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## AN INTRODUCTION TO PROGRAMED INSTRUCTION

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The field of programed instruction is one which has witnessed a tremendous surge of interest and development in the past few years, and which shows as yet no signs of abating its phenomenal rate of growth. The term *programed instruction*, in a generic sense, can refer to any form of pre-prepared, pre-sequenced instruction directed toward a specific educational or training objective. In this broad sense, it comprehends instructional television and instructional motion pictures, as well as the somewhat more specialized forms that center around the concept of the teaching machine and related devices. The latter, more specific form of programed instruction is the topic of the remainder of this discussion. This form of programed instruction (to be shorten to PI for the remainder of this paper) deals with forms of reproducible instructional sequences in which the individual learner is made a central participant in the instructional process. More specifically, the learner is called upon to respond frequently in interaction with an instructional program and the rate at which instruction proceeds is governed individually by each learner's responses. An educational technique is thus created in which differences among students in background and aptitude are taken directly into account in the management of the learning process, in a way that is hardly possible in the fixed-pace instruction typical of the classroom lecture or its filmed or televised counterpart.

### BACKGROUND OF PROGRAMED INSTRUCTION

Programed Instruction is an outgrowth of a relatively young science known as behavioral psychology, or "learning theory." The basic assumption is that the best way to determine if learning has taken place is to observe behavior. Programing people talk about behavior in terms of specific skills or knowledge which must be described in measurable terms.

PI is also based on the principle of reinforcement. According to this principle, you can influence an individual's behavior by granting or withholding a reward. As you reinforce certain kinds of desirable behavior and fail to reinforce undesirable behavior, your student gradually learns what is expected of him, and he acts accordingly. Thus, as he answers a question correctly, he is led to new material based on that answer.

### CHARACTERISTICS OF PROGRAMED INSTRUCTION

There are two main types of PI, which will be discussed later, but essentially the technique can be defined as any teaching method that has the following characteristics:

1. Each student works individually on the programed instruction materials at his own pace. As an individual method of instruction, this allows more latitude for individual differences in learning ability than does a group method. It thus differs from lecture, TV, and movie presentations, which are typically made to large audiences working at a fixed pace.

2. A relatively small unit of information is presented to the student at a time. A statement to be completed, or a question to be answered, about this information is also included. This is known technically as the *stimulus*.

3. The student is required to complete the statement or answer the question about that specific bit of information. In technical terms, he is said to be making a *response* to the stimulus presented. *The statement or question is usually designed to make it probable that the student will give the correct response.*

4. The student is then immediately informed whether his response is correct or not. If it is wrong, he may also be told why. By this kind of *feedback* he is rewarded (told he is correct) if he gives the correct answer; in more technical terms,

his response is *reinforced*. In learning experiments, psychologists have found that reinforcement increases the probability of making the correct response to the same stimulus in the future.

5. The student is next presented with the second unit of information, and the cycle of presentation-answer-feedback or, more technically, stimulus-response-reinforcement of the correct answer is repeated. The same cycle is repeated again and again as all of the necessary information is presented in a logical sequence. Provision is also made for the practice and review of previously learned information.

Each unit of information presented is called a *frame*. This term stems from the fact that in the initial stages of PI work, when teaching machines were the primary media for PI, the information appeared through a window, or frame, on the machine. A series of such frames, presenting a logical sequence of information is called a *program*. Programs may run into hundreds or even thousands of frames, which present the subject matter step by step in a logical order, beginning with the simpler concepts and advancing to the more difficult.<sup>1</sup>

#### PROGRAMED INSTRUCTION AND TRADITIONAL TEACHING

At first it may appear that PI is really old hat—that it makes use of teaching techniques that have been known for years. Traditional instruction has always endorsed the principles of presenting the subject matter in a logical order, getting students to participate actively during a lesson, rewarding their successes and correcting their mistakes, and providing for sufficient review, but it has found them difficult to apply in crowded classrooms and lecture halls. By means of PI, however, it is now possible to apply these same principles with greater success.

If a program is to get results, considerable thought must be given to the objectives and the organization of subject matter. While a similar procedure must be followed in preparing any other teaching material, such as a textbook or a lecture, there are several important differences. In the typical textbook or lecture, little provision is made for the student to respond actively to the information presented by thinking of examples, testing himself, summarizing, and reviewing. He can remain quite passive when confronted with the

material, and there is no assurance that he is assimilating the information. Even in classroom discussions, while one student is responding the others may not be paying attention. In PI, on the other hand, there is more assurance that learning is taking place because the student is forced to participate actively at each step in the program by continually making responses. The program is planned with care and precision, so that the student will make the number and kinds of responses required by the objectives of the program.<sup>2</sup>

Another difference between PI and conventional teaching lies in the size of the units of information presented before the student must make a response. In PI a response is generally required at each step in the presentation of a concept, thus increasing the chances that the student is following its development. In textbooks and lectures, on the other hand, a more extensive presentation of information is usually made before there is any provision at all for responses from the students in the form of answers to questions or problems. In addition, there may be gaps in the presentation which the student is left to fill in for himself. It is therefore possible for a student to miss something during the early stages of a presentation and never fully understand the subsequent material.

