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PROGRAMMED INSTRUCTION: A REVOLUTION IN TRAINING. WHY? WHAT? HO--ETC(U)
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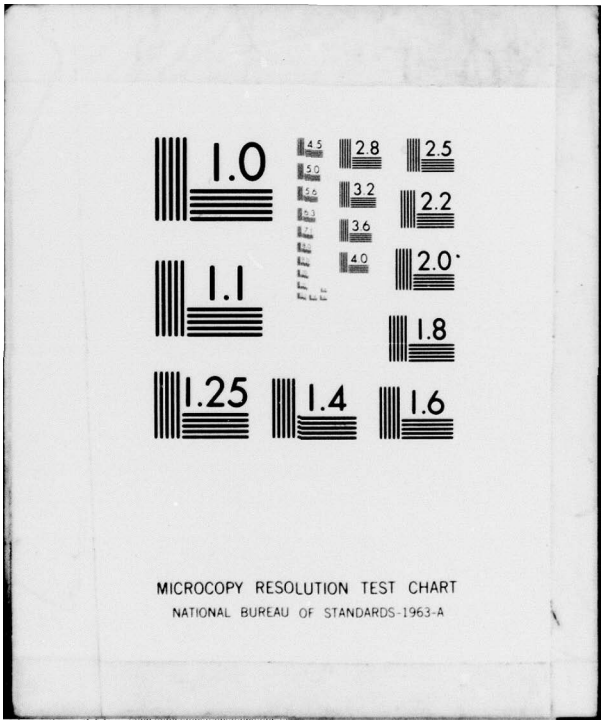
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There is a rather strong impression among many psychologists, educators, and school administrators, an impression I personally subscribe to, that recent developments in automated teaching presage a coming revolution in education and training. Whether the promissory note which is presently being written will actually be cashed, no one can say with unqualified finality. At the same time, however, there is growing evidence that the pay-off will be made. In an address last year before the American Psychological Association George Kneller stated the issue very succinctly when he commented in his opening remarks that:

> "Whether we like it or not, automated teaching is here to stay. Merely to oppose it is futile. Education must mirror the age it strives to improve. It cannot isolate itself from automation any more than from other social or economic changes. For automated teaching is one more of the applications of technology to human life. The question to be asked is not, 'Do we accept automation?' but 'How much of it and under what conditions?'"

On this foundation, I would like to first discuss the need for a revolution in education and training; second, identify briefly the characteristics of programmed instruction; third, summarize the Air Training Command plans and progress in programmed instruction; fourth, briefly state some problems and issues that confront us in the management of programmed instruction. I am hopeful that a preliminary answer to Dr. Kneller's question as to the how, where, and when of this issue will result from this discussion.

WHY PROGRAMMED INSTRUCTION?

Why a revolution in education and training? Why is evolution not adequate? One of the reasons we raise these questions is due to the fact that education has been simply evolving for centuries. Actually the book and the printing press were the first and last truly revolutionary efforts in the field of education. This accusation comes from Dr. Phillip Coombs of the Education Division of the Ford Foundation. Others have stated that automated teaching promises the first innovation in teaching since the invention of movable type in the 15th century.

This is not to deny that there have been vast social developments which have had extensive impacts on education. Our public school system is an admirable testimony to this fact. The process of education itself has been extended to millions who would not ordinarily benefit from it. Radio, television,

and other mass media of communication have had their undeniable effects. Advancements in the design of school buildings have been most notable. But despite these developments the fact still remains that there has been no "revolution", no "breakthrough", no "quantum jump" forward in the processes of education itself.

The newspapers reported a few days ago that in this year alone almost a million lost, bewildered, hopeless youngsters will leave school before graduation and enter a world which really has no place for them. Dr. Daniel Schrieber, Director of the School Drop-out Project of the National Education Association characterized these youngsters as "constantly running from work half-done, from school half-completed,.....truly fugitives from failure."

Jobs will be unavailable to many of these youngsters due to the impact of technology and automation on our society. We have a state of over-employment in our unskilled labor ranks and under-employment in our skilled trades. After citing as cases--that 50,000 elevator operator jobs disappeared in New York City alone during the past decade--that six men today can lay the same amount of railway track as 100 men did a few years ago--and that automated examining equipment for checking transistors will permit four men to do the work that 100 did a few years ago (And as an aside I might point out that we are finding out that pigeons can be trained to do a better job in this respect than men)--Schreiber emphasized to the National Association of Secondary School Principals that "How American education solves the problem of school drop-outs may well determine America's future."

In a recent Saturday Evening Post article titled We Waste One Million Kids a Year, Judge Mary Kohler, a member of President Kennedy's new National Committee on the Employment of Youth, makes essentially the same point with respect to the high school graduate. She emphasized that in 1960 of the 2,500,000 youngsters who reached 18 roughly one-third went to college, one-third quit school after graduation, and one-third had dropped out. More than one and one-half million of these youngsters did not have an organized plan to go from education to work that was either satisfying to themselves or that would enable them to make any significant contribution to society. Dr. Conant has pointed to the "social dynamite" inherent in this situation. Throughout the country the demand for jobs on the part of late adolescents has increased nearly seven times and the supply has only doubled. Cities all over the country are reporting drastic decreases in jobs available to sixteen and seventeen year olds.

A few weeks ago Lt General James E. Briggs, the Commander of the world's largest flying and technological training establishment, the Air Training Command, in addressing the World Affairs Council in Los Angeles, California,. commented in rather harsh tones about our "technological illiteracy" as a nation. In developing his thesis the General pointed out--that after the Air Force trains an electronics technician, for the price tag of $10,000 and two years of a four year enlistment, he is then lost to industry's talent scouts--that the problems of finding skilled and technically trained personnel plague not only the military but American industry as well--that our economy needs at least 250,000 technicians annually while the country produces less than 50,000 per year--and that by contrast the Soviet Union trains technicians for science, agriculture, medicine, electronics and similar fields at the rate of 1,600,000 per year. The argument was driven home by the General when he said and I quote:

"Something is drastically wrong when hundreds of thousands of technical jobs go unfilled in this country and at the same time millions remain unemployed. Well over a million of the unemployed are under 22 years of age. Most of them are untrained and have no salable skill. I was amazed to read in an Office of Education report that one company alone has an immediate requirement for 140,000 computer programmers and other data processing workers."

