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# An experimental study of three programed methods

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# AN EXPERIMENTAL STUDY OF THREE PROGRAMED METHODS

by

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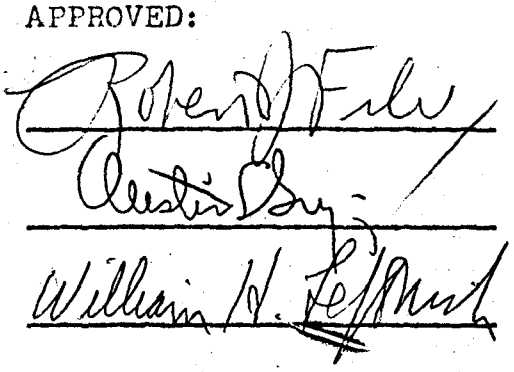
APPROVED:



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David K. Grove

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# INTRODUCTION

## Historical Review

The time has been too short to provide ultimate answers to ultimate questions concerning teaching machines and programed learning. Thorndike as early as 1912 stated that, "If by a miracle of mechanical ingenuity, a book could be arranged that only to him who had done what was directed on page one would page two become visible, and so on, much that now requires personal instruction could be managed by print (Thorndike, 1912)."

The current interest and effort in this field cannot be dated much before 1958, even though S. L. Pressey was pioneering with a form of teaching machine in his laboratory at Ohio State University in the 1920's and many psychologists date the newer movement from the time of a well-known article by B. F. Skinner that appeared in 1954. In this short space of time, the development of the movement has been phenomenal; research efforts first in the laboratory and now increasingly in the field, have grown apace; interest among the educational profession, industry and the public continues to mount.

An enthusiastic group of "teaching machine" specialists arose almost overnight. The amount of literature on pro-

gramed learning, "automated education," and the like increased rapidly. Papers and reports were rushed to publishing houses to meet the demand, and "teaching machines" became a by-word in the press. Out of it all came much good work, many sound studies, a number of useful experiments and a rapid development in the use of various devices and programs for "machine teaching."

Main Systems of Programed Training

All programed training makes use of successively presented units of information, usually accompanied by a test question and usually providing the subject with immediate knowledge of whether his answer is right or wrong. The purpose of a program whose assimilated data is in questions and answers is to shape a series of responses into a complex act.

Within this common framework there is--for psychologists, at any rate--a difference between two schools of thought which dominates the field and is reflected in the tasks and types of programs given to the trainee.

One viewpoint is that of Professor B. F. Skinner of Harvard University and his followers:

> To Professor Skinner, it is critical that behavior (i.e., some action by the learner) take place as a

necessary precondition for learning. He uses the Watsonian idea of conditioning as he leads the subject through the program: The more the successes mount, the stronger the motivation will be to continue learning, while material that generates errors is punishing. To maximize success he introduces in the questions a series of prompts which lead the subject straight to the correct answer. Implications of Skinner's viewpoint for programed training: The subject must "construct" or write out his answer to each question (behavior); the bits of learning must be prepared so that students answer nearly all questions correctly (reward fixes behavior).

The other main viewpoint is that of Dr. Normon Crowder of U. S. Industries and his associates:

Dr. Crowder believes that learning takes place at the moment that the subject reads the passage. The question that follows each bit of material need not require a write-in answer, and most of Crowder's programs use multiple-choice type responses. He believes that a program should be presented in large logical units of a paragraph or more, each of which would explain some principle in its entirety. Crowder programing provides a continuous review and insures the

mastering of points before the subject proceeds to new material. While Skinner uses the maximum amount of prompting which decreases as time goes on, Crowder uses only a few prompts, relying mainly on explanations of the material. The few studies that have been made of this problem show that partial prompting probably leads to the optimum learning situation (Cook, Miller, Grier and Stamen, 1962; Cook and Brown, 1963; Cook and Kendler, 1958; and Cook, 1958).

Both sides claim better understanding as well as memory of the material. Each method, in fact, is better suited than the other to certain applications. As things stand now in terms of theory alone, the Skinnerian view seems to rest on more substantial ground (Holland, 1960; Holland, 1964; Holland and Kemp, 1965); but some investigators such as Hughes (1963) and Pressey (1963) reported that use of a small-stepped linear program in Skinner machines was not very effective in teaching more complex concepted skills. Pressey feels that the learning theory developed from animal research upon which Skinner devised his style of presentation is at fault here, i.e., by rigid linear programing structural learning is sacrificed for bit learning. It is for this reason that Pressey advises the use of programing in conjunction with other techniques and lecture.

