film a three dimensional image is perceived by the viewer. The advantage of a hologram over older attempts at three dimensional photography is its flexibility and freedom from viewing restrictions. No special glasses or paraphernalia are needed. A hologram can be made, under computer control, of an abstract concept such as a three dimensional representation of a mathematical function. Holographic technics are relatively simple and inexpensive. Their application to instruction are largely speculative at present but their potential is large for the not too distant future.

In the area of miniaturization two products are sure to find widespread application in education. Microfilm technics are rapidly advancing from the awkward expensive devices that are a familiar part of today's libraries. Microfiche technics allow an enormous amount of information to be stored in easily filed units called fiche. A fiche the size of a three inch by five inch file card can contain the contents of a full volume of an encyclopedia. The images can be read with a microfiche viewer and selectively reproduced on paper. The obvious advantage of microfiche is its ease of storage and retrieval, either by hand or under computer control. The implications of this technology for school libraries are obvious.

The development of miniature electronic calculators is having impact on math and science instruction. Costs of these machines has dropped dramatically over the past three years. If the trend continues, the pocket calculator may soon replace the slide rule and table of logarithms in most math and laboratory courses. Pocket calculators, when in widespread use may change the nature of the problems

examined by students in these courses. Real life problems will be more accessible without regard to the complexity of the calculations.

Videotape technology presents a potentially important new tool for classroom use with the development of one-half inch videotape equipment. Besides the obvious advantages in storing larger quantities of prerecorded material, the new TV equipment presents a totally new area for student creativity and expression. Student TV production has several interesting and unique aspects. Foremost is its relevance. We are becoming, indeed some argue that we have already become, a media oriented society. Student TV productions are in the media from which they receive an increasing proportion of their information and entertainment. Also, it has the unique feature of being a cooperative medium. A serious essay or play cannot be written by a committee, but a TV documentary is generally the work of a number of people interacting continuously in the course of production. A TV production or film is rarely the work of a single individual.

The immediacy, relevance, and social aspects of TV production probably account for the excellent results of experimental programs involving inner city students. Pilot programs in New York and Los Angeles have produced results that show great promise both in terms of actual output and in terms of providing a connecting link between those students and the educational system.

The two aspects of technology that will have the greatest impact on instruction are developments in broadband communication and electronic data processing. Let's consider first the communications area. In this area, cable television is rapidly becoming a major force in education and in society as a whole. Recent federal rulings have literally awakened a sleeping giant. Studies are being made and political

action groups are being formed in communities throughout the country in an attempt to invest a modicum of public control of cable franchises. The issue is to guarantee some reasonable number of channels of each cable system for municipal use. The results are heartening so far. Included in most franchise agreements are at least a limited number of channels for use by the schools. This opens up almost totally unexplored vistas in instruction.

The Colorado Springs use of cable TV offers a nearby example of the impact this technology may have in curriculum and classroom practice. Wanting a high quality elementary art program, but lacking the funds for an adequate number of art specialists to implement such a program under the current system, Colorado Springs turned to their already existing cable TV system. The district art supervisors, working with the district TV production group have produced a complete series of weekly art lessons for all elementary grades. These lessons are presented several times each week on the districts cable TV system to allow for flexibility in classroom scheduling. Classroom teachers receive teachers guides, materials lists, etc. well in advance of each TV lesson. They can then augment the TV demonstrations in their own classrooms. A strong program of teacher orientation workshops is also included in the total program. In addition, the district art supervisors are available for consultation on special problems and are continuously revising and refining the demonstration lessons on the basis of feedback from the classroom teachers.

Similar activities are taking place in many districts throughout the country. The interesting point of this example is that the cable TV system with local production facilities provides a potent multiplier of the talents and expertise of a limited

number of master teachers. This effect is augmented by the classroom teacher in a rather new role, that of monitor and facilitater rather than a primary presenter and planner.

The number of channels available for school use in currently operating cable systems is limited. The limitation is not however one that is imposed by the technology. As educators learn how to make the best use of these systems the number of channels devoted to instruction can be increased almost without limit. Channels can become available eventually for individual use as well as for large group instruction.