Inasmuch as the Air Force has had to teach men uniform basic mathematics and electricity, and since industry has had to teach its employees these fundamental subjects essential to our technical age, he has been led to refer to the products of contemporary education as "technological illiterates". Undoubtedly these facts have contributed to his repeated request for a "breakthrough" - "a revolution" in education and training. And it is probably these facts more than any others that have led him with a feeling of "cautious urgency" to fully support his Command's exploration of the possibilities inherent in automated teaching and programmed instruction.

There is a national awareness within industry and throughout the country of the retraining problems that have been created by the impact of automation. I refer you to a recent article in Fortune Magazine, called the "Hard Realities of Retraining", wherein the problems concerning retraining have been more easily stated than solved. The issue is stated quite succinctly in this article as follows:

"The hope is that retraining might not only relieve current unemployment but would help solve the possibly more serious manpower problems the U.S. will face in the next decade, when technological advance will demand more and more skilled workers, at the same time that it is eliminating the jobs of the unskilled....With present population and job trends, a situation could develop in which a shortage of skilled workers ate into production and profits, while a growing caste of 'unemployables' on the public rolls gobbled up tax dollars and injected a troubling imponderable into the political scene. An all-out effort to uplift the whole labor force looks like the simple answer.

"But despite the high hopes and hearty testimonials it has aroused, retraining has so far proved something less than an economic Lydia Pinkham's...." *

The article goes on to describe numerous efforts at retraining which have failed miserably. This problem is not going to be solved by simply finding out how many jobs are "going begging for lack of skilled workers and

*Fortune Magazine, Jul 1961, The Hard Realities of Retraining

then training the same number of the unskilled unemployed to fill them". A means must be found to train the unskilled unemployed to a effective enough level of proficiency so that the "meat cutter" can become an "electronics technician." It is recommended in this article that we upgrade ".....the labor force by small stages all along .....teaching the ordinary laborer minor skills, equipping the semiskilled with new techniques, turning the skilled into advanced technicians and junior engineers. Even some who have been doomed as the unemployable may have a place in this scheme."

When "Sputnik" was first launched, a quasi-hysteria enveloped the country, and immediate pleas were made by many--to intensify the building of our schools--to increase teachers' salaries--and to attract scientists and technicians back to the school room even on a part-time basis. It is interesting to note that during the emotionally toned discussions there was nothing said about looking very critically at the educational process itself to see what could be done about developing a technology which would help alleviate the problem.

We will all agree that there is no "crash program" that can possibly deliver us from our dilemma. Many have noted that we are already a nation with a shortage of 150,000 teachers. Our instructional force now has over 100,000 teachers who have substandard credentials. Over 25% of our elementary school teachers are not college graduates. And the number of able and master teachers among those who have standard qualifications and college degrees is woefully low. The problem from the point of view of numbers will get worse and not better. By 1965 we will increase our present school enrollment by 5,000,000 students. At our present rate of production our teacher shortage will grow to be over a quarter of a million. To meet this shortage over one-half of all our college graduates would have to become teachers during the next five years. We are likely to react to this problem by stressing quantity over quality and by reducing still further teacher qualifications. This has been a common failing of our society. We tend to exalt shoddy education while looking down on excellent technology. John Gardner noted this several years ago when he so eloquently stated:

> "That society which exalts shoddy philosophy because philosophy is a lofty activity and looks down on excellent plumbing because plumbing is a lowly activity, that society will have neither good plumbing nor good philosophy. Neither its pipes nor its theories will hold water."

This then is the problem. We are living in an age in which our knowledge of man and his universe is doubling every decade. Ours is an age in which educational technology has not been able to keep up with the innovations of technology itself. Again we must turn with hope to the statement that the problems created by technology will be solved by technology. Can teaching truly become a science? If it does not and it remains an art what is our alternative? And ultimately will our desperate need for an educational technology be sufficient in and of itself to force the issue?

It is my opinion that there has been no development in education that has provided as hopeful a sign for the revolutionary emergence of an educational technology as was started by the efforts of Dr. Sidney Pressey some 35 years ago and so recently and dramatically revitalized by Dr. B. F. Skinner a few years ago at Harvard. This development has been referred to as programmed instruction or automated teaching. It is in this development that our hope for a revolution in education lies.

WHAT IS PROGRAMMED INSTRUCTION?

Speaking to a group is probably the most ineffective teaching process we have. When we lecture we rarely teach anyone anything. We are likely to do many other things. We may inspire and motivate some to look further into the subject. Others we may entertain. Still others we may bore. A very few we may instruct to a certain degree. When as teachers we lecture we are simply stimulus machines emitting auditory stimuli which are interpreted by each student in his own unique manner against his own idiosyncratic and experiential background. In fact it would be a most sobering experience for all when we lecture to or address a group if we could somehow stop the mental process of each person in the room at a particular point and have some device which would take a free-association record of everyone's thoughts and make some comparable notes between what we wanted to communicate and what the student or members of the audience "heard" while we talked.

Martin Mayer in his book, The Schools* tells the delightful anecdote about the man who was encountered quite by accident on a train saying to his dinner companion, "I remember when I was in college, one of my teachers was the son of Edward Everett Hale. He was himself a very old man by then. For some reason, I was his favorite, and one day he called me aside after a class and said to me, 'Son, I don't know whether you plan to go into teaching or not'--at that time I didn't have the slightest intention of going into teaching --'but if you do, I'd like you to have the benefit of my years of experience.