Overt versus Covert Responding

Concerning the question of whether subjects should write out their response, read complete statements or select a response from a multiple choice of answers, the evidence is not clear. Some empirical data point to the superiority of programed instruction over current conventional teaching methods; however, experimenters such as Goldbeck and Campbell (1962) report that well organized text or lecture material presented in a program-like format, but without questions, may be superior to programed instruction. Moore and Smith (1964) report that most of their groups favored the traditional method of teaching, using programed materials as a supplement.

In 1960, Holland, a close associate of Skinner performed an experiment directly related to the questions concerning constructed responses. Holland tested effectiveness of items with confirmation versus items with no confirmation versus complete statements with no blanks to fill. The first group, in a typical program, wrote the answers and received confirmation immediately. The second group who also wrote answers received no confirmation. The third group simply read the material which was re-written in the form of complete statements. "The third group made more errors than the other groups on a

post-test, and there was very little (significant) difference between the performances of group one and group two (Schramm, 1964)."

Cummings and Goldstein (1962) found that when subjects wrote answers to complex subject matter, they scored higher on pre-training and post-training tests than did subjects who read or "thought" the answers. From other studies in the literature (Krumboltz and Weisman, 1962 A; Suppes and Ginsberg, 1962) it appears that by actively writing a correct response rather than just reading or being told the correct response, leads to better retention.

However, Silverman and Alter (1961) compared written responding versus reading and in one of their three experiments found that reading was superior to written responding, which directly contradicts the Cummings and Goldstein study. It was thought that this significant result may have been due to the complexity of material: Complex subject material favors overt responding (Cummings and Goldstein, 1962; Goldbeck and Campbell, 1962); with an alternative being implied--simple subject material favors covert responding (Silverman and Alter, 1961). Holland (1964) who also used complex subject matter found overt responding to provide more significant results.

These experiments on complexity of material have important bearing on industrial programed training. Just by determining the material complexity, it would seem to give a good indication of which presentation mode to use, especially if retention is desired over a long period of time. Krumboltz and Weisman (1962 B) found on an immediate post-test, no significant difference among the experimental groups, but on a two-week delayed retention test the group which wrote answers scored significantly better than the others. Thus, overt responding seemed to increase delayed retention.

The comparisons of overt learning versus covert learning have so far indicated no clear superiority for either one, and any difference has not proven sufficiently great to warrant giving up the advantages of practice through active responding (Morse, 1963; Alter and Silverman, 1962; Evans, 1960; Evans, Glaser, and Homme, 1960; Feldhusen and Birt, 1962; Gropper and Lumsdaine, 1961; Hughes, 1961; Kaess and Zeaman, 1960; Kanner and Sulzer, 1961; Keislar and McNeill, 1962; Kormondy, 1960; Lambert, Miller, and Wiley, 1962; Michael and Maccoby, 1953; Roe, Massey, Weltman, and Leeds, 1960; Silverman, and Alter, 1961; and Stolurow and Walker, 1962).

Skinner, of course, advocates actively writing in the response; Pressey and Crowder contend that multiple-choice responses are the best in that less time is needed for reinforcement and to go through the complete program. Since Crowder believes in providing explanations, he designs a program in such a way as to inform the subject that he is right or wrong and how to correct the answer. Skinner's programs confirm the subject's responses by simply presenting the correct answer.

The research has shown that human beings are capable of learning by means other than the step-by-step conditioning which is characteristic of the Skinner-Holland program. Depending on the subject matter it may be that when one reduces the step size and error level to a minimum, then overt responding is hardly necessary. It should be noted though that the continued use of short steps rather than the increasing size of steps leads to more boredom among the subjects (Reed and Hayman, 1962; Naumann, 1962).

Knowledge of Results

Most of the studies indicate that knowledge of results contributes to learning (Angell, 1949; Meyer, 1960) but Glaser and Taber (1961) seem to reduce this general statement to the extent that knowledge of results is

doubtless more important when the probability of errors is high such as in complex material. In a typical linear program where probability of error is kept low such as in simple subject material, it becomes less important to have immediate knowledge of results.

