PROGRAMMED INSTRUCTION AND
BROADCAST EDUCATION

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ABSTRACT

PROGRAMMED INSTRUCTION AND BROADCAST EDUCATION

by Edward Francis Sarno, Jr.

During the last ten years, increased attention has been directed toward an educational technique known as "programmed instruction." Programmed instruction is a method of teaching where a student is led logically through a body of information in a series of relatively small steps. This process of teaching enhances learning by breaking the subject matter up into small easy-to-learn steps--each step logically building upon the previous one.

The purpose of this study is to evaluate programmed instruction as a possible teaching aid in broadcast education. The methods used in this study are: (1) to examine significant research findings concerned with programming; and (2) to develop an experimental programmed unit dealing with a phase of television and radio training.

Three types of studies are included in the review of the available literature on programmed instruction.

These are: (1) evaluative studies of the effectiveness of programmed instruction in relation to other forms of instruction; (2) analyses of the various techniques utilized in developing programs; and (3) studies which exemplify the use of programmed instruction in different subject-matter areas and grade-levels. The review of the literature covers the period 1926-1963.

An experimental program concerned with the basic physics of radio broadcasting is presented by the author as one possible use of programming in broadcast education. The fifty-one frame, constructed-response linear program has been validated and developed as an inexpensive educational aid.

Two major conclusions are reached concerning the value of programmed instruction: (1) the review of the literature indicates that programming does teach effectively--in many cases more effectively than conventional instructional methods; and (2) research is needed in experimenting with programmed instruction in different and varied subject-matter areas. This thesis is an attempt to include broadcast education within this potential scope of programmed instruction.

PROGRAMMED INSTRUCTION
AND BROADCAST EDUCATION

By

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INTRODUCTION

Programed instruction is emerging as a subject of vital concern to educators. Because the field is growing so rapidly, however, the state of knowledge about it is uneven. Many teachers and school administrators have never seen a program or a teaching machine. At the other extreme, some educators have begun to think of programed instruction as a revolutionary educational technique that may help to solve teacher shortages, and at the same time individualize and accelerate instruction.[1]

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" deserves a word of comment. In a generic sense, programed instruction 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 (though still quite varied) forms that center around the concept of the teaching machine and related devices. The latter, more specific form of programed instruction . . . deals with forms of reproducible instructional sequences in which the individual learner

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[1]The United States Department of Health, Education, and Welfare and the Center for Programed Instruction, <u>Programed Instruction and Teaching Machines</u>, A Report Prepared to Accompany a National Demonstration Exhibit (Washington: The United States Department of Health, Education, and Welfare and the Center for Programmed Instruction, 1963), p. 1.

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, in a matter suggestive of the Socratic dialogue 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.[3]

The above comments refer to a relatively recent innovation in education called "programmed instruction." Generally speaking, this concept refers to a method of teaching where the student is guided through a series of sequential steps which hopefully lead to a particular desired behavior. The techniques utilized are many and varied and much experimentation is being done to seek the best methods of programming. The forms which programmed instruction may take are likewise varied; textbooks have been programmed as have been film strips and television lectures. Devices ranging from simple punch-boards to complex "teaching machines" have been built to help present programmed materials effectively.

Underneath this maze of different ways of presenting programmed materials lies a fundamental unity. Hughes lists the following essential components of programmed

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[2]A. A. Lumsdaine, "Foreward," in J. L. Hughes, Programed Instruction for Schools and Industry (Chicago: Science Research Associates, Inc., 1962), pp. V-VI.

instruction:

1. Each student works individually on the programed instruction materials at his own pace. As an individual method of instruction, it 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 questions 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 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 the necessary information is presented in a logical sequence. Provision is also made for the practice and review of previously learned information.[3]

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[3] J. L. Hughes, Programmed Instruction for Schools and Industry (Chicago: Science Research Associates, Inc., 1962), pp. 2-3.

Although all programs contain some form of the above five characteristics, two basic types of programming have evolved. The first type is called "linear programming," requiring a constructed-response on the part of the student. Linear programs are carefully sequenced small units of information (called frames). In a linear program, students are required to proceed sequentially through the entire program constructing or writing-in answers to each frame as they proceed.

The second major type of programming is called "branching" or "intrinsic" programming. The basic difference between a branching program and a linear program is the fact that in branching, the student's future sequence of frames is determined by the responses he makes to previous frames.

> 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 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 alternatives. . . . Each piece of material that the student sees is determined directly by that individual student's immediately precedent behavior in choosing an answer to the multiple-choice question. Since the student's behavior in choosing an answer to the multiple-choice question is determined, presumably, by his state of knowledge at the time he makes his choice, . . . [branching] adapts

the program of material directly to the present state of knowledge of the individual student.[4]

Current State of Programmed Instruction

Although the philosophy inherent in programmed instruction can legitimately be traced as far back as the dialectic teaching of ancient Greece, modern concern for it is generally believed to have begun in the early 1920's. S. L. Pressey at Ohio State University is often referred to as the "father of programmed instruction" as his research in the 1920's first outlined the potential value of programming as an educational technique. Most of the research of the 1930's and 1940's concerned itself with the testing rather than teaching opportunities of programming and was met with an apathetic acceptance by the educational community.

B. F. Skinner at Harvard University was responsible for giving programmed instruction the boost it needed. In 1954, he explained how principles of learning, observed in laboratory animals for some time, could be applied to human learning through programming. This impetus provided by Skinner was such that educational concern for programming multiplied during the late 1950's and early 1960's.

Educators' reactions to programming have been mixed in terms of acceptance or rejection. There are some

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[4]Norman A. Crowder, "Automatic Tutoring by Means of Intrinsic Programing," in Eugene H. Galanter (ed.), Automatic Teaching: The State of the Art (New York: John Wiley and Sons, Inc., 1959), pp. 109-116.

educators who believe all programming can do is make "education automatic and students into robots." On the other hand, some educators feel that programmed instruction is the greatest educational technique ever devised. They feel by taking over the responsibility for rote learning it will enable teachers to concentrate on more important aspects of their profession by permitting more individualized attention to each student.

The bulk of the reaction toward programming falls somewhere between these two polar viewpoints. Studies have shown that programmed instruction is a valuable aid to learning, but much more research is needed before any conclusions can be drawn as to how much of the teaching burden can be, and rightfully should be, assumed by programming.

Commercial interest in programming has also boomed in the last five years. Production of programs has grown from merely a handful of companies in the late 1950's to a point where at least sixty-five firms are involved in preparing programs, according to a recent survey.[5]

Purpose of the Study

On the following pages is presented a history of programmed instruction in American education. The purpose of the study is to look at programming in some detail in

[5]James D. Finn and Donald G. Perrin, Teaching Machines and Programed Learning: a Survey of the Industry - 1962 (Washington: The United States Department of Health, Education, and Welfare, 1962), p. 21.

order to ascertain whether it might be utilized to some degree in broadcast education.

A sample linear program concerning the basic physics of radio broadcasting has been developed and validated by the author and is included as one possible use of programmed instruction in television and radio training.

Specifically, the contents of this study include:

1. A historical look at the background of programmed instruction in the United States. Starting with the pioneering work of S. L. Pressey, this section traces the early research to 1954.

2. Beginning with B. F. Skinner's classic statement on programming in 1954, recent research is surveyed up until the summer of 1963.

3. The characteristics of a short programmed unit on the basic physics of radio broadcasting is presented in terms of: (a) the intended use of the program; (b) material included within the program; (c) the behavioral objectives of the program; (d) rationale for the type of program developed; (e) validation of the program; and (f) program format.

4. The program itself--a fifty-one frame, constructed-response, linear program with eight accompanying panels.

5. Some concluding remarks about the potential of programmed instruction in broadcast education and suggestions for further research in the area.

Studies included in the two historical sections of the thesis were selected because the author felt they were significant dealing with either: (1) a comparison of programmed instruction with other forms of instruction; (2) an evaluation of different programming techniques; or (3) an example of a subject-matter area or grade-level where programmed instruction has been employed.

Limitations of the Study

There are three major limitations of the study involving the research cited:

1. Only studies which dealt with programed instruction in relation to formal educational situations were included in the thesis. No attempt was made to include the many examples of programming found in either industrial or military settings.

2. Only research dealing with programmed instruction in the United States has been included in this thesis. Recently, there has been indication that some studies regarding programming have been done in Great Britain and probably also in Japan and West Germany.[6]

3. No special attention is given to "teaching machines." These devices, whether they be simple or complex, are only ways to present programmed materials effectively and are not essential to the learning process. In

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[6]Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: The Fund for the Advancement of Education, 1962), p. 47.

fact, they are "little more than a case to hold the program."[7]

Two texts deserve special mention. The first of these is A. A. Lumsdaine and Robert Glaser's Teaching Machines and Programmed Learning: a Source Book. This book provides an excellent survey of the early research in the area. The second book deserving credit is a recent paperback publication of the Fund for the Advancement of Education entitled Programed Instruction Today and Tomorrow, edited by Wilbur Schramm. This short text is probably the best statement concerning programming available at the present time.

One final note regarding the study. The terms "programmed instruction," "programmed learning," and "programmed teaching" are used synonymously throughout the thesis. Although some critics object to certain of these terms, they are all referred to in the literature and are thereby included in this study.[8] Furthermore, the word "programmed" is sometimes written with only one "m." This trend to distinguish programmed instruction from computer programming is not widespread enough at present, however, to exclude both spellings of the word from the following pages.

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[7] Ibid., p. 1.

[8] Some educators, for example, feel that the term "programmed learning" is inaccurate as learning cannot be insured with this or any other educational technique.

To the best of the author's knowledge, this study is the first attempt to investigate programmed instruction in terms of its possible implications for broadcast education. Before any implications can be drawn, however, a survey of programmed instruction's history as an educational technique is needed. The next two chapters trace this history from 1926 to 1963.

CHAPTER II

EARLY RESEARCH, 1926 - 1953

Pressey, 1926

Although the concepts of programmed instruction date back as far as learning itself, the first teaching machine, labelled as such, was described by Pressey in 1926.[9] The apparatus consisted of a little window in which a typewritten or mimeographed question appeared, and a set of four keys, each corresponding to one of four multiple-choice answers to the question. The subject chose an answer, punched a key, and the next question appeared in the window. A counter on the back of the apparatus recorded the number of correct responses, simplifying the task of scoring. Although the device was primarily conceived as a testing device, Pressey visualized a secondary function as an "automatic teacher."[10] A lever could be

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[9] Edward J. Green, The Learning Process and Programmed Instruction (New York: Holt, Rinehart and Winston, Inc., 1962), p. 127.

[10] S. L. Pressey, "A Simple Apparatus Which Gives Tests and Scores and Teaches," School and Society, XXIII (March 20, 1926), pp. 373-376.

raised on the back of the machine to prevent the next question from appearing until the correct response was chosen to the current question. The subject was forced, therefore, to select the right answer before he could proceed with the program. One of the unique features of Pressey's machine was its immediate feedback as to the subject's progress. If the machine moved forward he knew his last answer was correct, saving time over the conventional method where tests had to be corrected and returned to the subject before he knew the results. Also, since the counter on the machine could be set to record wrong as well as right answers, a significant score could be tabulated. Lastly, if the subject went through the material a second time, an effective measure of progress could be found between the two scores.

Pressey concluded a list of the machine's advantages by stating, "In short, the apparatus provides, in very interesting ways, for efficient learning"[11] and concluded his paper by listing three distinct possibilities for his machine.

> (1) It is pointed out that objective tests naturally suggest the possibility of a simpler mechanism for testing. There are also some reasons for supposing that some of the teaching of drill material might be done by machines.
>
> (2) An apparatus is described which gives and scores tests, and informs the subject with regard to the right

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[11] *Ibid.*, p. 375.

answers (an attachment will reward the subject after any given number of right answers has been made).

(3) It is emphasized that teachers are now heavily burdened with routine and clerical tasks which might well be handled mechanically - thus freeing the teacher for much more real teaching, of the thought-stimulating and ideal-developing type, than is now possible.[12]

Pressey, 1927

Pressey mentioned in his 1926 paper that he had worked on a device which would delete a question after a correct answer had been given twice in succession. The next year he described such a machine.[13] The theory behind this program was that a subject was confronted with a certain question just until he mastered it,[14] and then his attention was shifted to more difficult items. Repetition was confined to areas where the subject was weakest. After successfully answering each question twice, and thereby ending the program, the device stopped itself and released a coupon to the subject, indicating mastery of the exercise and serving as a reinforcement to success.

Since Pressey was the first to concern himself with programmed instruction in terms of learning theory,

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[12] Ibid., p. 376.

[13] S. L. Pressey, "A Machine for Automatic Teaching of Drill Material," School and Society, XXV (May 7, 1927), pp. 549-552.

[14] Although Pressey describes two successive right answers as the criterion for mastery, the machine could also be set to progress after three or four correct answers.

he pointed out his device's function in regard to certain principles or "laws."