"The time will come,' he said, 'in your work as a teacher, when you know you have perfected your lecture on one aspect of your subject. You will approach what you are going to say with the knowledge that it is a perfectly organized, impeccably logical approach to the material, that you have finally presented something in such a way that nobody could possibly fail to understand it.

" 'You will deliver this lecture,' Hale said, 'and at the end of it a boy will stand up and ask you an utterly stupid question.

" 'Cultivate that boy,' Hale said. 'He's the only one who was listening.' "

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*Mayer, Martin P. "The Schools" Harper and Brothers, Publishers, New York Copyright 1961.

Teachers are too often **stimulus machines** - - not much more adequate than other stimulus-devices. In fact some stimulus devices such as TV and radio sometimes get through to a mass audience much more effectively than most teachers.

In order to teach we have to communicate effectively. We have to know how effective or ineffective our communication has been before we know how to modify this process. Modification must be based on knowing where, how, and why we have failed in the communication process. In order to find this out we have to listen to feed-back from the student. Until the loop is closed instruction has not taken place. Very few students learn very many things from teachers. Students acquire much knowledge from reading, studying, analyzing, and arguing. Teachers may inspire, motivate occasionally and may even illuminate an abstract or **abstruse** principle, but they rarely teach anyone anything, except in one specific kind of student teacher relationship - the <u>tutorial relationship.</u>

Now it is obviously impossible to effect this kind of relationship with every student in every classroom in this nation. Some means must be found to mass produce the elements of this relationship so that every student at his own level can have this quality of instruction. It would be wonderful indeed if we could take our master teachers (who are not very often our able scholars) and package for millions of students their techniques and abilities.

Programmed instruction is the first step in an effort to do this--an effort to package for all students the characteristics of the tutorial approach!

May I describe this "tutorial teacher--student relationship" from **an unforgettable** personal experience which I had thirteen years ago. I was teaching psychology at that time in a relatively small mid-western urban university. My salary as a new college professor was typical of the average college teacher - a stipend which permits one to live in a state of "genteel poverty." I was taking on whatever additional academic chores I could to add some nominal figure to my income.

I was approached by a young lady who was doing her graduate study in psychology at one of our leading mid-western universities. She was failing her course in advanced psychological statistics and she wanted to know if I would tutor her. After talking to her at some length I agreed to take on the task for $10.00 per hour and I informed her that she would need approximately 20 hours of tutoring.

Now $200 was an exorbitant sum for this young lady who was working her way through graduate school. She accepted my proposal. This initiated a series of events which altered completely the student-teacher relationship that I had been accustomed to. How did this relationship change?

First, I suddenly assumed complete responsibility for the student learning. Can you imagine how I would have felt had she--after spending all this money and time--failed the final exam?

Second, I had no means of knowing what her final exam would consist of. This was something I never had to contend with in my customary role as a teacher. I had to gamble on the "integrity" of her professor. I did, of course, have available what material and information he had provided her. This was not substantial by any means.

Third, in our sessions I had to ascertain every step of the way where she was confused. I listened to her more closely than I have ever listened to any student. Every feed-back that I could get from her helped me to develop empathy for her and made me more effective as a teacher. Of greatest importance was what she had to say to me - not what I had to say to her! I cannot help but be reminded at this point of Rogers and Roethlisberger's experiment in listening which they asked people to carry out to demonstrate how difficult it is to listen to what someone else has to say. When discussing any matter you are instructed not to respond to what the other person has said until you have repeated back to that person what he has said to you to his satisfaction. They insist that this will be one of the most difficult things you ever tried. This is doubly difficult for those teachers who have been used to pontificating on topics of great interest to themselves rather than to students. There is certainly a parallel to be drawn between this circumstance and the learning value of "reflecting feelings" in the counseling relationship. The successful tutorial relationship is the ideal student-centered learning situation. In order to be of assistance to this young lady I had to listen very carefully to her, and in many ways our tutorial relationship reminded me of those rare times when I have been successful in counseling students.

Fourth, there was another characteristic of my relationship with this student which followed from the point I just mentioned. I proceeded very cautiously. I never tried to take her to point "C" until she had mastered point "B", and I refused to challenge her with point "D" until she had mastered point "C". There was a similarity here between this approach and the principle of gradual progression which we get from the animal learning laboratory.

Finally, basic to this relationship was the commitment that I felt to this student. It was with much anxiety on the morning of her examination I waited for word of how she had done. I had her promise to call me as soon as she found out the results. My anxiety increased as by early afternoon I had not received her call. Late that afternoon, however, she called me overjoyed with the news that she had passed and informed me that the very next morning my check would be in the mail. That was $200 that I had no qualms about accepting. I had earned it. But much more gratifying than this was the satisfaction that another student had not failed to learn.

Now what has all this to do with automated teaching and specifically teaching machines? Above all one thing is being made clear - teaching machines do not teach. They merely present teaching materials which have been developed, or programmed as we now say, in a special way. A teaching machine is simply a device which presents stimuli and provides for active responses from the student. Many teachers are often stimulus machines, but they cannot provide for active student response except in the tutorial relationship.

The manner in which the information is prepared that goes into the machine, the size of the increments of the information presented, the sequence of the information, and how the student responds to the materials throughout the program, determine how effective the machines really are. We call this material and the manner in which it is prepared "the program" and for this reason "the program" is the heart of any teaching machine. In all fairness, I should point out, however, that I have received the following clarifying comment from Dr. Robert Mager which deserves mention:*.