Still another difference between traditional and PI is that a well-constructed program is developed empirically through a series of tryouts on typical students. That is, the program is repeatedly refined, with effective sequences of frames being retained and ineffective ones discarded. Thus a finished program is a carefully engineered presentation of subject matter that has proved effective with many students. Although it is also possible to modify traditional instruction on the basis of student reaction, this cannot be accomplished with the same precision that is achieved by PI.<sup>3</sup>

#### DIFFERENT KINDS OF PROGRAMS

There are two basic kinds of programs. In one type, the student has to compose the entire response, and is known as a *write-in* or *constructed-response* program. In another kind of program, the student is presented with a number of alternative responses to the question asked in the frame and is required to choose the correct one. This program, similar in format to an objective achievement test, is known as a *multiple-choice response* program.

<sup>1</sup> HUGHES, J. L., PROGRAMED INSTRUCTION FOR SCHOOLS AND INDUSTRY (Chicago: Science Research Associates, Inc., 1962), p. 7.

<sup>2</sup> Ibid, p.8.

<sup>3</sup> Ibid, p. 10.

Another difference existing between types of PI is found in the frame sequencing. When all students work through the same sequence of frames the program is called a *straight-line*, or *linear*, program. When the student is allowed to follow a sequence of frames determined by his own responses, the program is called a *branching*, or *intrinsic*, program.

*Linear Program.* The constructed-response, linear program was originally developed by B. F. Skinner and his associates at Harvard University during 1950's in order to apply to human learning the principles of reinforcement learning theory found successful in animal learning experiments. According to Skinnerian reinforcement learning theory, learning is most effective when the student writes in the correct response and is immediately reinforced by a statement of the correct response. An important objective of the linear type programs is to present material in a sequence that makes it possible for most students to respond correctly to each small unit that is presented. This permits the responses to be reinforced so that learning can take place effectively. It is thought undesirable for the student to make many errors in completing a program. If students make too many wrong responses—such as 5 or 10 per cent of the total—the program is considered a poor one and in need of revision. Through repeated try-outs on students and constant revision of frames, the error rate can be reduced to meet these standards.

The material to be learned is broken down so that one small unit of information is presented in each frame. The frames develop the material step by step in a fixed logical sequence determined by the program writer from his analysis of the information or behavior to be taught and from repeated try-outs on students. By completing a soundly constructed program, the student learns to make the numerous responses which result in his mastery of the material.

*Intrinsic Program.* While Dr. Skinner was developing his system of programing, Dr. Norman A. Crowder was developing what he called the Intrinsic method of programing. By intrinsic programing, it is meant that each student determines the sequence of frames he takes by his responses to the multiple-choice questions contained in the frames. In this kind of program a paragraph or more of information is presented to the student in a frame. At the bottom of the page, the student is tested by a multiple-choice question to see whether the information has been successfully communi-

cated to him. If the student chooses the correct response, he is directed to another page containing new informational material. If he chooses an incorrect response, he is shown why this response is incorrect and referred back to the original material for another try at answering it correctly. When he finally chooses the correct response, he goes on to the next unit of information.

All students do not proceed through the program in the same sequence of frames, because each frame they are given is determined by the accuracy of the response they have made to the preceding frame. A branching, or intrinsic, program is thus quite different from a linear program, in which all students follow the same sequence.

*It should be pointed out that tests have proven that the student can learn via either method of programing, even if he decides to cheat and look at the answer. While this action may take away the reward aspect of the program, the student is still getting the information in the smallest steps and in the most logical order.*<sup>4</sup>

#### *Uses of Programed Instruction*

While the preceding material has served as an introduction to PI and its objectives and characteristics, our attention must be turned to analyzing its use as a training device. To get a better idea of where PI might fit, the following categories illustrate the types of subject matter for which PI is suitable:

1. *Rote memory* (facts, names, technical terms, fixed rules)
2. *Pattern Recognition* (recognition of mathematical curves, technical sketching, 'three-dimensional visualization)
3. *Manual operations* (key-punching, typing)
4. *Understanding of concepts* (science, business, statistics, social sciences and most other academic subjects)
5. *Problem solving* (design work, maintenance and repair of equipment, mathematics and physics)

This list will very likely be extended. Experiments are being conducted now, for instance, to determine whether programed material can be used to teach creativity.<sup>5</sup>

<sup>4</sup> BUCHHOLZ, JOHN M., USE OF PROGRAMED INSTRUCTION IN SUBORDINATE DEVELOPMENT, (May 1966), p. 15.

<sup>5</sup> GOULD, E. NOAH, PROGRAMED INSTRUCTIONS FOR ENGINEERS MACHINE DESIGN, 37, (18): 108 (August 5, 1965).