> . . . the "law of recency" operates to establish the correct answer in the mind of the learner, since always the last answer chosen is the right answer. The correct response must always inevitably be the most frequent, since the correct response is the only response by which the learner can go on to the next question, and since whenever a wrong response is made it must be compensated for by a further correct reaction. The "law of exercise" is thus automatically made to function to establish the right response. Since the learner can progress only by making the right reaction, is penalized everytime he makes a wrong answer by being required to answer the question one more time and is rewarded for two consecutive right responses by the elimination of that question, the "law of effect" is constantly operating, to further the learning. Finally, certain fundamental requirements of efficiency in learning are met. The learner is instantly informed as to the correctness of each response he makes (does not have to wait until his paper is corrected by the teacher). His progress is made evident to him by the progressive elimination of items. And - most important of all - there is that individual and exact adjustment to difficulty mentioned at the beginning of the paper, by which wasteful overlearning is avoided and each item returned to until the learner has mastered it.[15]

Pressey, in the year between his first and second articles on teaching machines, had shifted much of his emphasis from merely a testing device to the much broader implications of programmed learning. He recognized, however, two questionable features of his machine which would have to be further investigated: (1) whether the multiple-choice system of response hindered learning by exposing the subject to wrong as well as right answers; and

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[15]Pressey, "A Machine for Automatic Teaching of Drill Material," op. cit., pp. 251-252.

(2) whether the response of punching a key is so different from the real-life reaction to the learned material as to pose a threat to transfer. The first of these questions was to later prova a major difference between Pressey's system of programming and others.

After hinting at an upcoming machine to be used in arithmetic drill, Pressey stated the major purpose of his article was to stimulate research in developing machines which could perform certain important functions of teaching. He concluded:

> (1) The paper reports an effort to develop an apparatus for teaching drill material which (a) should keep each question or problem before the learner until he finds the correct answer, (b) should inform him at once regarding the correctness of each response he makes, (c) should continue to put the subject through the series of questions until the entire lesson has been learned, but (d) should eliminate each question from consideration as the correct answer for it has been mastered.
>
> (2) Such an apparatus is described (a) as it appears to the learner and (b) as to "inner workings."
>
> (3) It is reiterated that labor-saving devices should be possible in education. Such devices might well handle certain types of routine work even better than the teacher. They should save the teacher's time and energy from such routine, so that she may do more real teaching of the ideal-developing and thought stimulating type.[16]

Peterson, 1931

One of the early experiments based upon Pressey's multiple-choice response machine was done in 1931 by a

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[16] *Ibid*., p. 552.

former student of Pressey's, Hans J. Peterson, and his brother John. A year earlier they had described two testing techniques affording knowledge of immediate results.[17] The first consisted of an envelope containing several layers of cardboard. The subject would punch a pin through one of several holes, each hole corresponding to an answer to a multiple-choice question. If the pin went through the envelope, the subject had answered the question correctly. The second device consisted of a sheet of multiple-choice questions upon which the answer column was chemically treated. The subject touched the appropriate answer block with a strip of moistened felt called a "chemopen." If the answer were correct, the block turned a predetermined color. If incorrect, a different predetermined color appeared. Therefore, a record of responses could be kept while informing the subject of his progress.

Recognizing an application of this second device in testing and also self-instruction, the Peterson brothers ran an experiment on the latter function.[18] A group of students in an elementary psychology class was divided

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[17] J. C. Peterson, "A New Device for Teaching, Testing, and Research in Learning," Transactions of the Kansas Academy of Science, XXXIII (1930), pp. 41-47.

[18] J. C. Peterson, "The Value of Guidance in Reading for Information," in A. A. Lumsdaine and Robert Glaser (eds.), Teaching Machines and Programmed Learning (Washington: The National Education Association, 1960), pp. 52-58.

into an experimental and control group ranked equally in ability by results of a previous test in psychology. The experimental group was given the chemically treated self-checking device, whereas the control group took only standardized tests. Even though the control and experimental groups were reversed during the five experiments carried out, the experimental group consistently scored better than the control group; this led the authors to remark, "this marked shift in gains always in favor of the group who used the self-checking device when other factors were constant, must apparently be attributed to the influence of the device on learning."[19]

> In conclusion, it may be said that of the five comparisons here made between performance with and performance without the self-checking feature of the self-Instructor and Tester, all comparisons showed statistically valid differences in favor of performance with the self-checking feature. On the average, the group . . . that used this feature of the device in reading gained from 2.4 to three times as much information as did those who used only the questions as a guide. Gains were practically as great when study-test questions were reworded and changed to completion form as when the same multiple choice questions were given both in the study test and in the final test. Almost invariably students express a strong preference for the entire device, including the self-checking feature, as compared with the mere list of objective questions.[20]

Pressey, 1932

In 1932, Pressey described two more devices concerned with saving time and energy in testing:[21] The

[19] Ibid., p. 55.

[20] Ibid., pp. 57-58.

[21] S. L. Pressey, "A Third and Fourth Contribution Toward the Coming 'Industrial Revolution' in Education,"

first, a separate answer form to a set of multiple-choice questions consisted of a 3" x 3" card; and the second, a mechanical punchboard, was similar to the "envelope" described by J. C. Peterson in 1930. This second device was designed to tabulate by item as well as score and total tests. Although these two devices served primarily testing rather than teaching functions, they did provide the subject with knowledge of progress quicker than conventional methods. Pressey concluded his paper with two predictions concerning the future possibility of an "industrial revolution" in education:

> 1. Education is the one major activity in this country which is still in a crude handicraft stage. But the economic depression may here work beneficially, in that it may force the consideration of efficiency and the need for laborsaving devices in education. Education is a large-scale industry; it should use quantity production methods. This does not mean, in any unfortunate sense, the mechanization of education. It does mean freeing the teacher from the drudgeries of her work so that she may do more real teaching, giving to the pupil more adequate guidance in his learning. There may well be an "industrial revolution" in education. The ultimate results should be highly beneficial. Perhaps only by such means can universal education be made effective.
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> 2. The advantage of a science is closely dependent upon the development of instruments in that science. There has so far been relatively little development of instruments specifically for the very extensive yet analytical research typical both of modern educational investigation and also more generally of the social sciences. New instruments and materials,

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School and Society, XXXVI (November 19, 1932), pp. 668-672.

> greatly facilitating research, may soon appear. There may then be sweeping research advances in these fields.[22]

Little, 1934

Another early study designed to evaluate the effectiveness of programming devices was carried out by Little.[23] The purpose of his experiment was to test the effectiveness of both Pressey's 1932 test-scoring punch-board device and a modification of his 1926 drill-machine as instructional techniques.

Fourteen groups were formed from students enrolled in a course in educational psychology. Four of these sections had their tests automatically graded by the test-scoring device and therefore had immediate feedback as to their progress in the course. Subjects in these groups receiving less than a B grade on a test were required to take a make-up examination and the average of the two grades was considered their score on the test.

Another four groups took their tests on the drill-machine and had all the advantages of the test-device groups as well as being able to go back later and correct their errors (although their first answers constituted their grade on a particular test).

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[22] Ibid., p. 672.

[23] James K. Little, "Results of Use of Machines for Testing and for Drill upon Learning in Educational Psychology," Journal of Experimental Education, III September, 1934), pp. 45-49.

The other six sections, the control groups, took their tests in the conventional manner and received their scores the next day. All the subjects were given a pretest as well as the University Intelligence Test to insure matching of ability and preparation in each section.

> The course was divided into 14 teaching units; for each, two 30-item true-false tests were available. There were also used: (a) a 140-item pretest (reliability .80) covering the entire course and given to all sections at the beginning of the quarter, (b) a 100-item selective answer (five choice) midterm covering the first half of the course, (c) a similar 100-item test covering the second half, and (d) three broad essay-type questions sampling from the entire course. In working up results, the midterm and final objective examinations were combined and considered one final test (reliability .92).[24]

After tabulating results for the three kinds of groups, Little concluded:

> 1. Students immediately apprised of their test results, and given opportunity to correct deficiencies by make-up tests, profit markedly in terms of final examination results over students who do not have such advantage.
>
> 2. Students immediately apprised of the correctness or incorrectness of their responses to each item of a test, and given opportunity to correct deficiencies by drill and by make-up tests, likewise so profit.
>
> 3. The greatest benefit accrues to students who usually score in the lower half of the distribution, although the entire group moves upward.
>
> 4. Mechanical self-scoring and drill devices have a practical use in the classroom. They are convenient for students, time- and laborsaving for teachers, and make possible instructional techniques not otherwise practicable.[25]

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[24] *Ibid.*, p. 46.

[25] *Ibid.*, p. 49.

Little reported two general conclusions concerning his study: (1) he believed his experiment to be the first instance of programming as a systematic part of a university course; and (2) the study was in direct contrast to present educational planning which stressed a strong tutorial approach, more elaborate physical plants, and an emphasis on the "personality" of the teacher. "In contrast, one purpose of this experiment has been to show that an impersonal attempt to organize procedures in college instruction for greater efficiency may produce demonstrable results and, at the same time, save labor.[26]

Hovland, Lumsdaine, and Sheffield, 1949

The little work done with programmed instruction in the early 1940's was by the United States Armed Forces during World War II. They experimented with several machines which provided subjects with immediate knowledge of results, but most of these devices were both cumbersome and expensive and therefore not practical for everyday educational uses.

One interesting experiment carried out during the war concerned teaching the military phonetic alphabet to two groups of Signal Corps men.[27] Two film strips, one

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[26] Ibid., pp. 48-49.

[27] Carl I. Hovland, A. A. Lumsdaine, and Fred D. Sheffield, Studies in Social Psychology in World War II, Vol. III: Experiments on Mass Communication (Princeton, N. J.: Princeton University Press, 1949), pp. 228-246.

for each group were prepared on the subject. Both films were identical, although the experimental strip called for active-participation from the viewers in the form of reciting responses in review sequences. The control strip merely presented standard review material to a passive audience. The results in number of phonetic names recalled showed a significant difference in favor of the active-participating group:

	within 2 seconds after seeing letter		within 15 seconds after seeing letter	
	mean number recalled	per-centage recalled	mean number recalled	per-centage recalled
Participation	17.6	68%	21.9	84%
Standard	12.6	48	17.2	66
Difference	5.0	20%	4.7	18% [28]

The study also indicated that the active-participation technique was most effective for slow subjects learning difficult material.

An interesting implication of the study was drawn concerning the value of overt versus passive responses in a learning situation. This consideration was to later play a major role in programmed learning theory.

> The motivation should not just provide a "motive to learn"; rather, it should provide an incentive to perform (as voluntary "active practice" during the

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[28] *Ibid.*, p. 236.

> film showing) implicit or overt responses that will transfer readily to the performance situation that defines the objectives of the film.[29]

Angell and Troyer, 1948

In 1948, Angell and Troyer described a new device for test-scoring which once again indirectly focused attention on programmed instruction.[30] It consisted of a punchboard similar to the one used by J. C. Peterson eighteen years earlier. The subject punched a hole with his pencil in one of five perforated answers to each multiple-choice item tested. If he were right, a red spot became visible where he answered and he proceeded to the next question. If he were wrong, no mark appeared and he chose another alternative.

This device had the following advantages: (1) it afforded the subject with immediate knowledge of results; (2) the subject could proceed at his own rate; (3) the items could be answered in any order the subject wished; (4) the device was self-scoring and a grade was easy to tabulate; and (5) it afforded a simple, economical means of testing while offering no mechanical problems.

Feeling that learning was enhanced by a subject's immediate knowledge of results, the punchboard was

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[29] Ibid., p. 246.

[30] George W. Angell and Maurice E. Troyer, "A New Self-Scoring Test Device for Improving Instruction," School and Society, LXVII (January 31, 1948), pp. 84-85.

experimented with and results were published the following year.

Angell, 1949

Angell reported in 1949 a study examining the effect of immediate knowledge of quiz scores as measured by performance on the final examination.[31] He used as subjects students enrolled in a freshman college chemistry course. Angell found that students using a punchboard technique in taking quizzes scored higher on the final examination. Moreover, he found that students receiving immediate knowledge of results by means of the punchboard favored this technique over conventional teaching methods and looked upon their quizzes as learning experiences.[32]

Jensen, 1949

Jensen found with a group of mature, superior students, studying educational psychology on an independent study basis, that use of a punchboard on practice tests increased chances of success in the course.[33] Final grades for the twenty-four accelerated laboratory subjects were

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[31]George W. Angell, "The Effect of Immediate Knowledge of Quiz Results on Final Examination Scores in Freshman Chemistry," The Journal of Educational Research, XLII (January, 1949), pp. 391-394.

[32]Ibid., p. 394.

[33]Barry T. Jensen, "An Independent-Study Laboratory Using Self-Scoring Tests," The Journal of Educational Research, XLIII (October, 1949), pp. 134-137.

compared with students in twenty-seven regular sections of the course. The results showed:

Grades:	27 regular sections	2 accelerated laboratories
A	10%	54%
B	18	13
C	42	33
D	19	--
E	11	-- [34]

Besides ranking much higher than those students in the regular sections of the course, the accelerated students covered the material much quicker. Furthermore, two-thirds of them were found to have used the saved time in part-time employment, extra courses or extra-curricular activities. This led Jensen to comment, "the students not only did well academically, but gained in capacity for independent and cooperative work. They saved time, which in most instances was used to advance or enrich their programs."[35]

Briggs, 1947

A similar experiment using superior students was carried out by Briggs.[36] Again students in the accelerated or experimental groups had use of a punchboard

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[34] *Ibid.*, p. 136.

[35] *Ibid.*, p. 137.