If frequent response confirmation is not required, an answer frame would not be required for every teaching frame in a porgram; with the result being that formats could be varied greatly and the design of teaching machines could be simplified (Glaser, 1962). In a review of the literature, Ugelow (1962) concluded that whatever else these various findings signify they certainly challenge the necessity for providing response confirmation in self instruction. Frequent confirmation of the learner's responses in some situations would be ineffective for learning and perhaps prove annoying to the subject.

Aptitude and Mode of Presentation

Abma (1964) in a review of the literature on programed instruction states that most experiments have been conducted with high school seniors and college students, even though the trend seems to be toward applying these training methods to the less formally educated group of people, such as general mechanical shop workers (McMurray, 1964). Feldmon (1964) studied the effects of learning by

program and text format at differing levels of difficulty. He used subjects that varied in education and intelligence and his main determiner for this experiment only was their verbal ability. He concluded that significant differences were found between learning by program or text with the difference in favor of more learning by text for the low verbal ability subjects (less formally educated people).

It may be hypothesized that programed learning format destroys organizational patternsof the learner by the constant interruption by calls for response and may lead to premature closure. For this reason it would appear that in subjects who have less formal education (e.g., manual construction workers) and less contact with program machines may have better retention and less post error rate (Reynolds and Glaser, 1964) using programed instructional material which has been rewritten in the form of a text book. People with average to above average education and perhaps higher intelligence who have had some contact with program type machines may have better retention and less post error rate using the typical machine, either by the Skinner or Crowder method.

Consensus of Experimentation

A review of the literature has revealed some significant points which are applicable to this present experiment. They are as follows:

1. Complex subject material favors overt responding.
2. Simple subject material favors covert responding.
3. If you reduce the program step size and error level, covert responding would be the most appropriate.
4. If the probability of error is kept low, it is not necessary to have immediate knowledge of results..
5. Programed textbook (covert) is best for low verbal ability subjects.

Overview

As the training needs of modern business and industry continue to mount, the field of programed instruction can be expected to play an extraordinarily useful role. The internal training of skilled operators is a classical problem of long standing. The increased instructional effectiveness that programing will bring might well alter the strategic role of selection tests and broaden the base of recruitment to a wider population range.

In developing training courses, existing training manuals might be helpful in some instances, especially with well organized technical material that is primarily verbal in nature. In other cases, existing training manuals might have to be scrapped and the terminal behavior requirements developed from scratch.

The nature of the terminal behavior might well depend on critical features of the post training work environment which is an increasingly important subject in industrial design. The principles of man-machine-system design call for the incorporation of "automatic, on-line feedback signals," which serve to motivate and guide aspects of production (Walters, 1964). Thus, the magnitude of the task assigned to training is reduced. These facts suggest that industrial training--programed planning should emerge as a collaborative effort between industrial and programing enterprises, an effort extending in both directions beyond the training phase per se.

The question now becomes one in determining the "best way" to intergrate programed instruction with the regular training programs. In order to help substantiate or refute the past experiments in this area, it is the purpose of this experiment to test three programed methods:

1. Use program with machine; write out answer; read correct answer.
2. Use program with machine; read correct answer.
3. Read programed material--retyped in magazine form.

It is predicted that there is no significant difference in the training effectiveness of the three methods of programed instructional material.

## METHOD

### Subjects

Thirty-three building construction foremen from different crafts and who have recently been promoted to foremen were used in the experiment. Although no testing of general intelligence was done, it was assumed that each man had average intelligence with the formal educational level being at approximately 8.5 mean grade level. Three groups of eleven men each were assigned at random to the training methods with the following crafts being almost equally represented in each group:

### Facilities, Equipment, and Programed Material

Min/Max Self Instructional Teaching Machines were used in the experiment. These devices could present systematically programed materials while making efficient use of the principles of reinforcement.

The teaching machines were composed of the following:

1. A data storage receptacle.
2. A display mechanism and write in answer slot to which the subject responded.
3. A manually operated rotation knob allowing subject to proceed at his own pace.

These program machines have a unique feature of allowing the subject to proceed at his own pace, and almost any type of self instructional program format could

have been used in the machine. It was originally designed in such a way that the subject could not peek ahead of the answers since the correct response to any given form was not revealed until the question had been moved up to a point beneath a small plexiglass window. He was unable to bring the original question back from its covered position after he had uncovered the correct answer.