The capstone of technological advances in instruction is of course computer technology. The use of computers to manage instruction is well known in such major programs as project PLAN and IPI. An area of computer application to instructional management that has not been as thoroughly discussed is the maintenance and transfer of student records. Ours is a highly mobile student population; a reflection of the mobility of our society. An increasing fraction of our students will attend school in two or more districts during their elementary and secondary years. Within district and between district, transfers have risen in some areas to alarming proportions. These physical transfers are often accompanied by late or nonexistent transfers of often sketchy student records. Computer technology is being applied to both the problems of quality and transfer of records. A program is currently being discussed at the federal level that would result in a national student data bank. Standardized input to the data bank would be made by every school district and in turn each district would have access to the bank for immediate and complete information on incoming transfers. The usefulness of that information is readily apparent,

particularly as our curricula and instruction become more individualized.

The use of computers in the actual instructional process is the key to large scale individualization of education. That important learning can take place with high efficiency through the interaction of students with expertly designed instructional software in the form of computer programs is by now a point beyond debate. Over the past decade I have reported to this convention the promise, problems and progress of computer assisted instruction. While the promise has been slower in fulfillment than was anticipated ten years ago, important progress has been made. I discussed two major new projects and some technical breakthroughs in the area of cost at last year's convention of the IRA. The conclusions drawn in that discussion are still valid. The technical and cost solutions for large systems utilizing a thousand or more terminals now exist and are being implemented on a pilot basis.

The marriage of large scale computer systems with cable TV systems will, in my opinion, change our society to a degree similar to the changes made by the automobile and airplane. The ordinary citizen in today's society is basically a receiver of information. The flow of information is essentially uni-directional and controlled in time by the publication dates of newspapers and magazines and the programming schedules of radio and TV networks. Moreover, the bulk of such information is designed for mass consumption with little attention paid to individual needs that are at variance with the perceived mass need. In a sense this condition is reflected in the educational model discussed earlier.

Cable TV systems with an answer-back capability coupled with computer technology will allow for a mass communications system that is multi-dimensional as well as multi-directional. Information can be accessed in a manner and at a

time that corresponds to the individual consumers interests and need. Such a system has far reaching implications for social organization, implications that are currently under discussion by far-sighted social thinkers. In the remainder of this paper the discussion will be confined to the implications for education and more specifically to the change in roles that may be forecast for teachers and notions of how to prepare for such change.

In order to discuss the change in role and function of the classroom teacher that may be brought about by instructional technology let us postulate a school that embodies all the advanced systems that have been described; a school that is at present only an idea but that might well become a reality within the next two decades. To do this we must make the pleasant assumption that today's problems of hardware cost and reliability and software availability will be acceptably resolved within the next twenty years. Granted that assumption, what would be the essential features of such a school?

At a very basic level, I believe we are safe in assuming that there will still be a school. There will still be a central physical location where students will congregate for a major portion of the day. From a technical standpoint much of the learning could be done at home. For adults I suspect that most instruction will take place in the home, but that model will not be followed to any large degree for children. The trend for many years has been to increase the use of schools as child day-care centers as the pattern has become more common in which both parents are employed outside the home. I see no reason for that trend to be reversed.

There is also a trend at present for schools to operate on a continuous twelve month basis. Technology will make continuous scheduling a practical reality.

In addition, the open classroom is another present day trend that will be realized through technology.

A basic feature of our school of the future will be truly individualized instruction; individualized to an extent that is hard to imagine today. Most, if not all basic instruction and learning of a sequential nature will be accomplished by the interaction of students and technological instructional systems. This is the feature that will change the role of the teacher in important ways. This is not to say that teachers will be eliminated or the need for teachers reduced. Quite the contrary; teachers will become recognized and utilized for what they are -- highly skilled human beings. Much learning is a private matter and this is the aspect of instruction that will be accomplished through technology. On the other hand, a great deal of learning is social by its very nature and must take place in a social setting. The ability to communicate, the ability to cooperate, the discovery of ones function and identity in society are examples of vital aspects of education that cannot be accomplished in isolation. It is in these areas that teachers will employ their skills.

There are three present roles of the teacher that will certainly disappear: the teacher as clerk, the teacher as disciplinarian, and the teacher as presentor of subject matter. The clerical aspects of teaching are gradually being assumed by para-professionals. This trend will certainly continue and be accelerated by computerized record keeping.