[36] Leslie J. Briggs, "Intensive Classes for Superior Students," *Journal of Educational Psychology*, XXXVIII (April, 1947), pp. 207-215.

self-test device. When the experimental and control groups were paired as to sex, intelligence and grade-point average, the following final grade results were noted:

Grade	Accelerates	Controls
A	26	17
B	38	32
C	32	41
D	3	7
E	1	3 [37]

Briggs summarized his findings by stating:

> On objective tests given both to the special sections and to the regular classes, both types of experimental groups were superior. Even when paired with others of equal ability in regular classes, the 'seminar' students still scored somewhat higher.
>
> Questionnaire results indicated that the 'seminar' students were almost without exception carrying additional academic and outside work without sacrificing health, social activities, or efficiency in their work. . . .
>
> The results appear to justify employment of such special procedures for superior students. . . . Similar measures, including careful selection and special methods, might well in the future save superior students at least one or two quarters in completing an educational program, and also save in staff time and classroom space.[38]

Jones and Sawyer, 1949

An evaluation of the Angell-Troyer punchboard was undertaken by Jones and Sawyer[39] in a freshman course

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[37] *Ibid.*, p. 212.

[38] *Ibid.*, pp. 214-215.

[39] Howard L. Jones and Michael O. Sawyer, "A New Evaluation Instrument," *The Journal of Educational Research*, XLII (January, 1949), pp. 381-385.

entitled "Responsible Citizenship" at Syracuse University. They found that students having the advantage of the punchboard in taking exams scored higher than students not using the device. An interesting finding of this study was that when a questionnaire was distributed to those students using the punchboard asking whether they liked it or not, 83% of the students answered "yes." Three interesting reasons given by the students in favor of the punchboard were: (1) they felt they were learning while they took the tests; (2) they had the advantage of knowing immediately their grade on a given test; and (3) they felt the punchboard encouraged greater care in their work and discouraged guessing. These findings led Jones and Sawyer to remark, "Perhaps the most important value of the use of the Angell-Troyer punchboard is the fact that students enjoy using it; 'it's fun' and students learn best when they enjoy that learning."[40]

Pressey, 1950

An interesting appraisal of testing and self-instructional devices was reported by Pressey in 1950.[41] In this rather lengthy article he described instances where such devices had been used successfully to teach

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[40] Ibid., p. 385.

[41] S. L. Pressey, "Development and Appraisal of Devices Providing Immediate Automatic Scoring of Objective Tests and Concomitant Self-Instruction," The Journal of Psychology, XXIX (April, 1950), pp. 417-447.

subjects ranging from nonsense syllables to technical material in Naval R.O.T.C. Experiments were also cited where punchboards had been employed in helping students prepare for credit by examination courses and as an aid in self-instructional laboratories. Again, the results were favorable. It is interesting to note here that as experiments with self-instructional devices progressed, the emphasis had slowly shifted from mainly testing functions to a realization of great instructional potential.

After reviewing a sample of the research for the past twenty-five years, Pressey offered four conclusions concerning programmed instruction:

> 1. It has demonstrated a simple way to telescope into one single simultaneous process the taking of a test, the scoring of it, the informing of students as to their errors, and their guidance to the finding of the right answers. . . .
>
> 2. The investigation has shown that such a telescoped testing process, which informs each student immediately as he answers each question whether his answer is correct, and guides him to the right answer when he is wrong, does indeed transform test-taking into a form of systematically directed self-instruction. . . .
>
> 3. The investigation has shown that when the self-instructional tests were used systematically in college courses as an integral part of the teaching method, gains were substantial, and sufficiently generalized to improve understanding of a topic as a whole--even help in related topics. . . .
>
> 4. . . . the total project has shown that there are various promising means for automatic scoring and self-instruction . . . In short, "human engineering" can aid educational and training programs by test-teach devices of various types. The major purpose of this project has been to evidence the value of the basic idea, as illustrated by the punchboard, and determine ways of using such a device so as substantially to improve instruction or training. The value

of such devices; and the need for carefully planned methods for their use, if those values are to be realized, both seem clear. Research aiming still more to realize these values, and to appraise certain of the other devices mentioned above, is now under way.[42]

Michael and Maccoby, 1953

Michael and Maccoby, in an effort to try to isolate effective factors involved in verbal learning, ran an experiment which required differing degrees of audience participation to a film.[43] Their purpose was to determine whether subjects learned more when required to make an active response during a training film because: (1) motivation to learn was heightened by requiring a response; or (2) the practice involved in making the response itself increased learning.[44]

Designing the experiment to evaluate several instructional techniques, Michael and Maccoby found that subjects who were required to make responses to questions on the film learned more efficiently the verbal material presented than subjects not required to make responses. Moreover, these gains in learning were attributed to the practice gained in making a response rather than any heightening of motivation in making a response.

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[42] Ibid., pp. 444-447.

[43] Donald N. Michael and Nathan Maccoby, "Factors Influencing Verbal Learning from Films under Varying Conditions of Audience Participation," Journal of Experimental Psychology, XLVI (December, 1953), pp. 411-418.

[44] Ibid., p. 411.

The most important implication for programmed learning found by Michael and Maccoby, however, was that learning was increased most by informing subjects of correct answers to questions after they had made their responses.[45]

Stephens, 1950

Stephens reported in 1950 a study undertaken at Ohio State University which attempted to evaluate a modification of the Pressey punchboard and a device called the "Drum Tutor."[46] The subjects took a series of multiple-choice tests dealing with nonsense syllables, elementary Russian vocabulary and advanced English vocabulary.

Testing was done under three conditions in an attempt to isolate the most effective method of presenting material:

1. Subjects were informed as to correctness or incorrectness of their responses but were required to remain at a given question until a correct response was made.

2. A normal test situation where only one response was allowed for a given question and subjects were not told whether this response was correct or not.

3. Only one response was allowed for a given question but subjects were informed whether the response was correct or incorrect.

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[45]Ibid., p. 418.

[46]Avery L. Stephens, "Certain Special Factors Involved in the Law of Effect," Abstracts of Doctoral Dissertations - The Ohio State University, LXIV (Summer Quarter, 1950-51), pp. 505-511.

After evaluating these three conditions of testing, Stephens found that learning was most effective when subjects were required to remain at a given question until a right response had been given. Results of retests over the material presented showed a lower error rate for the more meaningful material (Russian and English vocabulary) as compared to the nonsense syllables.

An interesting result was obtained when one section of a course in educational psychology was allowed to take practice tests on the "Drum Tutor." Although this experimental section was inferior to the control sections in general ability and previous college work, subjects using the "Drum Tutor" scored higher on the midterms and final examination than the better students not using the practice device. Not only did the experimental subjects do better on material repeated or rephrased from the practice tests, but they also did better with new items.

Jones, 1950

The use of self-scoring devices in remedial situations was reported in a study by Jones.[47] Use of a punchboard in a practice test situation proved not only beneficial for average students but also helped slower students in educational psychology. When poorer students in the

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[47]Robert S. Jones, "Integration of Instructional with Self-Scoring Measuring Procedures," Abstracts of Doctoral Dissertations - The Ohio State University, LXV (Autumn-Winter Quarters, 1950-51), pp. 157-165.

experimental groups were encouraged to do extra work with the punchboard, increased gains in learning were noted.

Perhaps the most important finding of Jones' study concerned the relevance of items used on the practice tests in terms of learning value rather than measurement. This finding indicated a need for attention to what a subject was learning as well as how well he performed on a given test.

> A basic issue concerns criteria for a good instructional test item. An attempt was made to develop methods for appraisal of test items for this use. It was believed that such criteria would be, in important ways, different from criteria of items for the more common test which is used simply for measurement. . . . Evidently a practice test item may be so easy that little gain is possible. . . . But difficulty may be due to obscurity; a good instructional test question should so elucidate its topic that the punchboard group does show gains. Comparison of punchboard and control groups appraises questions still further, and may show great differences. Thus of 30 questions repeated from a practice test to a mid-term examination, 1 showed a punchboard superiority of 74 per cent and 12 a superiority of 20 per cent or more. However, the punchboard classes did a little less well than the control group on 3 questions; they were too easy and a little confusing. An attempt to identify the characteristics of items high in instructional value indicated that they were of substantial initial difficulty, but presented a clear and significant problem . . . One of the most revealing outcomes of the detailed analysis of items was that relatively few questions could be called good in terms of learning value. Many of the alternatives were weak - nearly 50 per cent of all the alternatives were chosen by less than 10 per cent of the students - and differences between experimentals and controls indicated that most of the gains came in connection with only one of the alternatives. These weaknesses of items are not peculiar to this

analysis; however, as a method, it brings the problem sharply into focus, and furthermore permits doing something about improving questions.[48]

Severin, 1951

Concerned with the relevance of test questions used in testing devices to learning value, Severin[49] found that two possible alternative answers to multiple-choice questions permitted as much learning as four possible alternatives. Moreover, when he presented material dealing with vocabulary, Severin discovered that paired-alternatives proved more effective in terms of learning than simple multiple choice answers.[50] When the subjects were tested a week after taking the practice material, he found that no appreciable difference showed up in regard to whether the subjects had repeated the practice tests or not. In other words, the same amount of material had been learned by using the punchboard once as by going through the practice test twice.[51]

Although early experiments in programmed instruction were concerned primarily with the testing applications of such techniques, the emphasis slowly shifted to a point

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[48] Ibid., pp. 162-163.

[49] Daryl G. Severin, "Appraisal of Special Tests and Procedures Used with Self-Scoring Instructional Testing Devices," Abstracts of Doctoral Dissertations - The Ohio State University, LXVI (Spring Quarter, 1950-51), pp. 323-330.

[50] Ibid., p. 327.

[51] Ibid., pp. 328-329.

where the research placed more and more stress on the learning potential inherent in programming. Although almost twenty-five years had passed since Pressey first described his "teaching machine," not much sophistication had resulted from the ensuing research, and educators had viewed the whole area apathetically.

It took Harvard psychologist, B. F. Skinner, to shake loose the apathy and give programming the boost it needed.

CHAPTER III

RECENT DEVELOPMENTS, 1954 - 1963

Skinner, 1954

In March of 1954, Skinner presented a paper to a conference of psychologists assembled at the University of Pittsburgh to discuss current trends in psychology.[52] In this now classic statement, he outlined how many principles of behavior, which had been observed in the laboratory for some time, could be applied in correcting some of modern education's shortcomings.

Skinner had already proven that the behavior of an animal could be controlled (or 'shaped' as he called it) by applying the principle of reinforcement. By rewarding a pigeon with food for correctly performing a predetermined action, Skinner was able to build up complex behavioral patterns within relatively simple organisms. Why, he asked, couldn't these same principles used in the laboratory be applied in guiding or shaping human learning?

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[52]B. F. Skinner, "The Science of Learning and the Art of Teaching," Harvard Educational Review, XXIV (Spring, 1954), pp. 86-97.

Skinner envisioned if material to be learned could be broken down into small sequential steps, where one step logically followed and built upon the previous step, even involved learning experiences could be achieved.

Modern educational practices, according to Skinner, had many serious shortcomings. Reinforcement was negatively applied in most cases as what seemed to motivate a child to perform effectively his daily school chores was the fear of low grades, the teacher's displeasure, competition with classmates or disapproval from parents.

> In this welter of adverse consequences, getting the right answer is in itself an insignificant event, any effort of which is lost amid the anxieties, the boredom, and the aggressions which are the inevitable by-products of aversive control.[53]

Even when positive reinforcement was applied to school activity, Skinner felt that the time which elapsed between a student making a response and its related reinforcement was often long enough to make the response-reinforcement bond ineffectual. A good example of this was a student taking an exam (response) and getting the paper back in two days with a good grade on it (reinforcement). This two-day period was long enough to destroy the effect of the reinforcement on the response. Skinner remarked that "It is surprising that this system has any effect whatsoever."[54]

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[53] Ibid., pp. 90-91.

[54] Ibid., p. 91.

Another shortcoming outlined by Skinner was the material to be learned itself could be broken up into much smaller sequential steps which would seem much more palatable to the student. If a system of reinforcement was applied to each successfully completed step, the student could progress quite easily and painlessly from simple to complex learning patterns in a relatively short time.

Because it would be impossible for a teacher to reinforce each student for every small step completed in such a program, Skinner described a simple mechanical device which included the advantages he had outlined. The programmed material consisted of a series of questions built around small, sequential units of information. As the subject answered a question successfully the device presented the next logical bit of information. If the subject answered a question wrongly, he was not allowed to proceed until he selected the right response. A subject could proceed through a programmed unit of material at his own rate receiving reinforcement from the device itself. If this reinforcement of knowing immediately whether an answer was correct or incorrect and being able to progress successfully through the program did not effectively motivate the student, Skinner suggested the teacher could then provide supplemental reinforcement when needed.

Although he knew technological innovations would meet with some opposition, Skinner concluded that:

> there is a simple job to be done. The task can be stated in concrete terms. The necessary techniques are known. The equipment needed can easily be provided. Nothing stands in the way but cultural inertia. But what is more characteristic of America than an unwillingness to accept the traditional as inevitable? We are on the threshold of an exciting and revolutionary period, in which the scientific study of man will be put to work in man's best interests. Education must play its part. It must accept the fact that a sweeping revision of educational practices is possible and inevitable. When it has done this, we may look forward with confidence to a school system which is aware of the nature of its tasks, secure in its methods, and generously supported by the informed and effective citizens whom education itself will create.[55]

Even though the recent interest in programmed instruction can be traced to the impetus created by Skinner in 1954, Schramm notes, "the research that followed took five years and the National Defense Education Act before it reached any considerable volume."[56]

On the next few pages are presented some of the recent studies dealing with programmed instruction in terms of both areas in which it has been employed successfully and also in terms of research devoted to improving the techniques of this educational aid.