The programed material chosen for this experiment was based on the topic of "Materials Handling" which is of extreme importance to all construction foremen. Handling materials usually means moving materials, starting from the minute they come on the project site, and ending when they are either used or disposed of. The term "materials" refers to equipment, tools and all other materials--everything that is brought onto the project, no matter where or when, how much or how little. It has been estimated that 70 per cent of the total time on a project is spent in handling materials (Du Pont de Nemours and Company, E. I., 1956).

The company-provided training material selected for use was based on the Skinnerian method of constructed response. The subject would read the question, write his answer, and after rotating the program to the next frame

the correct answer would be immediately provided. Since this study dealt with different modes of presentation of programed material it was decided that in addition to the original method designed by the company, two other programed methods could be utilized. For the second method, it was necessary to complete all the blanks in the original format and retype the material into magazine form. This revised program, after being put in the machine, allowed the subject to read the material at his own pace. No writing was involved. For the third method the original program was used with instructions simply to read the material and then rotate the knob to read the correct answer. No writing was involved.

It was necessary to construct a large number of multiple choice, fill-in-blank type of test questions concerning the topic of materials handling. These questions were devised from the books, Construction Materials Handling and Method and Materials Training Manual (Du Pont de Nemours and Company, E. I., 1956 and 1955 respectively) and submitted to experienced construction personnel for evaluation. The process was one of having three judges evaluate each question to determine if it was "very satisfactory", "satisfactory", or "unsatisfactory" for inclusion in the test exercises on materials handling. One

hundred-fifty items were developed and submitted. If all judges marked the same question in like manner it was recorded as having received that rating. However, if there was no clear majority on a question, it was discussed with all judges until a common agreement was made. If the question received a "very satisfactory" or "satisfactory" rating it was retained, otherwise it was not used. After the meticulous evaluation by all judges, one hundred-five items remained. These same questions were typed in a programed format similar to the original company material (multiple choice and fill-in-blank), and where used as a pre-test and post-test.

The experiment took place between the hours of 4:00 p.m. to 6:00 p.m. after regular working hours and on an overtime wage basis. One group of eleven subjects entered the training room and sat down by the tables. The training room was air conditioned, well lighted and large enough to accommodate two men and their machines at each table. A brief introduction was given by the experimenter, explaining how to operate the program machine, purpose of the training session and a general orientation on the subject of materials handling.

The program session was divided into three parts. The first section consisted of the pre-test exercises. After each subject finished this part he notified the experimenter and the second part of the training material was loaded into the machine. After completing this part the subject again notified the experimenter and the third section or the post-test evaluation was loaded into the machine. Upon completion of these three sections of the training session, the subject was free to leave.

Each foreman was given the same pre-test and post-test exercises. However, since a purpose of the experiment was to study three different methods of presenting programed material the second section of the training session was divided as follows: Four foremen received programed method one (M 1 - read material, write answer); four foremen received programed method two (M 2 - read material, read answer); three foremen received programed method three (M 3 - read material rewritten in magazine form). The number of men that received each method was varied in each training session. Upon completion of the training eleven foremen had participated in each method.

Since the machines were loaded by the experimenter the subjects were told that after reading the beginning in-

structions they would know whether to write in the answers, not write the answers, or simply read the material which had been retyped into magazine form. The subjects were not told that three different types of programed formats were being used, nor were they told that the time needed to complete the various format methods was being recorded. However, the time necessary to complete the pre-test and post-test section of the experiment was not recorded.

Experimental Design

It was desired to test different modes of presentation of and responding to programed instructional material. The design chosen was a single factor Analysis of Covariance (Winer, 1962). It was assumed that for most practical purposes the groups of eleven men each could be considered as random samples from a common population.

Before the subjects were trained under the method to which they were assigned, they were given common test exercises on the subject of materials handling. The results from the performance defined the pre-test. After the training was completed the subjects were given the same exercises. The rating on the latter evaluation was the post-test. It was expected that this latter performance rating should be higher due to the training just received.

The three treatment methods were:

Method 1 = The programed material was inserted into a teaching machine. The subject read the question and then wrote an answer in the lower right frame. The next process was to rotate the material by turning the machine knob, thus bringing into view the correct answer.

Method 2 = The programed material was inserted into a teaching machine and the subject read the question. The next process was to rotate the material by turning the machine knob, thus bringing into view the correct answer. No writing was involved.