The disciplinarian role of the teacher will be minimized in parallel with the disappearance of the necessity of forcing a number of students to attend to the same task at the same time. Most of today's problems of classroom discipline arise from students being threatened, bored, or otherwise turned off by having to accom-

plish the private aspects of learning in a group situation. The residual problems arising from basic psychological disturbances will be met by trained professionals operating in a context that aids rather than frustrates their efforts.

The role of the teacher as a primary source of facts and concepts has already been discussed. It is likely that this role will be transformed rather than elminiated as I will suggest in a moment.

If those roles disappear, what roles will emerge? A most important role to emerge will be the teacher as a creator of instructional software. Master teachers will be required in all disciplines in every district to design and produce materials that are focused on the needs and backgrounds of their own clients -- the students served by that district or individual school. This will not be a weekend or summertime activity. It will be a year round job combining the work of the best trained teachers and curriculum specialists.

Obviously not all materials will need to be home produced. There will still be a general market for national publishers. However, nationally or regionally produced software will always be analyzed for needed adaptations to meet local conditions. These highly trained and highly paid specialists will be the teachers of the future in much of the same sense that we recognize teachers today.

I have been highly vocal in the past in criticism of locally produced software. That criticism still holds today because it is based on the difficulty of doing the job because of current technical limitations of the hardware system. The criticism is also based on past and current ignorance of doing the job. Both basis for criticism show signs of disappearing. Computers are becoming more transparent in the sense of the use of higher level languages that approach normal English. Experience and

expertise is also developing slowly in the serious application of learning theory to subject matter problems. These criticisms will continue to disappear as we develop a body of teachers who are experienced in the area of software production and as technology develops further aids to make that production easier and more flexible. At that point local control of the curriculum will become a reality.

The day to day contacts with students will be made by teachers in the roles of subject matter monitors, psychologists, recreation specialists and librarians. Monitors may be a poor description of the class of professionals who, while not creators of software systems, are highly trained subject matter specialists that perform day to day counseling functions. They will be the people who handle the unique problems and decisions not under computer control. They will be the teachers who guide small group projects, discussion sessions, field trips and other socially oriented subject matter activities. They will not be third grade or sixth grade teachers because the term "grade" will have lost its meaning. They will instead be diagnosticians that handle the unique problems that cannot be handled by the system.

Working in close cooperation with the monitors will be the specialists in child and adolescent psychology. The counselors may assume many of the aspects of the current homeroom teacher. When students no longer need to be grouped according to subject matter achievement, a pattern will emerge whereby they may be brought together as necessary in terms of move relevant factors such as physical and emotional maturity. The counselors and the subject matter monitors will work with both fluid and relatively permanent groups to accomplish the social aspects of instruction.

While the counselors and monitors may be considered specialists in the cognative and affective aspects of education, the recreation supervisors may be considered generalists in social development. The current recreational program of most schools, especially at the elementary level, bears marked resemblance to the system used in prisons where the inmates are marched to the recreation yard for prescribed intervals of exercise. In the educational model made possible by technology, the timing and amount of play and exercise will be much more under the control of the student. When fatigue, boredom or frustration occurs in one activity, the student will be free to move to another even if that other activity involves a period of play. Indeed there may well be neural or other sensory devices built into the system that will detect symptoms of nervous or physical fatigue before they can interfer with learning.

The recreation specialist, like the psychologist and subject matter monitor will be highly trained in the socializing aspects of education and like the psychologist and monitor will have instant access through a computer terminal to the relevant history of each student. That information will be the basic stuff on which special decisions can be made for difficult problems.

Finally, the role of the teacher as librarian is sure to increase in importance. As the volume of information and aids available to students on an occasional basis increases so will the storage and retrieval systems require more expert management.

If these are to be major characteristics of the teaching profession in the not too distant future, how should we go about the preparation and training of teachers? Fortunately time is in our favor. All this will not come about next year or within

the next five years. We have time to plan, to forecast and, most important, to control to some extent the direction and rate of technological development. One of the major long term problems is preparing teachers for the role of creator of instructional software. An important step in that direction is being made at the University of Illinois at Chicago Circle. A new program for a Doctor of Arts Degree is being instituted that will focus directly on the transmission of information through technological forms of instruction including TV and CAI. Similar programs are being considered or are in the planning stages at other institutions such as the University of Texas in the Permean Basin. The demand for such training is still small. As the demand increases, the number and variety of programs must increase with a minimum of lag between supply and demand.