Della-Piana, 1957

In an effort to explain how knowledge of results may best influence learning, Della-Piana suggested three

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[55] Ibid., p. 97.

[56] Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: The Fund for the Advancement of Education, 1962), p. 43.

possible processes:[57]

(a) showing progress and thus "motivating" the learner.

(b) presenting a standard and thus "guiding" the learner's trial responses.

(c) indicating errors and allowing the learner to find out why the response was wrong, thereby "activating a searching orientation" in the learner.[58]

An experiment was designed to evaluate which of two methods of feedback of results was most effective in learning concepts. The first method informed a subject as to the correct answer after one incorrect answer to an item was given. The second method encouraged the subject to keep "searching" for the correct response up to five trials at a given question. The concepts to be learned were some common attributes of certain geometric shapes. Each of the concepts was given a nonsense syllable name and presented to the subjects on 3" x 5" cards.

In comparing results of two posttests, Della-Piana found the following comparisons between subjects informed of a correct response (D-group) and those required to search for the correct response (S-group).

(a) No significant differences in number of concepts named correctly.

(b) No significant differences in number of series presentations required to name concepts correctly.

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[57] Gabriel M. Della-Piana, "Searching Orientation and Concept Learning," Journal of Educational Psychology, XLVIII (April, 1957), pp. 245-253.

[58] Ibid., p. 245.

(c) S-group learns to recall and recognize significantly more definitions of concepts than D-group.

(d) S-group (more than D-group) learns to recall definitions of a greater percentage of concepts they learned to name correctly.[59]

These findings indicated a need to Della-Piana for more research into feedback methods of how best to inform a subject in terms of knowledge of results.

Greenspoon and Foreman, 1956

Greenspoon and Foreman conducted an experiment to measure differences in learning associated with the time elapsed between attempting a motor skill response and being informed as to its being correct or incorrect.[60] The task chosen involved drawing three inch horizontal lines while blindfolded. The subjects were arranged in five groups: in four of these groups, knowledge of results was presented to a subject either immediately after completing a response, or ten, twenty or thirty seconds after completion of the task. The fifth group (control section) was never told whether their responses were correct or incorrect.

Results showed delay in feedback was related to the rate of learning. Those subjects who were given immediate knowledge of results did better than those given

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[59] Ibid., p. 251.

[60] Joel Greenspoon and Sally Foreman, "Effect of Delay of Knowledge of Results on Learning a Motor Task," Journal of Experimental Psychology, LI (March, 1956), pp. 226-228.

delayed feedback. Also, the rate of learning dropped off as the time between response and feedback increased. All four experimental groups, however, did better than the control group which was not given any knowledge of results.[61]

Wittrock, 1963

An attempt to evaluate response mode in an elementary science program was made by Wittrock.[62] Forty elementary school students took a completion item program by responding aloud the answers in an experimental section. A control section of forty pupils received the same program but were not required to speak the responses. Both groups were matched as to sex, IQ, mental age and as nearly as possible chronological age.

Immediately after completion of the program, a ten minute standardized interview and a multiple-choice written test were administered to both groups. Results indicated that overt responses seemed to enhance the learning of those children of average or below average intelligence but seemed an irrelevant variable for those students with an above average IQ. Results of a retention test one year later, however, showed loss in retention was statistically insignificant for both groups. These results

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[61] Ibid., p. 228.

[62] W. C. Wittrock, "Response Mode in the Programming of Kinetic Molecular Theory Concepts," Journal of Educational Psychology, LIV (April, 1963), pp. 89-93.

indicated a need for more research concerning optimum response modes.

Kromboltz and Weisman, 1962

Kromboltz and Weisman conducted a study to evaluate overt and covert responses in terms of immediate and retained learning.[63] The subjects consisted of fifty-four undergraduate students enrolled in an educational psychology course. Each of the students was given a program made up of 177 frames concerning test interpretation. Four test groups were formed: (1) subjects were instructed to write down a response to each frame; (2) subjects were told to "mentally compose" a response in their mind; (3) subjects read a form of the program where the responses were provided; and (4) the control group took a completely different 150 frame program on writing test questions.

Analysis of an immediate posttest indicated little difference in performance existed for either the overt, covert or reading experimental groups. Results of a retention criterion posttest two weeks later, however, showed the overt response group to have scored much higher than the other three groups tested. Results seemed to indicate that a written response is most effective in terms of retention of material.

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[63] John D. Kromboltz and Ronald G. Weisman, "The Effect of Overt Versus Covert Responding to Programed Instruction on Immediate and Delayed Retention," Journal of Educational Psychology, LIII (April, 1962), pp. 89-92.

Silberman, et al., 1961

A study which attempted to evaluate the relative merits of "branching" (allowing a subject to skip certain sections of a program) versus fixed sequence linear programming was reported by Silberman, Melaragno, Coulson, and Estavan.[64] The study consisted of two experiments, the first of which attempted to evaluate a program where a subject was allowed to branch at his own option. The second experiment was concerned with developing a criterion of branching built upon errors made in the program.

The subjects for the first experiment were chosen from the junior and senior classes of five high schools. The program presented to all subjects in this experiment consisted of sixty-one multiple-choice frames concerned with logic. Three methods of instruction were employed in the experiment. The first group of subjects were instructed to proceed through the program in a fixed sequence. They were to read an item, make a covert response, check to see if their response was correct and then proceed to the next item in linear fashion. The second group proceeded as the first group but were permitted to "back branch" or go back and review previous frames. The third group received a standard text unit

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[64]Harry F. Silberman et al., "Fixed Sequence Versus Branching Autoinstructional Methods," Journal of Educational Psychology, LII (June, 1961), pp. 166-172.

based on similar material and were instructed to study the material in any way they wished. A posttest of 24 multiple-choice questions and 24 free response items was administered to all three groups. Half of these questions tested material covered in the program and half were application-type requiring transfer of learning.

Results of the posttest showed the "textbook" section did best, the fixed-sequence with no review group did next best, and the "back branching" section did least well. Results in terms of mean score and time required to complete the posttest for each section showed:

treatment	mean score	mean time (in minutes)
Fixed Sequence	28.4	32.8
Back Branching	30.8	31.8
Textbook	33.7	31.5 [65]

The second experiment was concerned with evaluating a branching program determined by error rate with a fixed sequence linear program. Again, both programs concerned logic, and subjects were chosen from four high schools. Members of the branching group were given sequences of frames determined by their error rate on items in the program. Use of a computer in selecting a sequence of items for each individual made this procedure possible.

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[65] *Ibid.*, p. 167.

Each student in the branching section was paired with a corresponding subject in the fixed sequence group, and the sequences of frames picked for a branching subject were also given his equivalent in the fixed sequence linear group.

Posttest results showed no significant differences between the fixed sequence and branching groups as far as amount of learning but the authors admit one of the inadequacies of the study might be the use of error rate as the branching criterion.

> The results show that the particular method of providing for individual differences used in this experiment was not a sufficient condition for effective learning of the logic lesson. Perhaps the common principle of teaching that one should "provide for individual differences" needs to be qualified with the specific conditions for its accomplishment. It may be conjectured that some measures such as response latency or subject's self-evaluation are more appropriate than error rate, and that the computer should have considered these behavior measures for its branching decisions instead of, or in addition to, errors.[66]

<u>Roe, Case, and Roe, 1962</u>

A study to investigate the effect sequencing of frames had upon a program in terms of learning was done by Roe, Case, and Roe.[67] A seventy-one frame programmed unit was administered to thirty-six freshmen psychology

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[66] *Ibid*., p. 171.

[67] K. Vlachouli Roe, H. W. Case, and A. Roe, "Scrambled Versus Ordered Sequence in Autoinstructional Programs," *Journal of Educational Psychology*, LIII (April, 1962), pp. 101-104.

students. One half of the subjects received the linear program in correct sequence, the other half in scrambled order. Subjects were ranked in ability by means of scores on the College Board Entrance Examination. A criterion posttest was given both groups immediately after completion of the program.

Results showed no significant difference between either group in terms of error rate or completion time on both the program and criterion test. Also, differences in sequencing seemed to have little effect in terms of a subject's ability range. The authors concluded in light of such results that more research was needed on sequencing in terms of subjects' age level, different length programs and varied areas of subject matter.[68]

Levin and Baker, 1963

A recent study attempting to evaluate the effect of program sequence upon learning was done by Levin and Baker.[69] Subjects for the program on elementary geometry were thirty-six second graders who were broken into two matched control and experimental groups of eighteen subjects each. The programs used for both groups were identical except for a unit on angles toward the middle of the

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[68] Ibid., p. 104.

[69] Gerald R. Levin and Bruce L. Baker, "Item Scrambling in a Self-Instructional Program," Journal of Educational Psychology, LIV (June, 1963), pp. 138-143.

experimental program which was scrambled randomly while the whole control program was arranged in fixed sequence. This procedure allowed not only for a comparison of learning between the scrambled series of frames and its equivalent fixed sequence but also learning in terms of subsequent portions of the program in order to determine if sequence change affected future learning in a program.

Results indicated performance on the program as well as on a posttest was similar for both groups. Insertion of the scrambled sequence in the experimental program did not seem to hinder nor enhance learning to any great degree nor did it seem to affect future performance in the program. The authors concluded:

> While the present findings failed to support the assumption that item sequence is important, it seems neither appropriate, nor even tempting to abandon the hypothesis that the order of presentation matters under some conditions.[70]

Shay, 1961

Shay conducted a study to determine the role intelligence plays in a programmed instruction situation.[71] He hypothesized there was no relationship between it and the size of steps in a program. A programmed unit on roman numerals was developed which included three forms:

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[70] Ibid., p. 143.

[71] Carleton B. Shay, "Relationship of Intelligence to Step on a Teaching Machine Program," Journal of Educational Psychology, LII (April, 1961), pp. 98-103.

a 103 frame large-step program, a 150 frame medium-step program, and a 199 frame small-step program. As the programs decreased in level of difficulty more review material was also added.

Subjects included ninety fourth graders; one-third having above average IQ, one-third having an average IQ, and one-third having below average IQ. Nine experimental groups were formed from the subjects so that ten students from each ability range could take each of the three versions of the program.

When performance on a posttest was analyzed in terms of the numbers of errors and time required to complete the program, no relationship could be found between a subject's intelligence and the step-size program he took. Shay concluded, "if there is a relationship between intelligence and step size, it is not a strong one. This would suggest that alternative programs are not necessary on the basis of ability alone.[72]

Coulson and Silberman, 1960

The effectiveness of three variables employed in programmed instruction were studied by Coulson and Silberman.[73] They were interested in evaluating the multiple-

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[72] Ibid., p. 103.

[73] John E. Coulson and Harry F. Silberman, "Effects of Three Variables in a Teaching Machine," Journal of Educational Psychology, LI (June, 1960), pp. 135-143.

choice versus constructed modes of response; the extent to which small steps in a program enhance learning; and the effectiveness of a fixed sequence linear approach as compared to a branching approach. Eighty experimental college subjects were chosen to take a programmed unit on elementary psychology and 104 control subjects were used as a comparison to judge whether any significant learning had been achieved in the experimental group.

Results of a criterion posttest administered immediately after completion of the program and again three weeks later indicated:

> 1. Use of the simulated teaching machine led to significant learning by the Ss [experimental group], as determined by comparison with the control group.
>
> 2. The multiple-choice response mode took significantly less time than the constructed response mode. No significant difference was obtained between response modes on the criterion test.
>
> 3. Small item steps required significantly more training time, but also yielded significantly higher test scores than large item steps on the constructed response criterion subtest.
>
> 4. The branching conditions required less training than nonbranching, but were not significantly different on the criterion test. A significant interaction was obtained between the mode of response and branching variables on the constructed response criterion. This interaction resulted from a high mean criterion score obtained by the constructed response - nonbranching group.
>
> 5. No significant differences were obtained among the experimental groups on the multiple-choice criterion subtest, or on the total (multiple-choice plus constructed response) criterion test.[74]

[74] *Ibid.*, p. 143.

Keislar, 1959

A multiple choice program designed to promote arithmetic understanding was developed by Keislar and adapted to a teaching machine called the Film Rater.[75] The program concerned rectangles and consisted of 120 frames, ten of which outlined the objectives of the program and explained operation of the machine.

Subjects were chosen at a fifth and sixth grade level and were divided into fourteen experimental groups on the basis of sex, intelligence, pretest scores and reading ability. The experimental groups were allowed to operate the machine on successive days for two or three periods a day. The control groups received no special instruction during this time. A posttest consisting of the eight questions included on the pretest plus eight more difficult questions was administered to both the control and experimental groups at the end of the training period.

Although the experimental groups performed significantly better in their understanding of rectangles on the posttest than the control groups, the program appeared too difficult and suggestions for revision of the program included the following three items:

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[75]Evan R. Keislar, "The Development of Understanding in Arithmetic by a Teaching Machine," Journal of Educational Psychology, L (December, 1959), pp. 247-253.