Some of the applications that have been made of PI throughout the business community are presented below:

To orient newly hired personnel to a company's special requirements.

To train sales, service, and maintenance personnel on products new to them and on product changes.

To train personnel who are widely dispersed.

To retain or upgrade engineers in new technological developments.

To train personnel for any job with a high turnover.

To train managers of engineering personnel in better supervisory practices.

Although there is no conclusive evidence to help you decide which programing technique to choose in teaching a particular subject, one general rule may provide some guidance. The kind of program used should be geared to the principal type of behavior you are trying to teach—recall or recognition. If the student must later recall the material verbatim and without any prompting, the Linear method is generally more appropriate. For example the technician learning new technical terms and equipment nomenclature usually needs some practice in making these new responses in order to develop the facility required. The construction-response method would seem to be the most appropriate.

On the other hand, when the ability to discriminate is the desired behavior, a multiple-choice program that gives the student practice in making these discriminations would generally be the appropriate one. It may also prove more efficient, since less time is needed to choose a response than to construct one. It is important to remember that both methods of PI have their uses; it is unwise to become committed to one of them to the exclusion of the other.

#### RESULTS FROM THE USE PROGRAMED INSTRUCTION

A further discussion of the use of PI would be useless unless some conclusive results can be given as to the validity of PI applications. Actually, these examples are easily shown, since many experiments have been conducted on the subject of PI versus Conventional teaching. Some of these results are presented below:

In experiments conducted by the U. S. Army, trainees taking courses using PI learned the

material twice as fast as trainees learning through conventional lecture-text book methods, and more important, retained the information for twice the time.

400 Eastman Kodak employees were selected to learn a new data collecting system using IBM cards. Forty were taught by conventional means, the rest by PI. After 1 week, the latter group was working at a 1% error level, whereas the group taught by conventional means took 7 weeks to reach a 2% error level.

In the public schools of Roanoke, Virginia, an 8th grade class, taught by programed instruction, learned the same amount of Algebra in a half-year as a ninth grade class learned in a year by conventional methods.

These results are coupled with the growing number of companies, such as Boeing Aircraft, General Motors, etc., who depend heavily on PI as the backbone of their subordinate development programs.

#### CRITERIA FOR USE OF PROGRAMED INSTRUCTION

From the preceding discussions, it should be clear by now that PI has a variety of uses, and can adapt to many different programs. Generally, since PI is especially effective in teaching rules, procedures, and other fixed subjects, PI can be used quite effectively to ensure a threshold knowledge for any other technique used in training police officers. The following conditions are conducive to the successful application of PI techniques:

Subject matter to be taught is fixed in nature.

Personnel to be instructed are at various levels of experience and capability.

Personnel to be instructed are at various locations, widely separated.

The subject to be taught is general enough to use available commercial PI materials, or the development program is of such a scale as to make special PI material economically feasible. As a supplement to any other form of instruction.

Personnel capable of carrying out a diverse program are not available.

#### ADVANTAGES OF PROGRAMED INSTRUCTION

Some of the advantages of PI may already be obvious to you, but the following information is presented to summarize the advantages of PI.

1. Programed instruction can be used with groups of people in formal classes, but since it is, in

effect, auto-instruction of *and* by the individual, PI is just as effective when an employee studies during his lunch hour or at home.

2. Programed instruction offers a consistent means of instruction. Whether you assemble 50 trainees in a single room or teach them individually while they are scattered in branch offices around the country, PI ensures identical training. There are no such variables such as a dynamic vs. a conservative instructor. With PI there is *no* instructor. Therefore, when it is important to teach a skill uniformly, (as in a subject like "Fundamentals of Police Science"), PI becomes extremely valuable.

3. Information is imparted in the same amounts but in  $\frac{2}{3}$  the time. That's because the lessons, which are carefully structured by psychologists and training experts, are more intensive, more concentrated. There is no irrelevant material.

#### DISADVANTAGES OF PROGRAMED INSTRUCTION

Programed instruction is not a panacea by a long shot. To bring the total picture of PI into clearer focus, the following disadvantages are

presented:

1. High Cost! However, this high cost can be saved many times over if you can eliminate travel time and costs necessary for general training. Off-the-shelf items are also more plentiful if they apply to your particular problems.

2. Short working period on PI. Experiments have proven that the average student should not spend more than 30-40 minutes at a stretch on a PI text or teaching machine. This is because of the high intensity of data presented in most PI texts.

3. Cannot be applied to every situation. There are some subject matters and assignments, such as research and creativity, that as of now are not conducive to PI techniques.

#### SUMMATION

It is hoped that this text has proven enlightening with regards to the use of Programed Instruction. Its uses are many, and the results from most applications are impressive. Its effectiveness as a training tool is directly proportional to the planning and organization that has gone into the overall program. Program Instruction's credentials are quite impressive. *It must be doing something right.*