> "When one says that 'Teaching machines do not teach,' the implication apparently is that teachers do teach. The problem, I suppose, is with the meaning of the word 'teach.' If a teaching machine is a thing that presents information to the learner and adjusts itself on the basis of the learner's response, then so does the teacher. As a matter of fact, the machine can be far more effective than the teacher in presenting information in an appropriately organized fashion, and in accommodating itself to the needs of the individual learner. If you mean to imply that the difference is one of function, and that the teacher does something more than simply present the program, then you might say this rather than that machines don't teach but teachers do. While instructional devices that do more than simply present the program do not abound, they do exist and will become considerably more sophisticated as time goes on. Whether a device can or should be able to do anything a teacher does is another matter."

But regardless of the potential merits of teaching machines, as such, programmed instruction is an effort to package for the student the essential aspects of the tutorial method of instruction. Since the material is prepared and sequenced for instructional purposes it seems much more appropriate to refer to it as programmed instruction rather than programmed learning because learning does not actually take place until the student interacts with the materials.

In this respect the student is led "one step at a time" along the learning path. He actively responds to a curriculum that has been logically sequenced so that his response always carries him a little closer to the ultimate desired learning outcome. The student is required to respond to questions, solve problems, or complete exercises. Whenever the student makes a response he is immediately informed how correct or accurate his answer is and, where necessary, provided with additional information to correct his answer. It is this aspect of programmed instruction which comes the closest to approximating the tutorial relationship.

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*Personal correspondence from Robert Mager to Lt Col Gabriel D. Ofiesh dated April 16, 1962

Within this framework there have evolved three basic techniques which deserve concern: the linear, branching, and mathetical approaches.

The linear method (largely developed by Dr. B. F. Skinner of Harvard) is also referred to as straight-line or constructed response programming. This method relies very heavily on the reinforcement (reward) aspects of simple conditioning learning theory. The ideal program according to Skinner would be one where the student would make no errors whatsoever in his responses. To accomplish this goal the information is presented to the student in very small steps and the student is steadily cued or prompted in such a manner that he cannot help but make the correct response. Learning becomes almost effortless but not thoughtless and it is meant to be that way. Every response made by the student is an overt as well as a covert one. It is the nature of the constructed response on the part of student (i.e. filling in a blank, drawing a diagram, solving a problem, writing a word, etc.,) which determines the extent to which the student participates actively in the learning program. After he constructs the correct response he immediately knows whether or not he is correct and this knowledge or feed-back is supposedly reinforcing. The burden is on the program, however, to lead the student to construct the correct response.

The branching method (developed by N. Crowder of U.S. Industries) is also referred to as intrinsic programming. This method presents a much greater amount of information to the student at one time than does the linear method. The essential distinctions between the two methods are: (1) the branching approach does not seek the ideal errorless performance of students as does the linear method, (2) branching or intrinsic programming does not encourage mistakes, but does provide for them when they occur, (3) the constructed response is not critical for learning as it is in the linear approach. Crowder describes his intrinsic programming as follows:

> "Automated tutoring" is an individually-used, instructorless method of teaching which represents an automation of the classical process of individual tutoring. The student is given the material to be learned in small logical units (usually a paragraph or less in length) and is tested on each unit immediately. The test result is used automatically to control the material that the student sees next. If the student passes the test question he is automatically given the next unit of information and the next question. If he fails the test question, the preceding unit of information is reviewed, the nature of his error is explained to him, and he is retested. The test questions are multiple-choice questions and there is a separate set of correctional materials for each wrong answer that is included in the multiple choice alternative. The technique of using a student's choice of an answer to a multiple-choice question to determine the next material to which he will be exposed has been called "intrinsic programming.

The basic question that is raised between these two rather distinctive techniques is: "Do students learn more effectively from making errors and finding out why they are wrong or do they learn better by making no errors whatsoever?"

Most recent developments in programmed education lay heavy stress upon format of materials. Both the linear and branching approaches are essentially format systems, since they are alternative ways of making the final presentation to the learner. The mathetical approach is not a "format system" as such.

The mathetical approach (developed by Dr. Thomas Gilbert of TOR Industries) begins with an essentially different formulation. The assumption is not made that the best format for presenting all materials is the same in every case. Adherents claim that rather than being a programming method per se, it is a technology or system for finding the best way to arrange materials for learning given certain terminal criteria.

A process of finding the best way of arranging materials for learning has been worked out, both in broad outline and in significant detail. Format decisions, such as whether linear, branching, or other display methods shall be used are made near the end of the process rather than being affixed in the beginning. The programmed - instructional lessons and other materials thus produced differ from each other depending upon the type of subject-matter involved.

A detailed statement or blueprint of the educational objective is made and written in behavioral stimulus-response terms. This S-R blueprint is referred to as the "prescription" of behavior. This is essentially a convenient and standardized way of presenting the terminal behavior to be taught. It is however the most difficult and time consuming aspect of the task. Besides immediate knowledge of results, mathetics has added other important reinforcers or motivators such as (1) task completion at each step, (2) observing knowledge grow, and (3) learning by doing.

A "backwards" approach is used in the teaching of behavior chains (i.e., series of S-R connections) in which the learner begins at the end and gathers more and more into his repertory at each exercise. In this way he is always finishing the task.

Discriminations such as languages and decision making processes are taught all at once providing optimal opportunity for the student to compare all parts of the complex. Branching is used when the population is likely to differ with regard to prior knowledge - (example -- if a student can answer a particular frame correctly he then can skip a certain number of subsequent frames). Use is made of what are called "soft simulators" of paper and cardboard enabling the student to do more than learn verbal knowledge in connection with the subject. Finally, each lesson contains both a theory section and an operational section. In the operational section the student runs through the actual operations he will be later required to perform. He does this using

the simulators.*

It appears at present that mathetical lessons tend to be much shorter than the customary programmed instructional package and are greatly reduced in bulk.