> 1. Since the reading load was probably a major obstacle for many pupils, sentences should be shorter and the total amount of reading less for each item . . .
>
> 2. The steps in many if not most cases could be made smaller . . .
>
> 3. A wider variety of items should be used for each new process. . . . Although completion items may be necessary to teach this type of behavior, better results in this program could probably have been obtained if, instead of the single form, a variety of multiple-choice forms had been used . . .[76]

Ferster and Sapon, 1958

An application of programmed instruction in the area of foreign language was reported by Ferster and Sapon.[77] A program was developed to teach the equivalent of a college semester course in German within a much shorter period of time. After completing the programmed material the subjects were given a posttest covering the following areas: (1) a test of vocabulary on a recognition basis; (2) a test of the ability to write German sentences by the translation of English material; (3) a measure of active vocabulary independent of structural mastery.[78]

Results of the posttest showed:

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[76] Ibid., p. 252.

[77] Charles B. Ferster and Stanley M. Sapon, "An Application of Recent Developments in Psychology to the Teaching of German," Harvard Educational Review, XXVIII, (Winter, 1958), pp. 58-69.

[78] Ibid., p. 65.

> The mean time spent on material was 47.5 hours. The range of scores in recognition vocabulary was 76 to 98 per cent, with a mean of 88 per cent; sentence translation 70 to 93 per cent, with a mean of 81 per cent; and active vocabulary, 90 to 100 per cent, with a mean of 96 per cent.[79]

Ferster and Sapon found that the major factor affecting the subjects' motivation toward the program was the difficulty of the material presented. Whenever the level of difficulty rose and errors became more frequent, motivation dropped off. The authors suggest that disposition to return to the study material probably decreased because the increase in errors probably made the task one in which the amount of work required was disproportionate to the reinforcements received.

Another modification suggested by the authors concerned the bulk of labor required in taking the program. Instead of making the responses longer as the material became more complex, they decided only to require the subject to respond to the material currently being taught. This shortening of responses would probably increase motivation towards the program.

A third modification involved sequencing the items in the program so an item would build upon a previous one in such a way that probability of correct responses could be improved. In other words, in a utopian sense:

> . . . a series of materials could probably be constructed in which each item is scientifically designed so that the student will progress from a zero knowledge

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[79] Ibid., pp. 65-66.

> of German to a complicated repertory of the level of a year of college German without ever having made an error. An achievement of this kind would be made possible through use of processes by which new verbal behavior is created rather than by the traditional processes of recall and verbal memory.[80]

Keislar and McNeil, 1961

In an effort to teach scientific explanations of physical phenomenon to first grade students, Keislar and McNeil turned to programmed instruction.[81] They believed the reason previous experiments in teaching scientific theory had not proven successful was a theoretical language had not been effectively presented to the youngsters.

The program consisted of 432 frames broken down into thirteen daily lessons. The sequence of the program was arranged to prepare the student to answer the later more difficult questions by requiring him to answer each frame correctly before proceeding to the next. The theoretical and scientific terms and concepts of the program were related to everyday occurrences in the child's world by means of analogies and pictorial prompts. Two matched groups of children were formed: the first, the experimental group, went through the program on a machine called the Videosonic Tutor; the second group, the control group,

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[80] Ibid., p. 68.

[81] Evan R. Keislar and John D. McNeil, "Teaching Scientific Theory to First Grade Pupils by Auto-Instructional Device," Harvard Educational Review, XXXI (Winter, 1961), pp. 73-83.

received no such special instruction.

At the conclusion of the program, a posttest in the form of a ten minute interview was given both groups. All but one subject from the experimental group scored higher on the posttest than did their matched controls. The one exception in the experimental section seemed withdrawn during the interview but answered five questions--all correctly.

As a result of posttest scores Keislar and McNeil drew three conclusions:

> 1. While there are great individual differences, first grade pupils can learn an abstract scientific language. . . . The kinds of behavior called for by the program and the performance of the children on the post-test demonstrated that children had acquired general understanding, not mere rote learning. . . . The program is still too difficult for most first grade children. Revision of the items should include a more detailed sequence, more adequate reviews, and a wider sampling of the phenomena being discussed.
>
> 2. Even though the multiple-choice method was used throughout as the sole means for responding, most of these children were able to use previously unfamiliar terms as well as their own words. . . . A few of the children showed some hesitation in verbalizing scientific terms. This might have been because these children had never before been called upon to say the words overtly. Future experiments with the Videosonic Tutor should provide for recording the child's voice. With practice in speaking out loud, pupils would probably show (a) more facile expression and (b) more accurate use of scientific language in the solution of new problems.
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> 3. The Videosonic Tutor held the interest and attention of all these six-year-old children over a period of almost three weeks. While it is important to conclude that this interest will continue on the part of young children for a full school year, it seems highly probable that effective programming is the key to motivation.[82]

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[82] *Ibid.*, pp. 82-83.

Smith, 1962

Two hundred and twenty-eight cadets at the United States Air Force Academy were subjects in an experiment to evaluate programmed instruction against conventional classroom teaching.[83] The subject matter area chosen was elementary statistics. The subjects were broken down into four ability levels of thirty-three students each as determined by previous mathematical achievement. Half of the subjects from each of these four ability ranges were randomly assigned to experimental sections; the other half comprised the control groups. Eight groups were thus formed from the four ability levels. The experimental sections were given a programmed textbook on statistics while the control sections were taught the same material in the conventional manner.

Two hypotheses were tested. The first was the assumption that no significant differences in learning would occur between the two methods tested, and the second hypothesis was that ability level of the subjects was not a factor in one treatment being more effective than the other.

Results of a posttest given both groups indicated:

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[83] Norman H. Smith, "The Teaching of Elementary Statistics by the Conventional Classroom Method Versus the Method of Programmed Instruction," The Journal of Educational Research, LV (June-July, 1962), pp. 417-420.

(1) No statistically significant differences, ascribable to differences in the method of instruction, exists between overall achievement of the two theoretical populations from which the treatment groups were assumed to have been drawn.

(2) No statistically significant differences, ascribable to differences in the methods of instruction, exist in achievement at any of the four ability levels of the two theoretical populations from which the treatment groups were assumed to have been drawn.[84]

In terms of time required to complete the program, however, the following figures indicated some superiority on the part of the subjects using the program.

Ability Level	Time Consumed (in minutes)	
	Experimental Group	Control Group
1	698	982
2	568	997
3	819	1,132
4	840	1,135
Mean	738	1,117 [85]

One interesting aspect of the investigation concerned the experimental students' appraisal of programmed instruction. Over eighty-three per cent of the subjects stated on a questionnaire that they enjoyed taking the program and over sixty per cent preferred it to conventional instruction. Over half felt they learned with less

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[84] *Ibid.*, p. 418.

[85] *Ibid.*, p. 420.

effort by means of the program and received more individualized attention from it than traditional methods.

Smith concluded that although the experiment failed to indicate any significant differences in learning between programmed instruction and conventional techniques, there was a possibility programming might affect various ability levels differently; more research was needed before any definite assumption could be made.

Reed and Hayman, 1962

A study using a published programmed textbook, English 2600, was carried out in the Denver Public Schools and reported by Reed and Hayman.[86] Two tenth grade English classes in each of five high schools were given the programmed text. Each experimental section had a matched control section which received regular classroom instruction on similar material during the experiment. Students were grouped as to high, average or low ability so a comparison of the program's effectiveness at different ability levels could be made.

A comparison of pretest and posttest results indicated the program seemed to be most effective for students of high achievement. The more able students using English 2600 did better than their matched control

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[86] Jerry E. Reed and John L. Hayman, Jr., "An Experiment Involving Use of English 2600, an Automatic Instructional Text," The Journal of Educational Research, LV (June-July, 1962), pp. 476-484.

subjects, but low ability experimental students scored lower than their counterpart controls. No difference could be found for either experimental or control subjects of average ability. Moreover, gain in learning was substantial but about the same as a result of either method of instruction. As expected, high ability students completed the program quicker than average students who in turn completed it faster than students of low ability.

Reed and Hayman summarized their findings by stating:

> . . . learning was substantial for all students, and overall, those who worked with English 2600 learned about the same amount as those with the more traditional learning experiences. The results indicate, however, that English 2600 was more effective with high achievement students than it was with low achievers.[87]

Evans, Glaser and Homme, 1962

Evans, Glaser and Homme developed a program on symbolic logic and administered it to sixty college students in an effort to identify effective variables in programmed instruction.[88] Of the six sections tested, two sections followed similar linear programs, but one group had review material whereas the other group did not.

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[87] Ibid., p. 479.

[88] James L. Evans, Robert Glaser, and Lloyd E. Homme, "An Investigation of 'Teaching Machine' Variables Using Learning Programs in Symbollic Logic," The Journal of Educational Research, LV (June-July, 1962), pp. 433-452.

The other four sections received programs which had been developed in less orderly systematic fashion. The third and fourth groups were required to construct their answers to the frames in the program but only one section received knowledge of results of their response where alternative responses were involved. A fifth group was given the correct answers to the frames and not required to make a response. The sixth group was given a set of multiple-choice alternatives from which to choose the correct response.

Results of performance and time spent on the program as well as analysis of immediate and three delayed sets of pretests and posttests indicated the following conclusions to the authors.

> 1. Experimental variations in mode of responding significantly affect learning time. Ss [subjects] not required to make an overt written response to each item can complete a learning program in about sixty five percent of the time required for composed or multiple-choice responding.
>
> 2. Criteria performance in terms of error scores is not significantly affected by mode of responding, including no overt responding at all.
>
> 3. Systematically constructed programs can produce, in less learning time, criterion performance comparable with that of a less systematic program.
>
> 4. Ss who responded covertly to learning programs take significantly more time on performance tests which immediately follow the program than do Ss who make their responses overtly. Such differences in test time disappear after retention period of one week.
>
> 5. Differential retention effects were observed as a function of the type of criterion performance measured. Error scores on true-false tests decreased significantly; error scores on recall tests showed slight

but significant increases; on tests involving deductive proofs no significant changes were observed.

6. No significant relationships were observed between performance following the programmed learning sequence employed, and sex, mathematical experience, or college class.

7. Implications of the results for the area of verbal learning were discussed. It was hypothesized that the relevance of variables such as response mode and immediacy of feedback are inversely related to the probability of correct responding in the course of learning.[89]

Rushton, 1961

The city of Roanoke, Virginia, initiated an experiment where accelerated learning of algebra was accomplished through use of a programmed textbook.[90] A demonstration class of thirty-four eighth grade students were given a programmed unit in algebra without the aid of a teacher or homework. Scores on the Lankton first year algebra tests showed that forty-one per cent of the experimental subjects did better than the average ninth grader on the national examination. Only one of the subjects tested fell into a low ninth grade category. These results led to an expanded use of programmed material in Roanoke. During the 1961-62 school year, programmed texts were used to help teach algebra, geometry, trigonometry, and calculus to 847 pupils. School officials are so pleased with

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[89] Ibid., pp. 450-451.

[90] E. W. Rushton, "Greatly Accelerated Learning of Algebra Through Use of Programed Materials is Demonstrated in Roanoke, Va.," The Nation's Schools, LXVII (February, 1961), pp. 76-79.

the results of programmed instruction that they plan to program other subject-matter areas in the near future.

Coulson and Silberman, 1961

Coulson and Silberman reported a study where eighty junior-college students were given a programmed unit in elementary psychology.[91] Learning variables investigated included fixed sequence versus branching frames, multiple-choice versus constructed response mode, and small versus large-step size.

Results of the study indicated the following four points:

> 1. Training with the manually controlled machines yielded significant student learning in each of the experimental groups.
>
> 2. "Branching" students required significantly less training time than "fixed sequence" students, and did not differ on a post-training criterion test.
>
> 3. Students receiving many items with small steps learned more than students with fewer large-step items, but also required significantly greater training time.
>
> 4. "Multiple-choice" students required less training time than "constructed response" students; the two groups did not differ on criterion performance.[92]

Wurtz, 1960

An interesting experiment utilizing programmed

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[91] John E. Coulson and Harry F. Silberman, "Automated Teaching and Individual Differences," Audio-Visual Communication Review, IX (January-February, 1961), pp. 5-15.

[92] Ibid., p. 6.

instruction was carried out in Los Angeles with students in a driver training class.[93] By employing a device called the Aetna Drivotrainer which simulated actual driving situations, students were trained more economically and as well as those receiving conventional instruction.

Shafer, 1961

Shafer developed a social studies program and tried it out on an eighth grade class of above average intelligence.[94] She drew three conclusions concerning the experiment: (1) frames must be carefully constructed so as to lead to the desired response and eliminate unwanted answers; (2) programs should be geared explicitly to ability level of the intended subjects; and (3) students' reactions are essential to program revision.

Although programming seemed to lend itself to use in social studies, Shafer felt much refinement was needed before a "teacher will have on hand at all times the right program for the right student."[95]

[illegible]

At Michigan State University, a programmed unit

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[93] Roger Wurtz, "A Teaching Machine for Driver Training," California Journal of Secondary Education, XXXV (May, 1960), pp. 301-304.

[94] Susanne M. Shafer, "Teaching Machines and the Social Studies," Social Education, XXV (February, 1961), pp. 85-86.

[95] Ibid., p. 86.

on heredity was developed and administered to students in a freshman natural science course.[96] Five experimental sections used the programmed material and five control sections used the conventional course manual.

The program was developed by the Natural Science department to help alleviate the growing number of students per staff member. Three criteria were set up which the program had to meet:

(1) It should be almost completely self-administering, thereby not increasing the work-load of the staff member even if more students were assigned to him.

