

Programmed Instruction

Guidelines for Evaluation of Published Materials

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A fairly recent development has been programmed instruction. The technique has gained the aura of a fad, with a concomitant flood of programmed texts, courses, and presentation devices in the marketplace. Without some method of critically evaluating programs the prospective user of this material is defenseless against the "band wagon" advertising of many, if not most, program publishers.

This article will outline steps which can be followed in critically examining published programmed materials without becoming technically competent or psychologically trained in program construction.

Definition

The essential characteristics of programmed instruction were defined by Hughes¹ as any teaching method in which:

1. The individual student works at

his own pace, allowing more latitude for individual differences in learning than conventional instruction methods.

2. One relatively small unit of information is presented at a time. A statement and/or question, called the *stimulus*, is also included.
3. Completion of the statement or an answer to the question about the unit of information is required of the student. This is termed a response to the stimulus presented.
4. The student immediately receives *feedback* about his response. That is, he immediately finds out whether his answer is correct or not.
5. This feature of immediate feedback to each response embodies the principle of *immediate reinforcement*. The student receives immediate positive reinforcement if his response to a stimulus is correct, or immediate negative rein-

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- forcement if his response is wrong. He may also be told why his response was wrong if this is the case.
6. Each unit of information is termed a *frame*. Frames repeat the cycle stimulus-response-reinforcement to present all of the information included in a *program* in a logical sequence. The program also has provisions for periodic review and practice of information learned.
 7. Programmed instruction may or may not require the use of mechanical presentation devices called *teaching machines*. It is the teaching machine that has been tremendously popularized in the press rather than the method of programmed instruction. Programmed texts may be just as effective as teaching machines in any particular situation. In this case, machines would only be an expensive frill to a sound program.

Types of Programs

Programs may be classified by two characteristics: the mode of response and the sequence of frames.

In some cases the student has to write in the entire answer to each frame. This is known as a *constructed-response* program. Other types of frames give the student alternative answers or responses from among which to choose. This is a *multiple-choice response* program. These are the two basic modes of response utilized in present programs.

The other characteristic of programs is the sequence of frames. Some programs require the student to respond to a fixed sequence of frames regardless of the correctness of responses. A program constructed in this manner is called a *linear* program. Other programs are so designed that the sequence of frames a student works on is determined by his own

responses. This type is called a *branching* program because the student can branch off from the principal course of instruction to be corrected or perhaps even started over on certain sections of material.

Most published programs at present are the constructed-response, linear type developed by B. F. Skinner. N. A. Crowder has been instrumental in developing the multiple-choice, branching type of program from a different theoretical basis than Skinner. There is no crucial evidence concerning what type of program is best. The appropriateness of a type of program may depend on what behavior is to be learned. The Skinner-type program (constructed-response, linear) may be best for teaching recall or completely new material. The Crowder-type program (multiple-choice response, branching) may be best for teaching recognition, discrimination tasks, or enrichment of previously learned concepts. The interested reader is referred to Hughes' text for a fuller discussion of this topic.

Sources of Information

Many books have been published about programming. Some of these are extremely technical, designed for an audience sophisticated in psychological terminology. Among the easiest to understand, yet giving a complete view of programming is Hughes' "Programmed Instruction for Schools and Industry." A programmed text on programming techniques was written by Brethower.² Working through this program should give a rather complete understanding of construction techniques to the student, along with a "feel" for programmed material that can only be gained by working through a program from start to finish. Other perfectly acceptable books for learning about programmed instruction may be obtained at any library.

Many articles pertaining to research on programmed learning have been published in a variety of professional journals. However, these are usually concerned with theoretical issues on a technical level. Journals appropriate for information for the industrial user of programmed material are *Training and Development Journal*, *Audiovisual Instruction* and *Programmed Learning*.

Considerations Before Selecting Programs

Published programs vary widely in quality of construction and content. This appears to hold true even among programs published by the same company. For this reason it is necessary that the prospective program user be able to evaluate a program in reference to his needs.

Before programs are even looked at, the training objectives should be established. Even though various programs may have similar names and teach the same subject, they may deal with material at different levels of accomplishment or present completely different theoretical models. Training objectives, in terms of specific post-program behaviors the student should gain, have to be spelled out in as much detail as possible.

The present level of proficiency of the students which will participate in the training should be determined. Whatever programs are utilized have to be at an appropriate difficulty level to benefit the student. Achievement tests are available for the purpose of determining the qualifications of trainees. It is possible in this manner to utilize programs which will bring students who need some "brush-up" work up to standard to begin the training, while not wasting the time of more advanced students.

These two considerations, training objectives and qualifications or readi-

ness of students, are basic to choosing programs. They are of special importance in industrial situations, since training objectives are usually fairly specific and trainees are apt to have varied academic backgrounds with varying levels of technical proficiency.

Once the content or subject matter and level of programs needed for a particular training situation are determined, specific programs can be evaluated.

Steps in Evaluating Published Programs

A joint committee on Programmed Instruction and Teaching Machines was organized in 1961 by the American Educational Research Association, American Psychological Association, and the Department of Audiovisual Instruction, National Education Association under the auspices of the Educational Media Branch of the U. S. Office of Education. (An ASTD Committee cooperated with this group.) This committee worked on the problem of establishing criteria for judging programmed instruction material. Most of the criteria cited in this paper originated in the 1962 Interim Report of this committee,³ as well as from other sources cited under References.⁴ (See "Recommendations for Programmed Instructions," Leonard C. Silvern, *Training and Development Journal*, Jan. 1966 and earlier related reports in this *Journal*.)