All programmed instructional packages, however, are crucially dependent on another prior step which experience has shown is probably the most important aspect of the completed process. This is the "task" or "learning outcome analysis." The traditional statement of task or learning objective has been most inadequate. Such learning outcomes or job training standard elements as "Be familiar with....", "Understand the....", "Operate the....", and "Repair the...." are not good enough. The analysis of learning outcomes which initially guides the development of the programmed instruction materials must be intensive, extensive and specific. This beginning step must define as completely as can be done what performance the student is expected to demonstrate at the termination of the program.

Dr. Robert F. Mager points out in his book, Preparing Objectives for Programmed Instruction that:

> "A meaningfully stated objective, then, is one that succeeds in communicating your intent; the best statement is the one that excludes the greatest number of possible alternatives to your goal. Unfortunately, there are many "loaded" words, words open to a wide range of interpretation. To the extent that we use ONLY such words, we leave ourselves open to misinterpretation.
>
> Consider the following examples of words in this light.

Words Open to Many Interpretations	Words Open to Fewer Interpretations
to know	to write
to understand	to recite
to really understand	to identify
to appreciate	to differentiate
to fully appreciate	to solve
to grasp the significance of	to construct

*I am indebted to Dr. Charles Slack of TOR, Inc. for this brief and succinct description of "Mathetics".

*Mager, R. L., Preparing Objectives for Programmed Instruction, 1961, Fearon Publishers 828 Valencia Street, San Francisco 10, California.

to enjoy	to list
to believe	to compare
to have faith in	to contrast"

It is essential in programmed instruction that learning objectives state in concrete and explicit terms the terminal behavior desired at the conclusion of the program. There must be no misinterpretation by anyone as to the nature of the desired learning outcomes. It has been said that this condition is desirable for all education and training programs. True. It is impossible, however, to develop an adequate programmed instruction package without this. Programmed instruction forces this issue like no other technology we have developed.

In summary then, what are the salient features of programmed instruction?

1. The program begins with a specific description in behavior terms of desired learning outcomes.

2. The program is a carefully and logically arranged sequence of information designed to guarantee learning of specific desired learning outcomes.

3. The student is required to be an active participant throughout the program by continuously interacting with the programmed materials.

4. The program is arranged so that every student can proceed at his own individual pace.

5. The program must provide the student with immediate knowledge of the correctness of his responses.

THE AIR TRAINING COMMAND PROGRAM IN PROGRAMMED INSTRUCTION

I have already mentioned the interest of the Commander of the Air Training Command in any developments which bear promise of contributing to a breakthrough in training technology. His support of exploratory developments in programmed instruction has also led to plans which I would like to briefly summarize at this point.

The Air Force wide interest in the subject of programmed instruction was expressed by an Air Staff policy letter in October 1961. This letter stated that programmed instruction may well represent the first major advance in education and training in many years. Early in November of last year (1961) ATC initiated its indoctrination of key Air Training Command personnel in programmed instruction. This effort included attendance of HQ staff and technical training center representatives at an intensive week-long workshop. These representatives were selected to play a key role in monitoring and encouraging the development of programmed learning projects at the technical training centers and the flying training installations.

In the middle of November (1961) a conference of key personnel from the technical training centers was held at Hq ATC to discuss command policy and the dimensions for the ATC "experiment" under Phase I. The results of this conference were in turn coordinated with DCS/Flying Training. Following this coordination it was agreed within the ATC staff that we would place increased emphasis on exploiting the significant findings of training research as one means of insuring maximum efficiency in our training mission. Under Phase I the following specific objectives were outlined:

a. Familiarization of all instructors and training supervisors with the concepts, terms, principles, techniques, and procedures associated with programmed learning and automated instruction.

b. Development of a limited "in-house" capability at each training facility to produce programmed learning materials (programs).

c. Development of experimental programmed learning materials.

d. Use and formal evaluation of the effectiveness of these experimental programs.

e. Determination of the feasibility of further expansion, exploitation, and sophistication of programmed learning techniques within the Air Training Command.

Letters of instruction in support of these objectives were sent to their respective activities by DCS/Technical Training and DCS/Flying Training. I am distributing a handout which outlines in detail the ATC program to date.

The Selection of Contract Courses for Training of Programmers: It was the original intent in assessing the variety of companies, institutions, and/or individuals who claimed a capability to offer the Air Training Command courses in programmed learning to sample a wide variety of techniques. However, an analysis of the responses to a letter that was mailed to over 120 companies, institutions and/or individuals indicated that the variety available was not as great as was originally supposed. The techniques found to be available were linear, branching, mathetics.

It was concluded that we ought to seek "expert knowledge" based upon the high experience level of the instructors who would teach the courses along with a variety in technique. There still would be representation of the three basic approaches. No student would receive cross-sectional training in a variety of techniques and/or capabilities at any one time. It was felt wise to have each programmed instruction team learn one approach well until it had developed a program through this method. Consideration could then be given to having the team extend its knowledge to other approaches. As of this date the analysis of all the responses has not been completed. New companies are being contacted as information is received about their capability.

Training the Programmed Instruction Writers: Under Phase I of the Air Force program it was desired to develop an in-house capability within the Air Force and largely within the Air Training Command in Programmed Instruction writers (PIWs i.e. individuals or teams who were skilled in developing and writing the programmed instruction packages - - PIPs).

ATC desired to assess its capacity for producing its own unique programs rather than have various companies and institutions which do programming assume the task. From this assessment it was decided to develop these skills within a portion of the personnel who are specifically engaged in preparing training materials.