(2) It must not result in a deterioration of quality of learning on the part of the student.

(3) It must be regarded by a majority of both the students and staff members as a genuinely useful and stimulating aid to learning and not as a mere novelty.[97]

A thirty-item objective test administered to both the experimental and control groups at the end of the training session indicated the following results.

	experimental	control
number of students	144	131
mean of scores	19.75	17.93 [98]

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[96]Chester A. Lawson, Mary A. Burmester, and Clarence H. Nelson, "Developing a Scrambled Book and Measuring Its Effectiveness as an Aid to Learning Natural Science," Science Education, XLIV (December, 1960), pp. 347-358.

[97]*Ibid.*, p. 354.

[98]*Ibid.*

Student and staff questionnaires concerning the program tended to indicate approval and favor for the program. Results of this study have led Michigan State University to program more units for inclusion in the freshman Natural Science program.

Programmed Instruction Today

As the above research has indicated, educators have paid more and more attention during the last few years to programmed instruction. Although at the present time most utilization of this relatively new educational technique is at the elementary and secondary school levels, each year shows an increase of programming at the college level. Most colleges and universities have begun experimenting with programmed instruction in one or two basic courses, but a few have already delegated programming a major role in their curriculum planning. A good example of this type of institution is Earlham College which has already developed and tested programs in elementary Russian, genetics, English, music, statistics, Spanish and religion.[99] Earlham reports such favorable results with programming that it intends to increase its use in the near future.

More and more subject matter areas are being

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[99]John A. Barlow, "The Earlham College Self-Instructional Program," Audio-Visual Communication Review, VIII (July-August, 1960), pp. 207-209.

programmed for various educational levels. Programs dealing with special education, such as training for the deaf and instructing students to use the library, are being developed and tested. If one scans the latest issues of the journals, he can find articles explaining programmed instruction and suggesting implications for the particular fields involved. Speech educators have recently realized great potential for their field and one author has developed sample programmed units concerning speech.[100] This same author states:

> While the basic course appears the obvious place to test out programming, parts of more advanced courses may be supplemented by program procedures. The mechanics of television, debate techniques, operation of the vocal mechanism, stage vocabulary and many other speech topics can be partly or completely programmed by existing techniques.[101]

Programmed Instruction is big business. The United States Office of Education estimated that some 122 commercial programs were available by the end of 1962. Hundreds of schools are now administering programs to millions of students.[102] Unfortunately this emphasis upon the commercial potentialities of programming has stunted its growth a bit. For several years the quality of the

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[100] L. S. Harms, "Programmed Learning for the Field of Speech," Speech Teacher, X (September, 1961), pp. 215-219.

[101] *Ibid*., p. 219.

[102] Schramm, Programed Instruction Today and Tomorrow, *op. cit*., p. 6.

programmed material took a back seat to fascination with the gadgetry involved in teaching machines and the speed with which a salable commercial program could be produced. Many talented educators were lured away from doing the valuable research necessary to a new field and persuaded to produce salable commodities. Fortunately, stress is now being placed on the quality rather than quantity of the programs written, and worthwhile research is being undertaken in an attempt to further perfect this teaching aid.

Programmed instruction is not a panacea. At best, all it can hope to accomplish is what a good teacher can do under ideal learning conditions. Around ninety-five per cent of the programs produced today are Skinnerian in nature,[103] requiring a constructed response to each frame of a linear program. Branching or "intrinsic"[104] programming is also becoming more popular. There are also various combinations of linear and branching programs being developed and much experimentation is being done as to which approach or combination of approaches is the most effective presentation style for a particular situation.

Much good research has been done on programming during the last five years but much more is needed in such

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[103] *Ibid.*, p. 2.

[104] Norman A. Crowder, "Automatic Tutoring by Means of Intrinsic Programing," in Eugene H. Galanter (ed.), *Automatic Teaching: The State of the Art* (New York: John Wiley and Sons, Inc., 1959), pp. 109-116.

areas as response mode, size of step, sequencing, format, length of program, as it relates to particular learning situations. Future plans for programming are fantastic in nature. There are even plans to use programmed computers in research on programmed instruction itself.[105] Experimentation to date, however, has been optimistic enough to assume that programming will occupy a larger role as an educational technique in the future. Schramm has offered the following guidelines which programmed instruction might beneficially follow:

> (1) More of the effort at making programs must be placed on the growing edge of the art, rather than the safe and conservative commercial "center."
>
> (2) More research must be directed toward the larger implications and theoretical problems of programed instruction; in order to accomplish this, long-term commitment of top-level researchers will be required.
>
> (3) The schools must make more imaginative applications of programed instruction, accompanied by developmental research and testing.
>
> (4) Teachers must be trained to use programed methods expertly; and the possibilities of making and using programs should be explored as one introduction to the human learning process in teacher training.
>
> (5) Other channels of teaching - such as television, textbooks, films and other audio-visual means, workbooks, class teaching, and group study - must be examined to see where they can beneficially apply some of the principles of programed instruction.

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[105] Harry F. Silberman, "A Computer as an Experimental Laboratory for Research on Automated Teaching Procedures," Behavioral Science, V (April, 1960), pp. 175-176.

(6) The skills and understandings of programed instruction must be shared with the developing nations, and used where possible to speed economic and social development.

(7) Adequate channels of information must be established among the many and diverse people interested in the development of programed instruction.

This represents a very large program, but the stakes, too, are very large, and the goals most attractive.[106]

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[106] Schramm, Programmed Instruction Today and Tomorrow, op. cit., pp. 39-40.

CHAPTER IV

CHARACTERISTICS OF AN EXPERIMENTAL PROGRAM IN BROADCAST EDUCATION

A review of the literature concerning programmed instruction indicates that this educational technique can be employed beneficially to some degree in broadcast education. Two conclusions can be drawn from the studies cited in the two previous chapters of this thesis.

1. Programmed instruction can be utilized successfully in college level training.[107]

2. Research has indicated that programmed instruction is effective in subject-matter areas containing a high percentage of factual materials.[108]

This section of the thesis describes the characteristics of a short program developed on the basic physics of radio broadcasting. This subject matter was chosen for two reasons: (1) it is basically factual material; and

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[107] E.g., Roe, Case, and Roe, 1962 (page 45 of this thesis); Coulson and Silberman, 1960 (page 48); and Evans, Glaser, and Homme, 1962 (page 58).

[108] E.g., [illegible], [illegible] (page [illegible] of this thesis); Lawson, Burmester, and Nelson, 1960 (page 62); Coulson and Silberman, 1961 (page 61); and Ferster and Sapon, 1958 (page 51).

(2) appears to be an area of radio and television training which most students find fairly difficult to grasp. Therefore, if programmed instruction proves effective in teaching this subject matter, it could possibly be utilized as a regular part of course instruction in the future.

Intended Use of the Program

The program about to be described was developed as an aid to teaching the physics of radio broadcasting. It is intended to provide an elementary explanation of the subject as might be found in a non-technical introductory broadcasting course. The program aims to *supplement* lecture and assigned reading on the subject, not to replace it. The program could be used in two ways:

1. As a single program integrated with lecture, discussion and textbook readings.

2. As the first in a series of programmed units describing the physics of broadcasting in some detail.[109]

Although the author favors the first of these approaches, because it integrates the program with other

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[109] Although programming has been used for some time as a supplement to regular classroom instruction, self-contained series of programs are beginning to appear on the market. Examples of programmed series available for various subject-matter areas can be found in James D. Finn and Donald G. Perrin, *Teaching Machines and Programed Learning: A Survey of the Industry - 1962* (Washington: The United States Department of Health, Education, and Welfare, 1962), pp. 53-71.

forms of instruction, a short description of each use follows.

As a supplement to conventional instructional techniques the program offers the advantage of preparing students with selected basic material, which would provide a groundwork for further instruction in this relatively complex subject-matter area. By covering this basic material, the program can enable the instructor to integrate the material into a more complete discussion of broadcast physics. Supplemental textbook readings may be implemented to further unify discussion.

The second possible approach to use of the program is as an initial step in a series of programmed units. In this case, the series of programs would be presented in a given order as each unit would follow logically and build upon the previous unit. The program described in this section could very well serve as the first in such a series of programmed units.

Material Included Within the Program

The program here under discussion was prepared to include the following areas of broadcast physics.

1. A description of the process of radio broadcasting from the time sound is produced in a radio studio until this sound reaches a listener's ear. Particular attention is given to the various types of energy employed in radio broadcasting.

2. A brief discussion of electromagnetic energy (particularly radio energy).

3. The electromagnetic spectrum with emphasis upon the frequencies presently utilized in radio broadcasting.

4. An explanation of the terms "amplitude" and "frequency" as they relate to electromagnetic energy.

5. A description of AM and FM broadcasting related to the modulation of either the amplitude or frequency of the radio energy involved.

6. A discussion of ground, sky, and direct waves with emphasis upon the characteristics of each.

7. The distance and frequency characteristics of ground, sky, and direct waves as they apply in present AM and FM radio broadcasting.

The above areas of the physics of radio broadcasting were included in the programmed unit because they are the basic concepts on which a more complete discussion of the subject is built. Definitions and terms used in the program are in accordance with those found in the standard textbooks in the field such as Head,[110] and Chester, Garrison and Willis.[111]

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[110]Sidney W. Head, Broadcasting in America: A Survey of Television and Radio (Boston: Houghton Mifflin Co., 1956), 3-41.

[111]Giraud Chester, Garnet R. Garrison, and Edgar E. Willis, Television and Radio (3rd ed. rev.; New York: Appleton-Century-Crofts, 1963), pp. 239-256.

Behavioral Objectives of the Program

Mager defines teaching or behavioral objectives as:

> . . . an intent communicated by a statement describing a proposed change in a learner--a statement of what the learner is to be like when he has successfully completed a learning experience. It is a description of a pattern of behavior (performance) we want the learner to be able to demonstrate. As Dr. Paul Whitmore once put it, 'The statement of objectives of a training program must denote measurable attributes observable in the graduate of the program, or otherwise it is impossible to determine whether or not the program is meeting the objective.'[112]

Behavioral objectives are as necessary in writing a programmed unit as they are in any other educational endeavor. If you do not know what you specifically expect a student to get from an educational experience, it is impossible to know exactly what content to include in the program or what method to use to convey this content. Also, when it comes time to evaluate a program in terms of its usefulness and efficiency in teaching a given subject, how can it be evaluated without knowing what the student was expected to get out of the program?

In order to be useful, behavioral objectives have to be stated in rather concrete terms. To ask a student to "understand" or "know" a given topic is abstract and less definitive than asking him to "list" or "define" aspects of a certain topic. These latter objectives are

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[112]Robert F. Mager, Preparing Objectives for Programmed Instruction (San Francisco: Fearon Publishers, 1962), p. 3.

also more simple when it comes to evaluating a program. Reliability is higher when one measures how effectively a student "defines" a topic than when one measures how well he "understands" this same subject. Vague terms like "understand" and "know" are difficult to measure effectively through testing.

In light of the above discussion, the behavioral objectives set up for this experimental program on the physics of radio broadcasting, in terms of what a student should be able to do after completing the program, are:

1. To be able to list the steps involved in radio broadcasting in terms of the type of energy employed from the time sound is produced in a radio studio until this sound reaches a listener's ear. These steps are: (a) SOUND ENERGY produced in the studio and changed by the microphone into (b) ELECTRICAL ENERGY which travels to the transmitter and is changed into (c) RADIO ENERGY. This radio energy travels through space to the radio receiver which changes it to (d) ELECTRICAL ENERGY and releases it to the listener as (e) SOUND ENERGY.

2. To be able to define the term "cycle" as it applies to radio energy. Cycle is defined as pulsations or impulses of energy.

3. To be able to define the term "frequency" as it applies to cycles of radio energy. Frequency is defined as the number of cycles occurring per second.

4. To be able to list the frequencies on the electromagnetic spectrum presently being employed in AM radio broadcasting. The frequencies 540-1600 kilocycles are listed as the AM broadcast band in the program.

5. To be able to list the frequencies on the electromagnetic spectrum presently being employed in FM radio broadcasting. The frequencies 88-108 megacycles are listed as the FM broadcast band in the program.

6. To be able to define the term "amplitude" as it applies to cycles of radio energy. Amplitude is defined as the distance between the positive peak and negative peak of a cycle of radio energy.

7. To be able to define AM radio broadcasting in terms of whether the amplitude or frequency of the radio energy is modulated. AM broadcasting is defined as the system of transmission where the amplitude of the radio energy is modulated while the frequency is kept constant.

8. To be able to define FM radio broadcasting in terms of whether the amplitude or frequency of the radio energy is modulated. FM broadcasting is defined as the system of transmission where the frequency of the radio energy is modulated while the amplitude is kept constant.

9. To be able to define "ground waves" in terms of the propagation characteristics presented in this program. Ground waves are described as those radio waves which tend to follow the curvature of the earth.

10. To be able to define "sky waves" in terms of the propagation characteristics presented in this program. Sky waves are described as those radio waves which reflect off the ionosphere before reaching earth.

11. To be able to define "direct waves" in terms of the propagation characteristics presented in this program. Direct waves are described as those radio waves which tend to travel in a straight line.

12. To be able to list the effective frequency range and distance characteristics of ground waves as presented in this program. Ground waves are effective at the AM broadcast frequencies for short range transmission.