Method 3 = The original company material with the correct answers was retyped into paragraph form. The programed material was then inserted into a teaching machine, allowing the subject to read the material in a familiar magazine style.

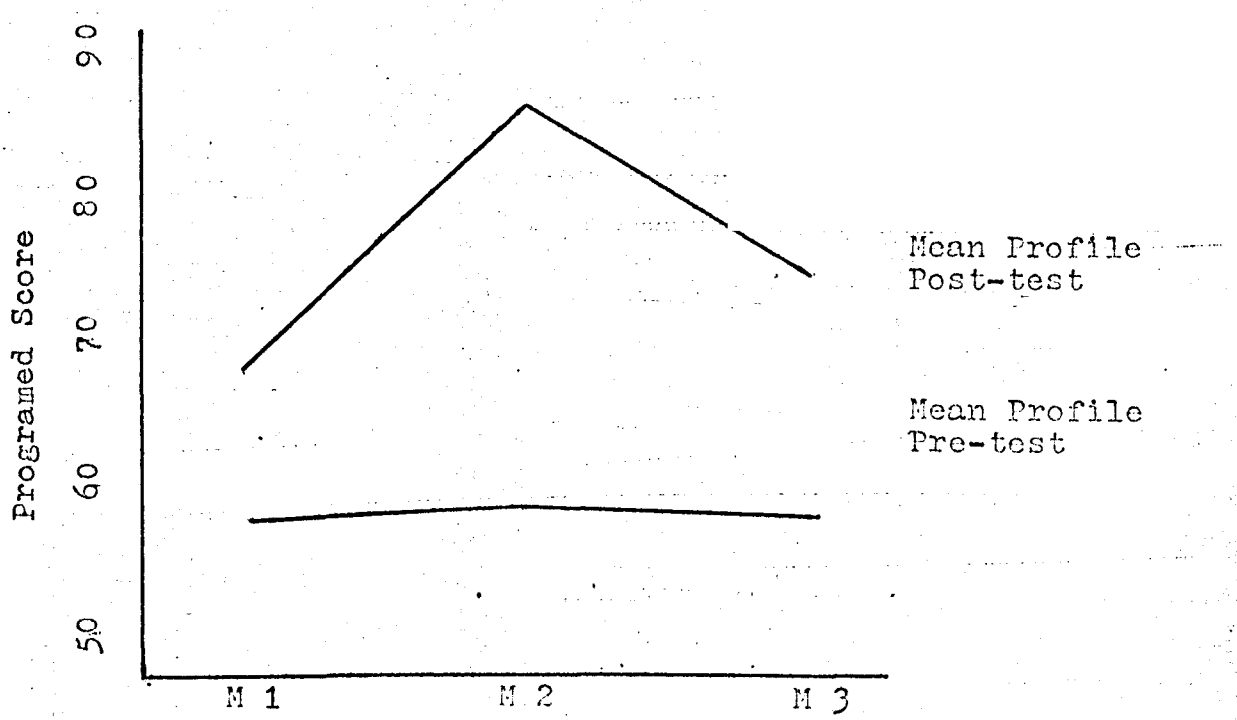
The intent was to determine if there would be significant differences between the criterion scores for the groups. Scores to be recorded were expressed simply as the number of correct responses.

The program machine used was a self-pacing machine, thus allowing each subject to proceed at his own speed. In order to determine the most effective treatment, it was desired to know the average time needed to complete the program under each treatment method. It was foreseeable that a treatment giving very significant results could possibly be obtained, but when considered on a wide scale training program basis, the time spent completing the program would perhaps not make that particular method economically feasible. For this reason the time spent completing the training program only was recorded for each subject and a single factor Analysis of Variance (Winer, 1962) was performed. If there were significant differences between the means, then a Newman-Keuls test on the means would be conducted. In both the single factor ANOCOV and ANOV, Winer's notation and formulation was followed as closely as possible.

## RESULTS

The mean performance scores of the pre-test and post-test are shown in Figure 1. The pre-test means indicate that prior to the training the subjects' knowledge of materials handling was quite similar. However, the post-test mean following treatment method two (M 2 - read programed material, read correct answer) is larger than the mean for method one (M 1 - read programed material, write answer, read correct answer) and method three (M 3 - read material rewritten in magazine form) indicating an apparent superiority in treatment method two (M 2).