The foundation of training for the role of monitor will be a deep preparation in a special subject matter area. A monitor cannot stay one chapter ahead of the class nor can a monitor know only a narrow range of the field. When students proceed at their own rate and according to their own needs a mathematics monitor working with any given age level of students may have to respond to problems of learning basic addition facts and differential equations within the same hour. The same spread will hold true in all areas. A monitor will have to be a subject matter expert in the truest and broadest sense of the word.

Coupled with subject matter expertise will be serious training in handling small group interaction and instruction. Unfortunately, before this training can be meaningful, a good deal more knowledge must be gained both in theory and in practice. The insane quality of much current practice and discussion about classroom projects, mini-seminars and group activities in general is not based on unwillingness

of teachers but on a serious lack of knowledge about goals and techniques. If there is one vital issue that we must attend to in the preparation for technology it is gaining and transmitting solid ideas about effective and important small group instruction. I have seen many examples of CAI systems providing teachers with the opportunity to spend important amounts of time with small groups only to witness them doing exactly the same things with a group of four that they did with a class of thirty. The problem is not that the teachers are unwilling to change directions and activities. The problem is that they simply do not know what to do. Their training in this area failed when confronted with reality because the content of that training was meager to say the least.

In the long term, we have time to solve our problems in preparing for the new roles. But what about the short term, what of the immediate future? I wish I could be more optimistic but I fear we are going to have to suffer through a protracted period of adjustment. Clearly we cannot prepare teachers for roles that don't exist, and yet as those roles develop through the introduction of new systems much agony will be caused by the lack of preparation.

There are two positive steps however, to reduce the confusion of change. First, we can and must prepare teachers with as clear an understanding as possible of the potential as well as the problems of technological systems. We must at all costs avoid the sort of problem my ten year old daughter recently encountered. She was using an audio listening post for one aspect of a language arts unit. The problem being attacked was aural comprehension. When I noticed that she had missed several questions on the test sheet I asked her why she hadn't followed the printed directions on the unit which said to listen to the story as many times as necessary

to complete the test. She responded that the teacher had made them turn off the audio after only one presentation. The incident is a small one and of no great importance in itself but it does illustrate a major short range problem. We must prepare teachers adequately in the theory and rationale of technological instruction systems to insure that they will at least follow the directions. The directions are often vitally important. The conditions for use or non-use of a particular technology are often paramount considerations. Attention to the conditions and directions often means the difference between success and a silly waste of money and time: witness the use and misuse of language labs.

A clear step to take in preparing teachers in the rationale and necessary conditions for the use of technology is to use that technology to the fullest possible extent in their overall training. It is an old but accurate truisim that we tend to teach the way we have been taught. Many of the better schools of education are making serious moves in this direction. Unfortunately, there still remains a certain amount of resistance or at best apathy toward the whole notion of instructional technology. The result is that teacher training institutions tend to be the last places to employ technological advances. Students are more often exposed to lectures, such as this one, about technology but are given little or no opportunity to experience learning through technology.

Pre-service training is only part of the answer, however. We must also plan for more intensive and systematic programs of in-service training. If a law was passed prohibiting the purchase of a piece of hardware until an adequate in-service training program was in place, it would save large amounts of otherwise wasted money.

In-service, like the pre-service programs, must make extensive and intelligent use of the technology on which the training is focused. Preparation for use of a new system is not complete until there is an intuitive grasp of what that system is about. Such an understanding can only be achieved by actually learning through the sytem as opposed to learning about the system. This, to me, is the single most vital element in preparing teachers for the use of technology.

Technology may for reasons I discussed earlier, become an increasingly important tool for improving the quality of our educational system. It may also become a method for giving the appearance of change when in fact the status quo has simply been given a cosmetic treatment. The choice between the two extremes is in the hands of the education profession. The outcome will be determined by the extent that we prepare for change or simply let change be thrust upon us.