Our effort to train the programmed instruction writers revolved around three aspects:

1. Selecting the proper contract schools

2. Selecting the students who would be trained as programmed instruction writers (PIWs)

3. Selecting the topics that would be programmed

We are also continuing to contact new companies as information is received about their capability. The general pattern followed in the courses is to have the instructors meet with the students for a two-week period. Students entering the courses have a topic already assigned to them covering on the average of 10 hours of conventional instruction. The total number of students in any one course does not exceed 20. Following the first two weeks of formal training, the students return to their home base and continue to work on their projects. Periodically throughout the subsequent 6 months students will meet again with instructors and receive additional instruction and assistance in the editing and refinement of their materials. Following this 6 month period the PIP will be administered over the subsequent 6 months in the actual training situation under proper controls in order to adequately assess the merits of the auto-instructional materials in comparison with the conventionally developed block of instruction.

Tentative quotas have been assigned to technical training centers, flying training activities and other training and education activities in the Air Force for those programmed instruction courses which began 15 Jan and are to be offered through 23 May to initiate the development of the in-house capability.

There have been requests for additional in-puts which would necessitate the offering of additional courses. The plan at present is to offer two 3-4 day orientation courses for supervisors and planners at Randolph Air Force Base on 15 May and 21 May. This will ensure that future in-puts into contract courses for the training of programmers will be carefully and intelligently planned. Future supervisor and planner courses will be scheduled as requirements dictate.

Topics were selected by the training centers and flying bases and approved by Hqs ATC. A list of those topics which have been approved to date are listed in an appendix to the program report.

Off-The-Shelf Materials: Numerous off-the-shelf programmed instructional materials are presently being reviewed by the technical training centers for their possible use with personnel awaiting training and in off-base programs. The possibilities of using programmed instructional materials that have already been validated for high school programs such as courses in mathematics are being considered for their remedial and refresher value in the training of basic airmen. Also training in electronic fundamentals through the use of off-the-shelf materials is being considered. It is an integral part of Air Training Command policy to keep abreast of the development of the off-the-shelf materials to minimize duplication of effort whenever possible. Where validated off-the-shelf materials are now available or are likely to be available in the near future, they will be tried out. These subject areas will not be [illegible] programmed by an in-house capability unless experiments with off-the-shelf materials warrant it.

OJT-PIPs: It is apparent to many that one of the widest applications of programmed instructional materials will be their use in the numerous on-the-job training programs within the Air Force. In addition to the use of the improved publications it is anticipated that the on-the-job training programs will present the opportunity for the wide-spread usage of this approach. To look into this possibility as another facet of the ATC experiment each center was directed to select one OJT package to be programmed and to assign at least two and preferably three technical writers to receive the training and to be assigned to that project exclusively.

Evaluation: (1) A first evaluation project will be undertaken to determine the effectiveness of the contract courses which have provided training in programmed instructional techniques. (2) A second evaluation project will be undertaken to determine whether potentially good programmed instruction writers (PIWs) can be identified and selected for future training. (3) A third evaluation will be undertaken of the programmed instruction package (PIP) after it has been developed by ATC personnel.

These evaluation projects are also outlined in more detail in the hand-out.

The Management of Programmed Instruction During Phase I: Study must be initiated early during Phase I to explore some of the problem areas in the management training which will emerge with the application of programmed instruction. There will of necessity be some differences in the administration of programmed instruction during Phase I as contrasted with Phase II because by definition Phase I is exploratory, experimental, and developmental whereas Phase II will consist of the realistic application. Command guidance and policy has to be formulated therefore for the separate management of both Phase I and Phase II.

Under Phase I guidance must be provided to training activities with respect to the:

1. Selection of contract courses for special training of programmed instruction writers.

2. Selection of appropriate subject matter areas.

3. Selection of potential programmed instruction writers.

4. Evaluation of Phase I.

5. Development and evaluation of OJT packages.

6. Selection and experimentation of off-the-shelf materials.

Preliminary management instructions have been delineated for items 1 to 4 of the above list. Since definite consideration is being given to accelerating the development of some model OJT packages in programmed instruction form and to the experimental try-out of off-the-shelf materials, guidance must be provided in the future on how these materials are to be selected, developed, administered, managed and evaluated.

Other training management areas will probably have to be explored as we increase our experience level during Phase I.

PROBLEMS AND ISSUES

I would like to enumerate briefly some of the problems and issues that have already evolved with developments in this new educational technology. The state of the art is still a nubile one in spite of the interest that has developed and the many programs that are on the books. Let us not ask for too many answers too soon. We have just started to open the door to the possibilities inherent in the writing of programmed materials so that they will teach in and of themselves. These are very early efforts. We should retain flexibility in our thinking. We must refuse to lock onto any "conclusions" with respect to technique, format, sequence, etc. Who knows what a programmed package will look like ten years hence in comparison to these first primitive efforts? On the other hand we must be wary that we not let the "best" become the enemy of the "good". Our instruction - techniques have been so inadequate that even relatively "poor" programs have in some cases demonstrated superiority to the traditional methods of teaching. This should not encourage us, however, under the pressure of urgency, to expedite the development of poor programs.

We have already enough evidence to permit the delineation of certain trends and the emergence of some issues and problems. These problems will not be solved and the issues will not be resolved unless education and training administrators are willing to experiment and to explore new ways of doing things. We will not have a revolution in the education and training process unless we are willing to make a simultaneous revolution in educational administration. This point needs to be emphasized over and over again. You cannot think about an individual - student-paced instructional program without being willing to

discard the present lock-step method of education which we have traditionally had for hundreds of years. If programmed instruction is to fail as an educational technology let it fail on its own merits and not due to a lack of creative administrative support. We must be willing to innovate. We must ask many questions and be willing to seek the answers. What are some of these problems and issues?