The characteristics of any program may be divided into two categories: internal and external. Internal characteristics are those determined by the content and method of construction of the program. These may be evaluated by a visual inspection of a program. External characteristics are those which cannot be determined by inspection of the program itself, referring largely, but not entirely, to experimental data about the program.

A manual or similar publication setting forth the technical information pertaining to external characteristics of a particular program should be made available by the publisher. A variety of criterion measures concerning the empirical effectiveness of the program should be included, as well as information pertaining to number of actual administrations and revisions of the program, qualifications of the author, actual completion times, student attitudes, and evaluations of retention after a period of time or on-the-job performance. Data of this sort frequently are not available. If not, the prospective user should communicate his need for such information to the publisher. If it is found that such data cannot be obtained, the program should be utilized only with extreme caution.

Internal Characteristics

The adequacy of the organization, content, and level of the subject matter of a program should be checked by a person who is technically competent in the subject matter field. It is evident that not everyone is qualified to judge the presentation of, say, advanced algebra or organic chemistry in a program.

Complete, easy-to-follow instructions should be given to the student on what programmed instruction is, and how to use the particular program.

A table of contents and detailed index should be included in the program. This is a qualification of any good text book, but is more important in a program since information is often difficult to find due to the arrangement of frames with the text.

The construction and organization of frames within a program are basic to the effectiveness of the program. Frames should present units of information, and be easy to understand

and complete. They should not be ambiguous, either in meaning of information presented or in the response called for. The responses required should be significant, that is, directly related to the concepts to be learned instead of trivial unrelated information. Frames should progress in a logically organized manner, building on previously learned information in small steps. Provisions should be included which provide for periodic review, and practice of previous material. Finally, frames should be checked for technical errors, grammar, and general care in editing. There are many more technical considerations which could be evaluated (see Brethower²), but if frames meet the above criteria they should be satisfactory.

Inspection of the program should reveal whether it begins at a suitable level for the students for which it is intended. Likewise, the program content determines whether the program is suitable or not for the training objectives previously determined.

The program should include suitable achievement tests to measure pre-program proficiency, progress during the program, and post-program proficiency.

External Characteristics

Most of this information should be available in the form of a program manual as stated earlier. The author should be identified, and his qualifications listed.

A statement of the program's purpose and intended use, including age and grade levels it is appropriate for, prerequisite skills required of the student, and specific competencies the program will provide the student should be clearly written out. References to, or abstracts of, any published reviews or studies of the program should be furnished.

Information on the method of con-

struction, number of experimental administrations and to what type of students, and number and types of revisions should be included. Response errors to any constructed-response, linear program frame should be less than 5% to 10% total.

There should be adequate validity data concerning gains in student proficiency from these sample administrations and present users of the program. Hopefully, achievement data would be available for the type of student for which the program is being evaluated. Information concerning the effectiveness, or performance characteristics, of the program is probably the most important single item to consider in evaluating a program.

If parallel forms of achievement tests are available, there should be data evidencing the equivalence of these forms.

Average completion time for the program should be available.

Suggestions

There should be no question about any of the above data if the author, publisher, and prospective user of a program perform their tasks correctly. Cost and ease of administration, along with time available, are further considerations in the use of a pro-

gram. However, it is suggested that these considerations should not overshadow the importance of the internal and external characteristics of various programs as outlined above.

A further point to consider is whether the student has to write in his responses on the program text, or simply "think" the correct answer. Available evidence suggests that covert responses (thinking or saying) may be just as effective as overt responses (writing or doing) in many instances. Much depends on the subject matter of the program, since subjects such as mathematics would probably necessitate writing answers. However, the time saved by covert responses, plus the re-usability of texts which are not written on are serious considerations.

An aid in the evaluation of programs is a reproduced check list including all of the various topics covered in this paper, plus any others needed (see appendix). This helps to make the evaluation of different programs more comparable, and assures that no important criteria are excluded. The check list also makes a handy permanent record of the evaluation which can be filed for future reference.

References

1. Hughes, J. L. "Programed Instruction for Schools and Industry," Science Research Associates, 1962.
2. Brethower, D. M. "Programed Instruction: A Manual of Programming Techniques," Educational Methods, 1963.
3. "Criteria for Assessing Programmed Instruction Materials." 1962 Interim Report of the Joint Committee on Programmed Instruction and Teaching Machines: American Educational Research Association; American Psychological Association; Department of Audiovisual Instruction, National Education Association. Prepared with the cooperation and support of the Educational Media Branch, U. S. Office of Education, under NDEA Title VII. *Audiovisual Instruction*, 1963, 8, 84-89.
4. "Criteria for Assessing Programed Instructional Materials." *Programed Learning*, 1964, 1, 97-107.

Appendix**Programed Text Evaluation Check-List**

Title:

Author:

Qualifications:

Publisher:

Date:

Intended Uses:

Prerequisites:

Time to Complete:

Subject Summary:

Format (type of program, method of response)

Cost:

Comments

Manual Available?

Meets Training Objectives?

Achievement Tests:

☐ Pre☐ Periodic☐ Post

Checked by technical expert

Name

Comments

Instructions to Student:

Table of Contents:

Index:

Frames:

Units of Information

Easy to Understand

Complete

Ambiguous

Significant Responses

Progress Logically

Progress in Small Steps

Periodic Review and Practice

Technical Errors, Grammar

Student Attitude Data

References to Published Studies

Experimental Administrations and Revisions

Validity Data

(Effectiveness of the Program)

Evaluated By:..... Date:.....