FIGURE 1. Performance Evaluation - Three Programed Methods



It was necessary to make a statistical adjustment for the effects of the pre-test with the result being that an Analysis of Covariance was performed. The data is summarized in Table 1. It had been hypothesized that there would be no difference between the treatments, after the post-test data have been adjusted for linear trend on the pre-test. Thus, the experimental data indicate statistically significant differences at the .05 level between the post-test scores for the groups even after the adjustment is made for linear effect of the pre-test.

TABLE 1. Performance Evaluation of three Programed Methods

ANOCOV - SUMMARY TABLE

| SOURCE | DF | MS | F |
|---|---|---|---|
| BETWEEN METHODS | 2 | 726.82 | 5.91* |
| EXPERIMENTAL ERROR | 29 | 122.95 | |

*F.95 (2,29) = 3.32

Since significant differences were found among the three criterion treatment effects the hypothesis of no difference was rejected. In order to determine where the significant differences were, a Newman-Keuls test was performed. It was determined that the mean post-test performance following treatment method two (M 2) was significantly larger than the mean performance following treatment method one (M 1) at the .05 level and larger than treatment method three (M 3) though not significantly. This is interpreted to mean that the programed method two (M 2 - use program with machine, read correct answer) was significantly superior over method one (M 1) in presenting the material to the subjects to facilitate learning. More learning on the subject of materials handling was achieved by the programed method two (M 2). The programed method three (M 3 - read programed material re-typed in magazine form) in terms of total score, should be considered as the second best method to facilitate learning.

Any programed material training program must be evaluated not only in terms of the best learning - facilitation method, but also in regard to time needed to complete the program. An Analysis of Variance on the completion times - treatments alone is summarized in Table 2. The experimental data indicate statistically significant differences at

the .05 level between the programed methods - completion times. Since significant differences were found among the three completion times, the hypothesis of no difference was thus rejected

TABLE 2. Completion Ti
Three Programed Methods

ANOV - SUMMARY TABLE

| SOURCE | DF | MS | F |
|---|---|---|---|
| BETWEEN METHODS | 2 | 493.37 | 4.68* |
| EXPERIMENTAL ERROR | 30 | 105.46 | |

*F.95 (2,30) = 3.32

In order to determine where the significant completion time differences were, a Newman-Keuls test was performed. Treatment method one (M 1 - use program with machine, write out answer, read correct answer) had the highest recorded completion time and differed significantly from treatment method three (M 3) at the .05 level. Method two (M 2) completion time was the second highest

but the differences between M 1 and M 2 were not significant. It is noted that a purpose of the experiment was to find out which programed method could be completed in the shortest time. The data can also be interpreted to mean that M 3 differs significantly from M 1 for the subjects in M 3 completed the training material much sooner than subjects in M 1.

In brief, subjects who participated in training method two received significantly higher scores on the post-test performance evaluation. Subjects who participated in training method three, however, had the significantly shortest completion time of the programed methods.

## DISCUSSION

The Skinnerial view (overt) is that more learning will occur when the subject writes or constructs the response, rather than when the correct answer is simply read. The literature review indicates overt responding favors complex subject material whereas simple subject material favors covert responding.

The main objective of having any response at all is not to test but to insure the attention and active participation of the subject. Perhaps most importantly, if the subject is highly motivated he will pay attention and read the items carefully anyway. It will make no difference if he constructs the response, makes multiple choice responses or no overt responses at all.

A program is only as good as the material it contains and for the particular program under consideration, more emphasis should have been placed on the main criteria for establishing a program (Collegiate School Conference, 1960): First, the program ought to reflect an adequate and current understanding of the subject matter, and, second, the program ought to use the techniques of programing to advantage. When writing a program we must consider the age and educational level of the participating subject but the company programed material appeared not

to take into consideration what the average building construction foreman should know; rather, the writer must usually be a subject matter specialist of the programed material and of the people involved.

There appears to be a growing conviction among many in the field that the types of programing techniques employed should be determined by the material being taught and the level of the subject taking the training program. The formal educational level of the subjects participating in the experiment was approximately 8.5 mean grade level. To someone not familiar with construction personnel, this may indicate below average intelligence, but in actuality, they are very knowledgeable in the field of construction. They are considered to be below average on verbal ability.