First, what threat is posed to the teacher in programmed instruction? Will he be replaced? I do not think the teacher will be replaced. Not because I do not think that programmed instruction cannot replace many teachers. There will always be a role for the able master teacher. But many mediocre teachers will not be replaced in the foreseeable future simply because there will continue to be a shortage of teachers and it will take many many years to program all of our fundamental and basic curricula. We cannot train programmers that rapidly and they in turn cannot develop programs that quickly. Even with the extensive program we have embarked on in the Air Force we will by mid 1963 have trained only several hundred programmed instruction writers. Some have noted that this effort of ours will double the number of able writers of programmed materials in the country. Even should this be so this limited in-house capability of ours will provide only a minimal launch pad should we decide to go all out in programming the major portion of our 2400 plus training programs. Programming a one-semester course takes many many hours and people who not only have the skill but an unusually high ability to persevere at a task. So there is no immediate threat to the teacher. There is much to be done. I get somewhat disturbed, however, when I hear those who would alleviate the average teachers' anxieties by informing them that programmed instruction will free the teacher from repetitive and drill like aspects of teaching. I believe that to many teachers this promise will be more of a threat than programmed instruction. If you took away from some, not all, but some teachers this aspect of their work they wouldn't know what to do in a seminar type discussion with students who would now be armed with a repertoire which will allow them to know what they are talking about.

Last year during and following the 1961 National Education Association Convention there emanated broad press coverage on the topic of teaching machines. A study of this press coverage delineated some strong emotionally-toned apprehensions about the de-humanizing aspects of teaching-machine technology and education. There was one editorial, however, which I believe stated the issue with objective and realistic though unpleasant force. The Montgomery, Alabama Advertiser stated:

> "....Teachers who merely parrot their lectures, who fail to inspire and encourage, are merely human machines. And they are neither as efficient nor as cheap as some of the 'gadgets' replacing them.
>
> The NEA bleats are thus undeserving of much public sympathy. The arguments against mech-

anization, in a profession already mechanized by tired dogma and time-serving teachers, are essentially the same as organized labor's attacks on new machines to do the job better."*

What needs to be constructively defined, however, is the role of the able master teacher and counselor and how he fits into the automated, educational "system".

What will be the impact of programmed instruction on aptitude, proficiency and achievement testing? I think that many of us have known for years that in many aspects of education the tail of testing has wagged the dog of learning. We tend to learn what we will be tested on and we tend to be tested on what we can measure. Due to a lack of knowing precisely what it is we wanted to teach we have developed an artifact in a relative grading system which measures student achievements against the performance of his peers. Already we have found that programmed instruction plays havoc with normal curve since the program is planned to enable nearly all students to accomplish a 95 or 98% level of performance if given sufficient time. Several studies have indicated that there has been little or no statistical correlation that could presently be identified between present aptitude measures and the very restricted range of distribution near the high end of the achievement scale. Of course this prospect of having to give "A"s or "B"s to nearly everyone terrifies the living daylights out of educators and laymen alike.

Noteworthy is Peterson's study of the effectiveness of an early version of programmed learning.* Although learning increased (40%), the previously valid psychological tests (correlation .68) dropped significantly (correlation .30) in ability to predict achievement.

Since both technical training placement and initial assignments are based upon aptitude tests, we might well ask what effect will the introduction of programmed instruction have upon the validity of current aptitude tests? This is not to deny that there is a correlation between aptitude and learning. Rather the question is raised as to what extent will we have to alter our present dimensions of aptitude measurement? Although we will obviously not do away with individual differences, will individual differences as we presently know them be of any substantive significance to the educator and training administrator?

May I mention another study which has somewhat similar implications.*

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*Occasional Paper No. 4, George Gerbner, Instructional Technology and the Press: A Case Study. National Education Association, 1201 Sixteenth Street N. W. Washington 6, D.C.

*Peterson, J. C. "The Value of Guidance in Reading for Information" in Teaching Machines and Programmed Learning, Lumsdaine and Glaser (Department of Audio-Visual Instruction - National Education Association of the US, Copyright 1960)

*Report, Basic Systems, Inc. Programmed Instruction for Industry, Reading Engineering Drawings, 1962, Basic Systems, Inc., 42 E 52nd St, NY, NY.

duPont had a need to train maintenance mechanics, pipe fitters and millwrights in the initial training of reading engineering drawings. Other categories of employees such as operating and production personnel, maintenance supervisors and some engineering trainees needed brush-up training in the subject. There was also the requirement for the program to be used as an aid in training operating personnel and newly graduated engineers and company lawyers who were being prepared as patent attornies to understand new equipment and processes. As of January of this year, duPont trained 111 men by the Programmed Instruction course. The ages of the men ranged from 23 to 61 years. Seven per cent of the trainees had an education below the 8th grade, with 9 per cent above the 12th grade. The program produced achievement test scores on a comprehensive 3-hour final examination of 90 or better for 82 per cent of all trainees. In comparison with students who were trained in the conventional manner the final examination average rose from 82 per cent to 91 per cent. If you recall, I had stated that 7 per cent of the trainees had had a below 8th grade level of education. It is interesting to note that only 4 per cent of the trainees scored below 85 per cent and none below 78 per cent. In other words even some of the students who were below the 8th grade level in their education were able to score above 85 per cent on a final criterion examination. Of equal significance to the training manager was the fact that training time was reduced by an average of 25 per cent over conventional teaching methods and that with the programmed instruction materials there was no requirement for instructors or organized classroom procedures. Of still greater significance from a manager and application point of view was that fact that in addition to improving training results where conventional instruction procedures are presently being used, the program enlarges the scope for allowing employees to be trained in situations where up until the present it has not been feasible or possible. Programmed instruction produces an opportunity for flexibility of application whereby trainees can proceed at their own pace, study during unusual hours, master the repertoire by themselves. The duPont study demonstrated, for example, that shift mechanics can often take the program during time they have available on the job.