13. To be able to list the effective frequency range and distance characteristics of sky waves as presented in this program. Sky waves are effective at the AM broadcast frequencies for short distance transmission during the day and long distance transmission at night.

14. To be able to list the effective frequency range and distance characteristics of direct waves as presented in this program. Direct waves are effective at the FM broadcast frequencies for short range transmission.

The terms and concepts used in this programmed unit on the basic physics of radio broadcasting comply with those found in the two textbooks previously mentioned in this chapter.[113]

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[113]Head, loc. cit., and Chester, Garrison, and Willis, loc. cit.

Type of Program Chosen

A linear-type program requiring a constructed-response to each frame was chosen to present the material for the following reasons:

1. There seems to be a single logical sequence in developing the material.

2. Material can be broken down effectively into frames requiring simple responses from the student.

3. Small steps seem necessary to prevent misinterpretation of the material.

4. Linear programming can be controlled, so small review sequences can be built in where needed.

5. Frequent responses prevent a student from reading too quickly or carelessly, forcing him continually to redirect his attention to the program.

6. Linear programming seems to be effective in cases where a student can not pace himself effectively or when he has poor study habits.

7. It allows use of the constructed-response mode which recent research has indicated to be an effective learning factor.

8. Little or no prior knowledge of the subject matter is required on the part of the student.

9. Linear programming permits better utilization of accompanying panels (charts, diagrams, etc.).

10. It seems to follow existing learning principles more closely than other forms of programming.

11. Controls on linear programming allow for more exact measurement of acquired learning in an evaluative situation.[114]

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[114]These advantages of linear programming are taken from remarks made by Dr. George Klare at a seminar meeting held at Resources Development Corporation, East Lansing, Michigan, on July 9, 1963. Dr. Klare is a Professor of Psychology at Ohio University in Athens, Ohio.

The final program consists of fifty-one linear frames requiring a constructed-response to each frame. Eight accompanying panels were developed to supplement the program. Use of "copy frames," or frames which include the response to be given within the frame, were kept to a minimum and only used where the author felt they directly contributed to the development of a sequence. The rate of redundant and review frames was also kept low, as one of the major criticisms against linear programming is it often becomes too easy and boring. Since the program was planned for a college undergraduate student, use of review sequences were included only where pretesting indicated.

The terms and concepts presented in the program were sequenced carefully and the relationship between them were stressed, Material was presented in what seemed to be the logical order by the author. The entire program was designed in a specific sequence which introduced terms and concepts only where they directly fit in and built upon previous material.

Validation

The program during its several stages of revision, was pretested on sixteen undergraduate students who professed no prior knowledge of the physics of radio broadcasting. A ten per cent tolerance for error rate was established in advance as the criterion for acceptibility of the program. Therefore, if any subject taking the program missed more than five of the fifty-one frames in the program, the faulty frames were rewritten and the program administered to another subject. The last six students taking the final revision of the program scored less than ten per cent in terms of error rate and the program was deemed acceptable. This ten per cent tolerance for error, although it is arbitrary, is a quite common standard in program pretesting and:

> experienced programers feel that by the time eight or ten individual tests and revisions have been completed, the program is capable of teaching 98 per cent of all the students who approximate the school and ability level of the students so far tested. This process is a very important one because: (a) it focuses attention on the individual learning process in a way that group teaching seldom does, and (b) it virtually guarantees that a program so made will "work." About a program so made, one feels a confidence that few textbooks can command.[115]

Format of the Program

A decision on the format of the program was made in light of the economics and ease of duplicating the program. The method chosen presented the sequence of frames in order on a sheet of paper. The answer to frame number one was printed to the left of frame number two, and so on. This method had the advantage of being able to present the entire program on only eleven sheets of paper and yet separated each frame from its corresponding

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[115] Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: The Fund for the Advancement of Education, 1962), pp. 3-4.

answer. By using a plain manila folder with the upper left-hand corner cut away, the program could be slipped through the folder in such a way that a frame appeared along with the previous frame's correct answer. An example of this procedure is shown on the following page. An instruction sheet explaining how to proceed through the program was distributed to each subject taking part in the validation.[116]

[116]The instruction sheet included with the experimental program is similar to one used at Resources Development Corporation, East Lansing, Michigan.

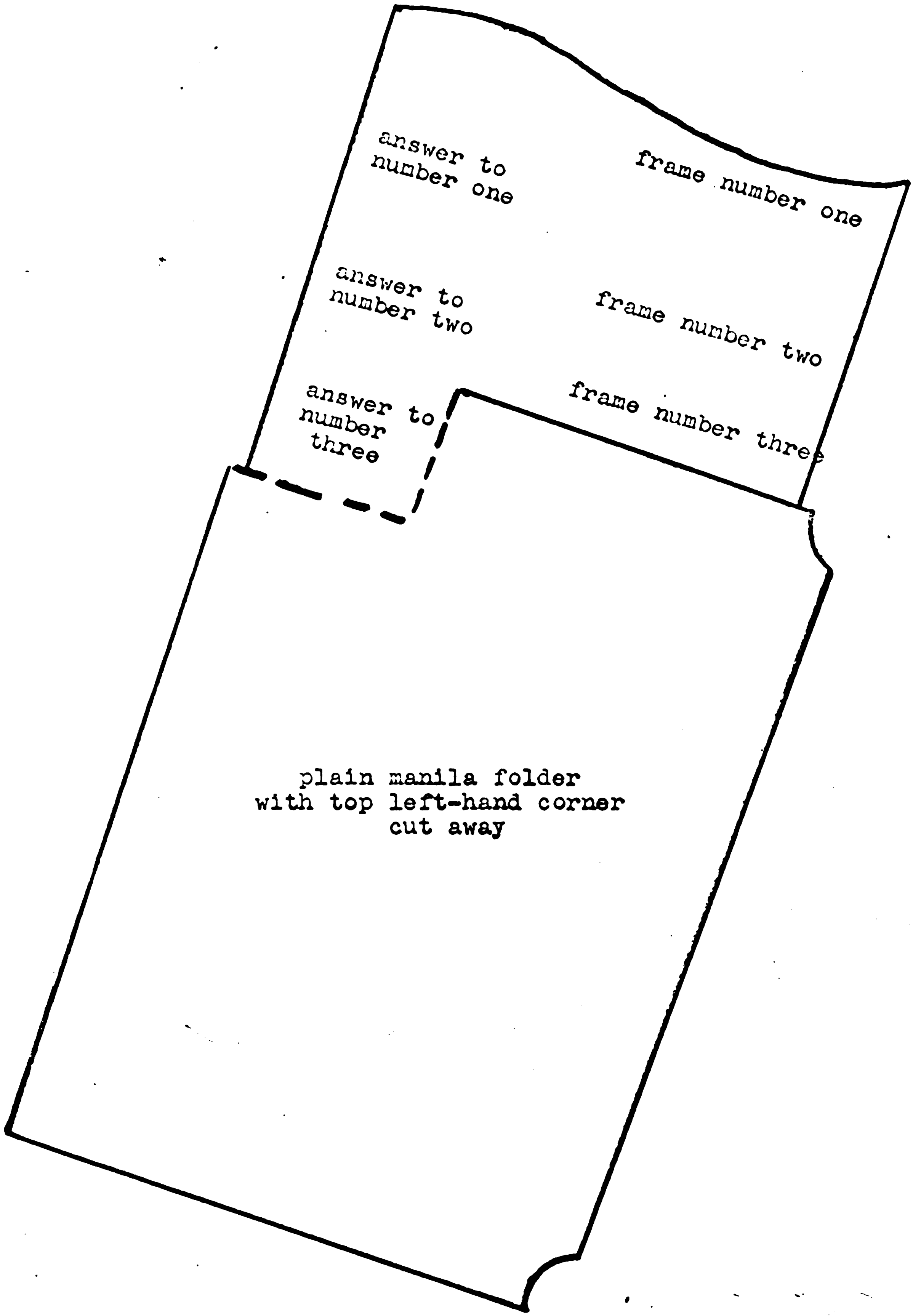

Figure 1. VIEW OF PROGRAMMED UNIT WITHIN FOLDER

CHAPTER V

A PROGRAMMED UNIT ON THE BASIC PHYSICS OF RADIO BROADCASTING

Instruction Sheet

Lay this instruction sheet and the eight accompanying panels to one side, and close the folder.

Now, using the corner of the page showing through the cut-out section of the folder, pull the first page ahead until the first line across the page just shows above the top edge of the folder.

The part of the program now exposed is the first "frame" of the program. Read the frame and decide how you would fill in the blank. Write in the answer, in the space provided. On several occasions you will be asked to choose from alternative answers. When this occurs, circle the answer you feel to be correct.

Now pull the page ahead further to see if your answer is correct; the correct answer appears at the left above the next frame. If your answer is correct, pull the sheet ahead to the next line across the page, and continue with the program; if your answer is not correct, mark it with an (X) and review the frame before continuing. When a page is completed, place it in the back of the folder.

It is important that you WRITE YOUR ANSWERS DOWN and that you write them <u>before</u> you look at the correct answer. Do not bypass or skip frames. Take as much time as you need to learn the material thoroughly.

The concept of energy is so bound up with modern living that we seldom realize that the phenomenon of listening to the radio is dependent upon ________.

energy

To help explain this phenomenon of radio broadcasting, let's use an example. The information which an announcer speaks in a radio studio is present in the air as sound. Therefore, the first kind of energy which occurs in radio broadcasting is ________ energy.

sound

This sound energy reaches a microphone which converts this sound energy to electrical ________.

energy

This electrical energy is converted from sound energy by the ____________.

microphone

Once this electrical energy leaves the microphone it travels through the control room equipment to the transmitter where it is converted to a third kind of energy known as radio ________.

energy

Much like the microphone which changes the original sound energy to electrical energy, the ___________ changes this electrical energy to radio energy.

transmitter

The radio energy radiating from the transmitter's antenna travels through space until it reaches your home radio _________.

receiver
or
set

There it is first changed to electrical energy and then released from the radio receiver in the form it started with at the radio studio: ________ energy.

sound

Looking at panel one, you see that from the time the information is spoken at the radio station until you hear it at home, three types of energy have occurred, and ________ of these have occurred twice.

two

If the announcer delivering the information in the previous example had spoken softly in some instances and shouted in others, we could say his volume or loudness had ________.

changed
or
varied

This characteristic of loudness is called amplitude. The ability to ________ amplitude is basic to radio broadcasting.

change
or
vary

If this announcer had also spoken in a high tone in some instances and in a low tone in others, we could say his pitch had ________.

changed
or
varied

This characteristic of pitch is called frequency. The ability to ________ frequency is also basic to radio broadcasting.

change
or
vary

In speaking of the characteristics of loudness and pitch produced by the announcer's voice we are speaking about two characteristics of ________ energy.

sound

Just as loudness and pitch are characteristic of sound energy their corresponding terms am__________ and fr________ are present in both electrical and radio energy.

amplitude

frequency

Now that we've briefly traced the process of radio broadcasting from a radio studio until you hear it at home, let's take a closer look at the type of energy which occurs between the transmitter antenna and your home receiver, namely ________ ________.

radio energy

Radio energy is included in a larger classification of kinds of energy called electromagnetic ________.

energy

One characteristic of this class of energy is that it travels through space at a constant speed. Radio energy being a kind of ________ energy travels through space at a constant speed.

electromagnetic

This constant speed is 186,000 miles per second. Light energy, as well as radio energy, travels at this speed. Light, therefore, is a type of ________ ________.

electromagnetic energy

Electromagnetic energy travels through space in pulsations or impulses called cycles. Radio energy travels in ______.

cycles

A cycle can be compared to a wave in the ocean. A wave rises to a crest and then dips to a trough before another wave comes along. This process is the same for a ________.

cycle

In panel two, a comparison is made between an ocean wave and a cycle. The crest of the wave is analogous to the ________ ________ of the cycle.

positive peak

Also, the trough of the ocean wave is similar to the ________ ________ of the cycle.

negative peak

As an ocean wave contains both a crest and a trough, a cycle has both a ________ ________ and a ________ ________.

positive peak

negative peak

The term frequency refers to the number of cycles occurring per second. One way of describing electromagnetic energy is in terms of ________.

frequency

When electromagnetic energy is being thought of in terms of number of cycles per second, or ________, it is often arranged numerically on a **theoretical electromagnetic spectrum.**

frequency

Panel three shows the section of the ________ ________ in which the frequencies now utilized in radio broadcasting lie.

electromagnetic spectrum

Looking at panel three, the frequencies now employed in radio broadcasting are from ________ to ________ kilocycles (KC) and from ________ to ________ megacycles (MC) on the electromagnetic spectrum.

540 - 1600

88 - 108

One kilocycle equals one thousand cycles and one megacycle equals one million cycles. Therefore, frequencies in the 540-1600 KC band have (more/fewer) cycles per second than frequencies in the 88-108 MC band.

fewer

The frequencies ________ KC to ________ KC are known as the AM broadcast band.

540 - 1600

The frequencies ________ MC to ________ MC are known as the FM broadcast band.

88 - 108

The initials AM and FM stand for "amplitude modulation" and "frequency modulation" respectively. The term modulation means "change." In AM and FM broadcasting, a change or ________ takes place.

modulation

Before we can explain this change, however, we must show the relationship between amplitude and frequency. Panel four depicts radio energy in terms of both amplitude and frequency. The vertical dimension of the diagram represents amplitude as the distance between the positive peak and ________ ________ of the cycle.

negative peak

Panel five shows an example of radio energy where the frequency has been kept constant and the ________ has been modulated.

amplitude

This system of broadcasting where the amplitude is modulated and the frequency is kept constant is called ___ ___ broadcasting.