Subjects that participated in treatment method one (M 1 - read question, write answer, read correct answer) were confronted with the boring and tiresome act of writing answers to many questions that were so simple that they apparently offered no challenge. Treatment one had the longest method - completion time of all groups. The subjects tended to write the complete answers only to questions that were interesting and challenging. Sub-

jects participating in treatment method two (M 2 - read question, read answer) had the second highest completion time.

Method one and method two subjects used the same programed material - version although their methods of responding were quite different. Overcueing which occurs when the right response is made too easy was the result of many prompts present in the programed material. The sequential redundancy provided a cueing effect, which, due to the simple subject material, made the responding task less and less interesting.

Method three subjects, however, had a significantly shorter completion time. Their method of responding was simply to read the company-provided material which had been retyped in magazine form (including the many prompts). no writing was involved.

A comparison of the three programed method completion times appears to indicate that the result of retyping the programed material into magazine form yielded a significantly shorter completion time. This type of covert responding most usually coincides with simple subject material. From comments made by the subjects and the impression

gained by the experimenter, this significant difference was not because of the material being retyped into magazine form, but mainly the retyped material, although the same coverage of topic involved only eight pages, whereas the original company version involved thirty-two pages. There was less physical effort involved although both the company and retyped versions contained the same amount of material.

The mean completion time for method three was six minutes less than that of method two and fifteen minutes less than that of method one. Method three and method two are quite similar in that both require no writing. Combined with the less number of pages involved for the one method, it appears that less physical effort was involved for both method three and method two because it was not necessary to write out the response.

Subjects that participated in treatment two had a significantly higher performance score on the post-test evaluation following the programed method. Their responding act consisted of simply rotating the programed material to the next frame and then reading the correct answer; no writing was involved. The subjects had been instructed to formulate mentally the answer before reading

the correct answer in the next frame. The reinforcer here most certainly would be seeing the correct answer, and, in addition, simply advancing to the next frame can be reinforcing in itself.

Studies sponsored by the U. S. Navy show that if the subject is told the correct answer after reading the questions, without having to give his own written response, he retains more. This is referred to as a prompting technique. Here the subject does not lose any time searching for the correct answer, he avoids making incorrect responses, and there is a much shorter interval between his mental formulation of the answer to the question and the confirmation of it. If the subject was wrong in his thinking his error would be corrected before he builds new knowledge on a shaky foundation (Reported in Glaser and Taber, 1961). This would, in effect, necessitate a new programed format; combining the statement and immediate answer in the same frame.

It is noted that two of the characteristics of treatment three, which had the shortest completion time, were that the correct answer was typed in the statement or placed immediately thereafter, and that the retyping of material reduced the number of pages from an original

thirty-two to eight pages.

Table 3 shows a statement that would appear in the present company version of programed instructional material. It requires two frames for each statement. Table 4 shows a statement that would appear in a proposed method. The statement would be typed in the usual manner, but to the far left side of the page and immediately below the frame the correct answer would be typed. The next statement and frame would appear below the answer. This version would permit the subject to read the statement and by slightly rotating the programed material, the correct answer would be immediately provided. A number of effects would be incorporated in this new method:

1. At present, only five statements are allowed per page, whereas, the proposed method would permit seven statements per page. This would reduce the original company version of thirty-two pages to twenty-three pages of programed instructional material.
2. The proposed method would not require any writing, and, since there would be nine less pages of material, less physical effort would be involved in rotating the material inside the teaching machine.

TABLE 3. Example of Original Company Programed Material-frames: Two frames per statement or thirty-two pages per program.

| TIME SPENT COVERING UP FURNITURE IS (PRODUCTIVE) (NON-PRODUCTIVE). | |
|---|---|
| NON-PRODUCTIVE | |

TABLE 4. Example of Proposed Programed Material-frame: One frame per statement or twenty-three pages per program.

| HANDLING MATERIALS MEANS MOVING MATERIALS (EVERYWHERE) (ONLY IN THE SHOP) | |
|---|---|
| EVERYWHERE | |

3. Since there would be one statement per frame and reinforcement following almost immediately, the material would be somewhat similar to a magazine article. Combined with the shorter completion time that would be possible this would incorporate the significant effects obtained from treatment - method three.
4. By including the correct answer immediately below the statement frame, and since no writing is involved, feedback is possible with an extremely low error rate, if any. This would incorporate the significant effects obtained from treatment two.