Let me discuss briefly another issue. That is the problem associated with the sequencing of subject matter which the developments in programmed instruction have highlighted. In a study "On the Sequencing of Instructional Content" Robert Mager* asked naive students to be the primary source in determining the sequences of instructional content in a course in electronics. The results of his study indicated that there was a sharp disparity between the sequence of instructional content as determined by the instructor and as determined by the students. Mager pointed out, for example, that the learner begins his course in electronics with an entirely different set of concepts than does the instructor. When the outlines of eight different basic electronic courses taught by industry and the military were surveyed by Mager, it was found that nearly all courses began either with the subject of magnetism or with a discussion of theory. On the other hand, when the electronic course was sequenced by the learner it very often began with the subject of the vacuum tube. What was "logical sequence" for the instructor was not "logical sequence" for the students. When the students helped to sequence the material it was determined

*Mager, R.F., On the Sequencing of Instructional Content. Psychological Reports, 1961, 9, 405--413. Southern Universities Press 1961.

that there were several characteristics which these sequences had in common. Of particular significance was the fact that the initial interest of the learner in electronics was in the "concrete rather than the abstract, in things rather than in theory, in how rather than why.....function before structure.... (and further the student was interested in progressing from simple wholes to more complex wholes.)" The conclusions of this study indicate quite forcefully that the sequence determined by the learner bears very little resemblance to that which is customarily prepared by the teacher or curriculum specialist. The point here is that rather than ignoring these interests the instructor could well use them as fundamental departure points.

Another issue is concerned with what subjects and areas of knowledge and understanding can most profitably be programmed. We know that programming course materials is expensive. To what extent will it be profitable to program subjects which are undergoing constant change? The Dartmouth Medical School reported a few weeks ago that the use of programmed instruction in parasitology has nearly doubled the learning performance. The faculty members, who conducted the experiment, said the self-teaching materials increased the students' learning efficiency 1.85 times compared with another class conducted in the conventional manner.

These findings imply that not only elementary subjects but even the critical area of graduate study where knowledge is expanding rapidly and is growing increasingly complex is an area that programmed instruction can map. They added that just as a first-grader must learn letters before knowing how to spell, a graduate student must often master a body of factual knowledge before he can reason critically about the subject.

In the last year, Prof. Robert J. Weiss, chairman of the Psychiatry Department, and Edward J. Green, Associate Professor of Psychology, have devised programmed instruction for parasitology, pharmacology, bio-chemistry, anatomy and physiology.

In continuing research, under a grant from the Carnegie Corporation, they will investigate the factors in self-teaching materials that make them more efficient; the reason why (as the experiment indicated) students of low academic standing benefited more from this method than did the top students, and how these methods might be used to revive forgotten knowledge later on.

Those are only a few issues. There are many more. Let me briefly state some of these in the form of questions that we must ultimately answer:

1. To what extent can good programmers be selected and trained en masse?

2. To what extent is it feasible to develop programmed instructional materials for the total training of programmers? Partial?

3. What educational administration problems emerge with the application of programmed instruction?

4. What will be the role of the able master teacher or instructor?

5. In a training program which is paced to the abilities of each individual student how will problems of student graduation and course completion be handled?

6. What would be a proper design for evaluating the effectiveness of a programmed instruction course?

7. To what extent can programmed instructional materials be used for remedial education?

8. What is the role of teaching machines, audio-visual devices and television with respect to programmed instruction?

9. What will be the impact on the educational system, administrators, and teachers of the large-scale adoption of programmed instruction?

10. To what extent can courses in the humanities and social sciences be subject to programming?

IN SUMMARY

In the past when students have not learned and materials of learning which have been prepared were not easily understood we rarely if ever blamed the teacher or the textbook writer. The student more often than not was to blame. Either he was too stupid or too dense to understand our "simple" explanation or - and this has been a recent explanation in explaining away our failures as teachers -- he was improperly trained and educated by other teachers or schools. In programmed instruction an entirely new concept of responsibility enters the learning situation. The burden of responsibility for the student learning is on the program. If the student doesn't learn something is wrong with the program. It must be thrown out and a new one tried. Or it must be "de-bugged" so that it will teach. Or it must be revised or the material must be re-sequenced or something else must be done to the program until it finally teaches--until it is such an excellent program that it teaches practically everybody who is willing to go through it -- to interact with it. Note that I said practically everybody. Although some idealistic die hards are willing to say everybody. But when I say practically everybody I am talking about 95 to 98% of your target population. Your target population may be more universal, however, than you have previously considered it to be.

New vistas open up to the zealot of programmed instruction. Students that other teachers and schools have given up on now become ripe material capable of cultivation.

On various occasions I have asked numerous members of an audience to try out programmed instruction materials themselves. I have urged them, however, not to select a program in an area where they have some proficiency and expert knowledge. I have asked them, rather, to select a program in an area which they have always found difficult - an area that seemed to pass them completely by in school and which they have, largely because of this unfortunate experience, dreaded studying. I have urged them and I urge you to study these subjects YOU find difficult with a programmed package. If it

is a good package you will find learning this "difficult subject" almost effortless.

In conclusion, I cannot help but paraphrase the words of Emma Lazarus inscribed on tablet in the pedestal of the Statue of Liberty which read:

> ".....Give me your tired, your poor,
> Your huddled masses yearning to breathe free,
> The wretched refuse of your teeming shore.
> Send these, the homeless, tempest-tost to me,
> I lift my lamp beside the golden door!"

The author hopes

I like to feel that programmed instruction and automated teaching--rather than dehumanizing man will humanize him. It is poor teaching and poor, dull and boring teachers who have hidden behind the routine and drill that have led to much student failure and to the subsequent dehumanization of man. I like to think that the plea of programmed instruction to our society is to offer the lamp of learning beside the golden door in the best socratic and tutorial tradition of teaching, asking that we bring the difficult, stupid, unmotivated, gifted though neglected students - - "tempest-tost" by other teachers - - and telling those students that the burden for learning is no longer solely on their shoulders but that it is now equally if not more so on the shoulders of he who would consider himself a true professional in the field of education and in what may someday become the science of pedagogy.

The students'