



AEROSPACE INFORMATION REPORT

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APPLICATIONS OF PROGRAMMED INSTRUCTION IN THE AEROSPACE INDUSTRY

1. PURPOSE - The purpose of this document is to acquaint those who have responsibilities for training materials (media) with programmed instruction. More specifically, it will define the area, list the objectives, describe the learning principles on which it is based, the variety of forms it may take, subject areas in which it may be used, the requirements for preparing a program, its effectiveness, dollar cost, and an overview as well as a bibliography of some of the important works on the subject.
2. DEFINITION - Programmed instruction is a technique for organizing information presentation which allows the student with or without benefit of a teacher to learn the information presented. The specially prepared materials which may be presented manually or automatically comprise the program.
3. OBJECTIVES - The objectives of programmed instruction are to:
 - a. Assure the rapid learning of specified materials.
 - b. Provide a means of instruction which is effective even if teachers are unavailable.
 - c. Assure equal level of learning for all trainees (quality control).
 - d. Reduce the required number of instructional hours without sacrifice of achievement level.
 - e. Permit the student to progress at his own pace.
4. PRINCIPLES OF PROGRAMMED INSTRUCTION - To develop a successful course of instruction employing the techniques of programmed instruction, the designer (programmer) must:
 - a. Establish the objectives of the course in terms of the behaviors expected of the student when training is completed, i.e., explain, demonstrate, fix, etc.
 - b. Determine the knowledge level and abilities of the students who are to be trained.
 - c. Prepare (write) an ordered sequence of statements and questions (frames) designed to develop the desired knowledge or skill.
 - d. Keep the information increments between frames at a level that will allow the student to respond with reasonable success.
 - e. Provide a way for the student to respond.
 - f. Inform the student "immediately" through the program about the correctness of his response.
 - g. Test the student to determine how well the training has accomplished the stated objectives.
 - h. Modify the program as required.



Documents

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Since the steps between questions are small the student answers most of the questions correctly. Success is necessary to provide the motivation to continue until all the materials (frames) have been learned. The questions and statements which constitute the program must be tested for clarity and understanding to determine their capacity to produce the desired knowledges and skills. Modification and rewriting based on evaluation must be done many times before a program achieves the desired level of learning effectiveness.

5. FORMS AND DEVICES - The program may be designed in a number of different ways, though they all have the same purpose. The program most often seen is based on the researches of Skinner. In this scheme the student is presented with a series of problems or statements. His job is to generate or construct the appropriate response which he compares with an answer provided in the program. He then moves on to the next item until he finishes the program. If the program is well designed, the student makes few mistakes, and these are immediately corrected. Each item is a stepping stone to the next. The difficulty level between frames is so small as virtually to assure success. The immediate knowledge or feedback the student gets facilitates learning. This type of program can be presented in book form or with a mechanical device.

Another form of programmed instruction is authored by Dr. Crowder. The material to be learned, including diagrams, pictures, etc., are usually presented to the student in book form, but may also be presented by a device. At the end of each frame the student is tested by being asked a series of questions. He chooses what he believes to be the appropriate answer and turns to a page in the book in accordance with the instructions for the selected answer. If he is correct, he reads on, learns more and tests his learning again. If he chooses an incorrect answer or provides an inappropriate solution, he is so informed when he refers to the appropriate page, as instructed. The basic information is restated, he is given clarifying material and instructed to return to the initial problem and select a more suitable answer. The Tutor Text, Crowder's name for his brand of programming, is not an ordinary book. The pages are not read consecutively but back and forth as the student succeeds or fails. This format is often referred to as a "scrambled text."

The simplest of all programming involves the use of test or other materials supported by true/false, multiple choice questions, sequentially organized to provide materials of increasing scope. Dr. Pressey designed a variety of devices to facilitate learning through testing followed by immediate knowledge of results. The simplest and best known of these devices is the "Punch Board Tutor." In practice, the student did not proceed to the next question until he answered the question at hand correctly.

All current "Teaching Machines" are mechanical or electro mechanical variations for presenting materials involving the basic concepts just discussed. The machines do the manual act of page turning and lever pressing automatically. In addition, they can keep track of performance and prevent "page turning" until the present task is successfully accomplished. The more complex computer machines can adapt to the student's knowledge and learning level and adjust the difficulty of the program and they can provide rewards or punishment in an adaptive manner.

6. PROGRAMMING PREREQUISITES - To prepare a program requires:

- a. A definitive statement of learning objectives. These are essential guides in preparing

the program as well as the criteria for evaluation. This is by no means an easily satisfied requirement. It takes skill as well as time to develop and sequence the content of a course of instruction to organize it into readily learnable steps and limit it to the objectives previously defined. To shape it on the basis of the predicted background of the student population for which the program is intended requires a subject matter expert with experience in task analysis and educational principles.

- b. The generation of words and pictures that make up the individual questions or frames requires skill in communication techniques and is performed by the programmer.
- c. The evaluation of the prepared materials against the criteria in a, above. Unless a high degree of successful learning takes place, the materials need revising. For most subjects this means a number of revisions before a suitable program is developed.
- d. The selection of the format-book, machine, etc.

It should be evident that programming is not a God-given-skill, that it takes time and effort to learn the techniques. The decision, therefore, "to make" or "buy" depends on the time available, the quality of the product required, and the funds available.

7. APPLICATIONS - Programming can be effectively applied in those instances where it is possible to express the outcomes of training in objective terms. The performance outcomes of instruction in math, physics, trouble shooting, etc., can be so stated and are, therefore, suitable for programmed instruction. Music appreciation, on the other hand, is difficult to program, because it is almost impossible to develop an objective statement of the performance which characterizes "appreciating" music. That which is difficult or impossible to program today may, none the less, be programmable tomorrow. Programming has been successfully applied to such academic subjects as English, mathematics, foreign languages, and logic, as well as more applied topics, such as the aerodynamics of sink rate, the 24-hour clock, trouble shooting, and the use of oxygen during sudden decompression. It is applicable to subjects in which acquiring information is the primary objective but it also is effective in learning to do tasks requiring reasoning and decision making.

More specifically programmed instruction is effective as compared with conventional instruction because:

- a. It permits learning in the absence of competent instructors.
 - b. It permits each student to proceed at his own pace.
 - c. All students learn to the prescribed level (standardized performance).
 - d. Course information can be learned away from a school (self study).
 - e. It can reduce the learning time without reduction in the level of learning.
8. EFFECTIVENESS - The literature abounds with references which indicate that a wide variety of subjects can be successfully learned through programmed instruction. There is no reason to reject this fact. There are many, however, who do. Their judgements not only reject the established facts but they often make unjustified comparisons. The question is not: "Are the best teachers better than programmed instruction?" The answer to that is