It is predicted that this proposed method of programed instructional material would be the best method for training building construction foremen on the topic of materials handling. Generalizations from this experiment and for the proposed method to other personnel are confined only to members of the building construction crafts. The proposed method would not have to be limited to the topic of materials handling, for it is thought by the experimenter that any topic of concern to all building construction personnel would be applicable.

Studies conducted on programed teaching machines have shown no clear superiority for any specific type of programed method. The most significant implied meaning from this experiment was that "simple subject material favors covert responding." This principle would not be credited to Skinner, since he advocates writing in the response. Within the schools of thought, it is probably most in agreement with the principles set forth by Crowder and Pressey. Regardless, the experiment has shown that where the subjects are less formally educated and have low verbal ability, they tend to prefer reading to writing the answers. This would certainly be true of construction personnel.

## SUMMARY

The purpose of the investigation was to study experimentally three different methods of programed instructional material as presented to building construction foremen in order to ascertain if the company provided material-version or modifications thereof would be the most suitable method.

A review of research studies dealing with presentation modes and methods of responding supported the following:

1. Complex subject material favors overt responding.
2. Simple subject material favors covert responding.
3. If you reduce the program step size and error level, covert responding would be the most appropriate.
4. If the probability of error is kept low, it is not necessary to have immediate knowledge of results.
5. Programed textbook (covert) is best for low verbal ability subjects.

Three-programed methods were chosen:

M1 - Use program with machine, write answer, rotate to next frame and read correct answer.

M2 - Use program with machine, do not write answer, but simply rotate to next frame and read the correct answer.

M3 - Use revised program with machine and by continuously rotating the material, the subject was able to read the same material rewritten in magazine form.

Thirty-three building construction foremen from different crafts and who had recently been promoted to foremen were used in the experiment. Three groups of eleven men each were assigned at random to the training methods.

The programed material chosen for this experiment was based on the topic of "materials handling." which means moving materials, starting from the minute they come on the project site and ending when they are either used or disposed of.

It was necessary to construct a one hundred, five item test concerning the topic of materials handling. Min/Max Self-Instructional Teaching Machines were used in the experiment. The program session was divided into three parts. The first section consisted of the pre-test evaluation which was loaded into the teaching machines. After finish-

ing this part, each subject was given the particular type of programed training material selected for use which was inserted into the machine. After completing this part, the third section or the post-test evaluation was loaded into the machine.

An analysis of the pre-test means indicate that prior to the training, the subjects' knowledge of materials handling was quite similar. An Analysis of Covariance was then performed. The data indicated statistically significant differences at the .05 level between the post-test scores indicating a superiority in one or more of the programed methods. A Newman-Keuls test was performed in order to determine where the significant differences were. The mean post-test performance following method two (M 2 - read programed material, read correct answer) was significantly larger than the mean performance following method one (M 1 - read programed material, write answer, read correct answer) at the .05 level. This is interpreted to mean that the programed material method two was significantly superior over method one in the facilitation of learning. Generalizations of this result may be made as follows: When it can be at least assumed that the subjects are less formally educated and having

low verbal ability, the most effective programed instructional material method is one that allows the subject to read the material, formulate mentally the answer, and by a slight rotation of the material, the correct answer is provided.

An Analysis of Variance was performed on the programed methods - completion times with the result that significant differences were found among the three treatment method completion times at the .05 level. A Newman-Keuls test was performed. The mean completion time of method three (M 3 - read programed material retyped into magazine form) had a significantly shorter completion time. It is interpreted that this significant difference was not because of the material being retyped into magazine form, but mainly the retyped material involved less number of pages than the original company material version.

The mean completion time for method three was six minutes less than the time for method two and fifteen minutes less than method one's time. It appears that less physical effort was involved for both method three and method two require no writing of responses. Method three, in addition, has nine less pages.

A purpose of the experiment was to determine the most suitable programed instructional method, in terms of the shortest completion time and to ascertain the method that facilitates learning the most. In order to obtain the most suitable method it is proposed that the characteristics of method two (facilitated learning) and method three (shortest completion time) be combined.

At present the question or statement is in one frame and the answer in another frame. This could be modified so that the statement would be in one frame and to the far left side of the page immediately below the same frame the correct answer would be typed. This would permit each programed page to have seven statement-frames instead of the present five frames and the entire program would be reduced from thirty-two pages to twenty-three. This would seem to be the best method for training building construction foremen on the topic of materials handling.

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