AM

Panel six shows an example of radio energy where the amplitude has been kept constant and the ________ has been modulated.

frequency

This system of broadcasting where the frequency is modulated and the amplitude is kept constant is called ___ ___ broadcasting.

FM

Radio energy which radiates from a station's transmitter antenna is spoken of as radio waves. The length of radio waves is related to the number of cycles per second or the ________ of the energy involved.

frequency

This relationship between frequency and length of waves is an inverse relationship. As the frequency of radio energy goes higher, the corresponding wave length gets ________.

shorter
or
smaller

The radiation of waves through space is called propagation. The characteristics of wave propagation differ for the two types of broadcasting discussed, namely ___ ___ (________ modulation) and ___ ___ (________ modulation).

AM amplitude

FM frequency

Panel seven depicts the three types of waves instrumental in radio propagation. They are ________ ________, ________ ________, and ________ ________.

ground waves

sky waves

direct waves

The type of waves which tend to follow the curvature of the earth is called ________ ________.

ground waves

The type of waves which reflect off the ionospheric layer of the atmosphere is called ________ ________.

sky waves

The type of waves which tend to travel in a straight line is called ________ ________.

direct waves

Waves which travel in a straight line are ________ waves; waves which bounce off the ionosphere are ________ waves; and waves which follow the curvature of the earth are ________ waves.

direct

sky

ground

Panel eight shows frequency and distance characteristics for ground, sky, and direct waves. Atmospheric conditions make one wave type suitable for short distance broadcasting during the day and long distance broadcasting at night at the AM frequencies. It is the ________ wave.

sky

Another type of wave effective for short distance broadcasting at the AM frequencies is the ________ wave.

ground

Short distance broadcasting is possible at the FM frequencies through use of the ________ wave.

direct

In summary, then, ground waves are useful in (FM/AM) broadcasting over ________ distances.

AM

short

Sky waves permit (FM/AM) broadcasting during the day over ________ distances, and at night over ________ distances.

AM

short

long

Direct waves are useful in (FM/AM) broadcasting over ________ distances.

FM

short

END OF PROGRAM

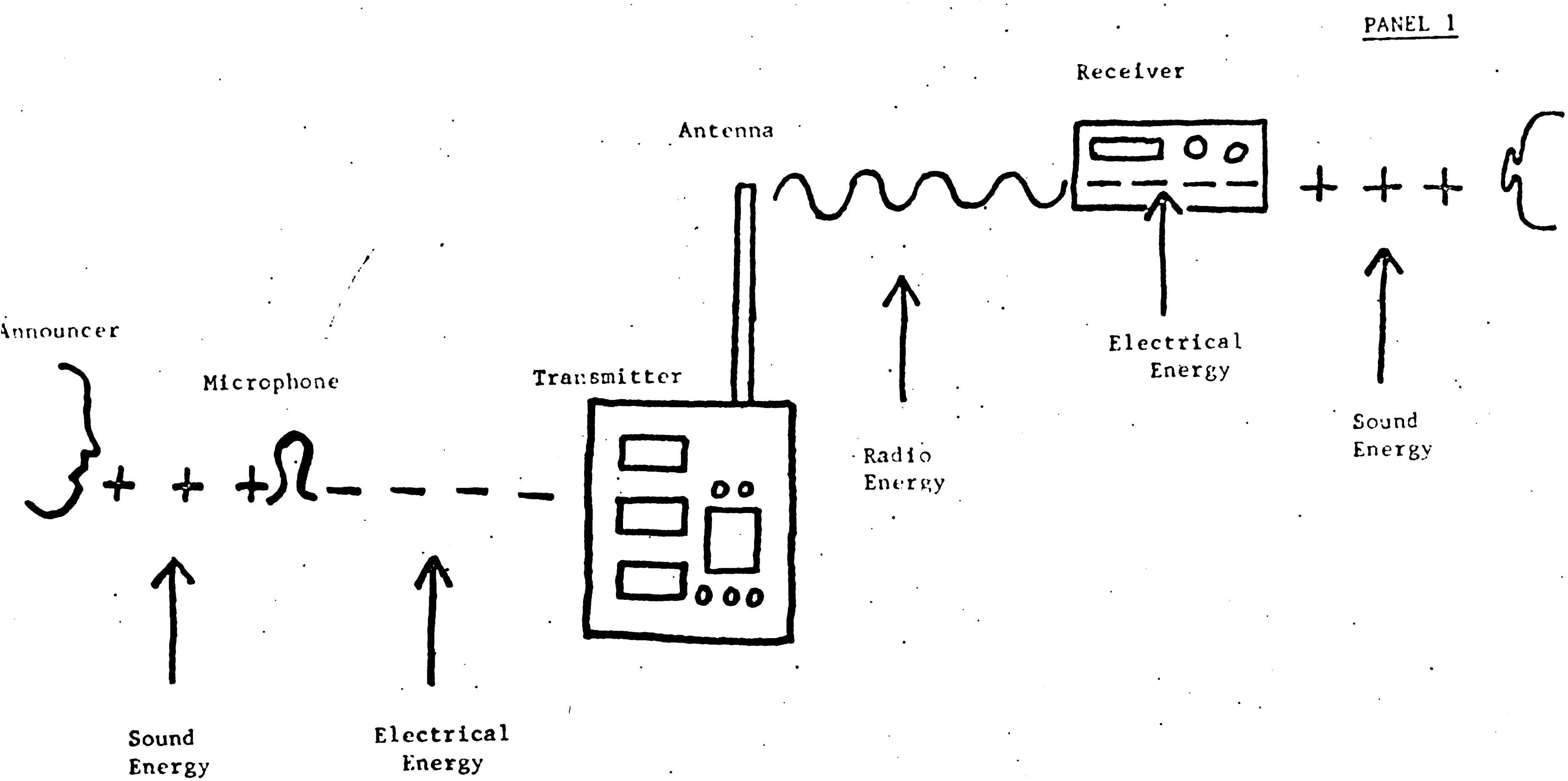

Figure 2. THE PROCESS OF RADIO BROADCASTING

Panel 2

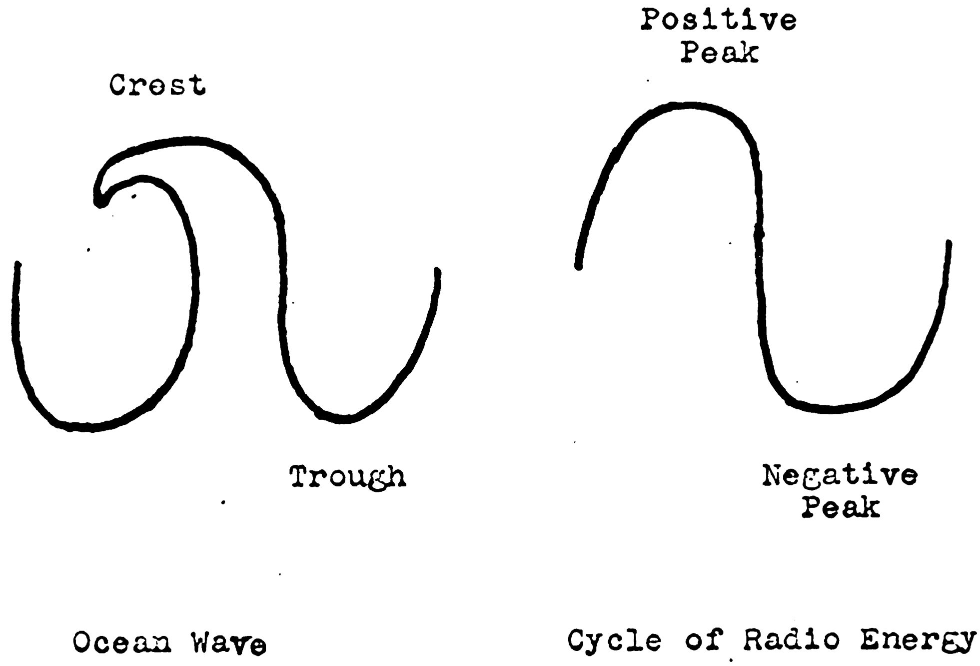

Figure 3. COMPARISON OF A CYCLE OF RADIO ENERGY TO AN OCEAN WAVE

PANEL 3

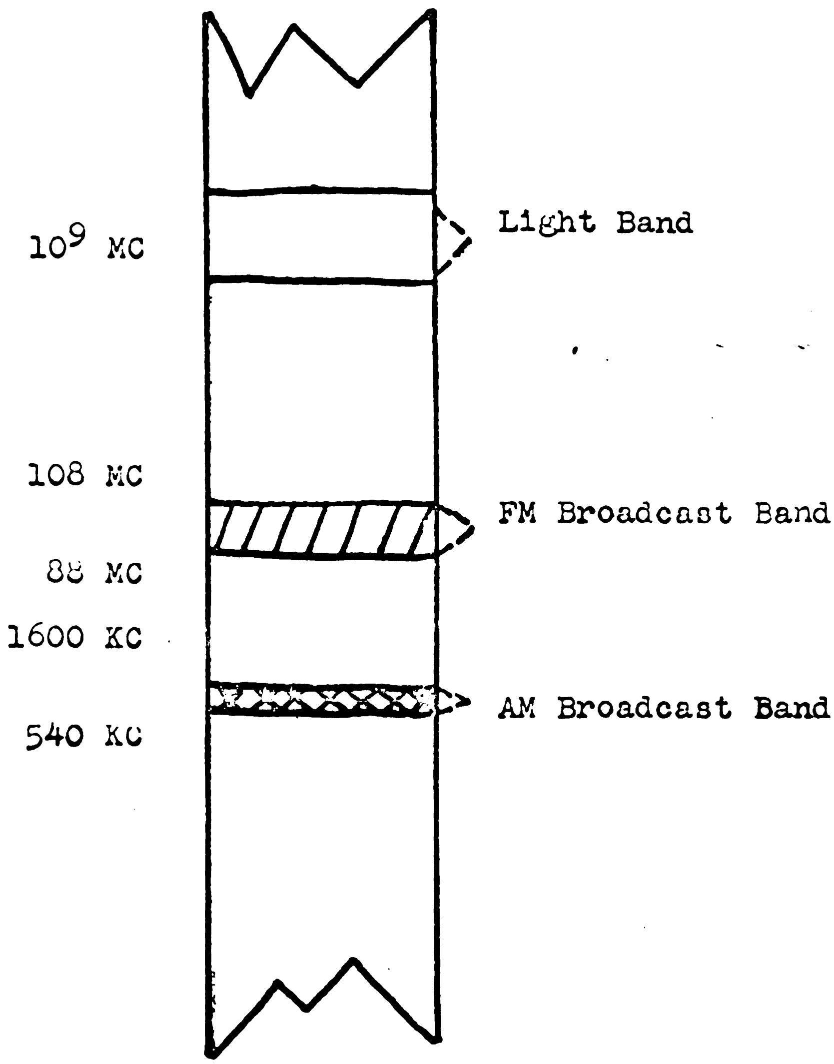

Figure 4. SECTION OF THE ELECTROMAGNETIC SPECTRUM

PANEL 4

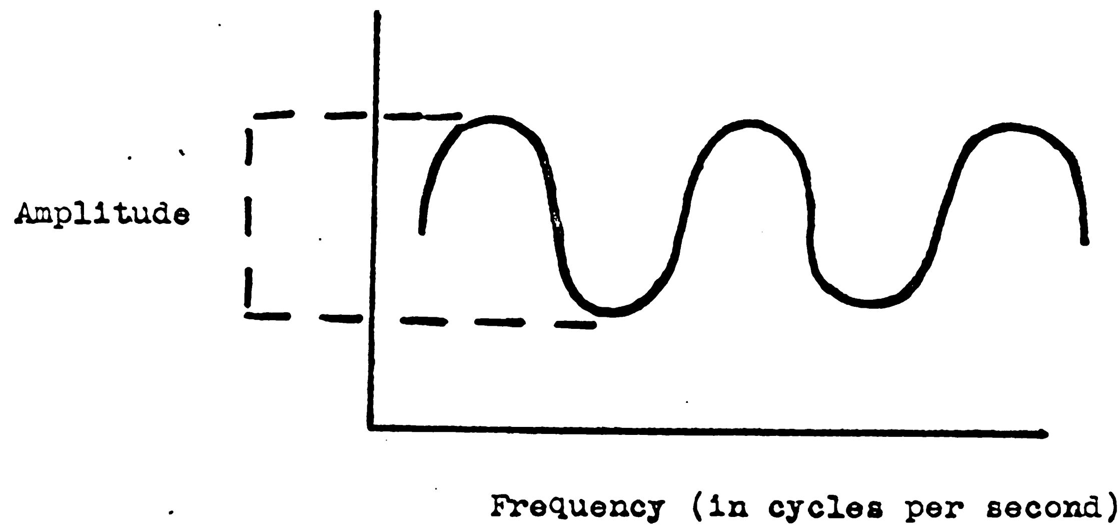

Figure 5. CYCLES OF RADIO ENERGY IN TERMS OF AMPLITUDE AND FREQUENCY

PANEL 5

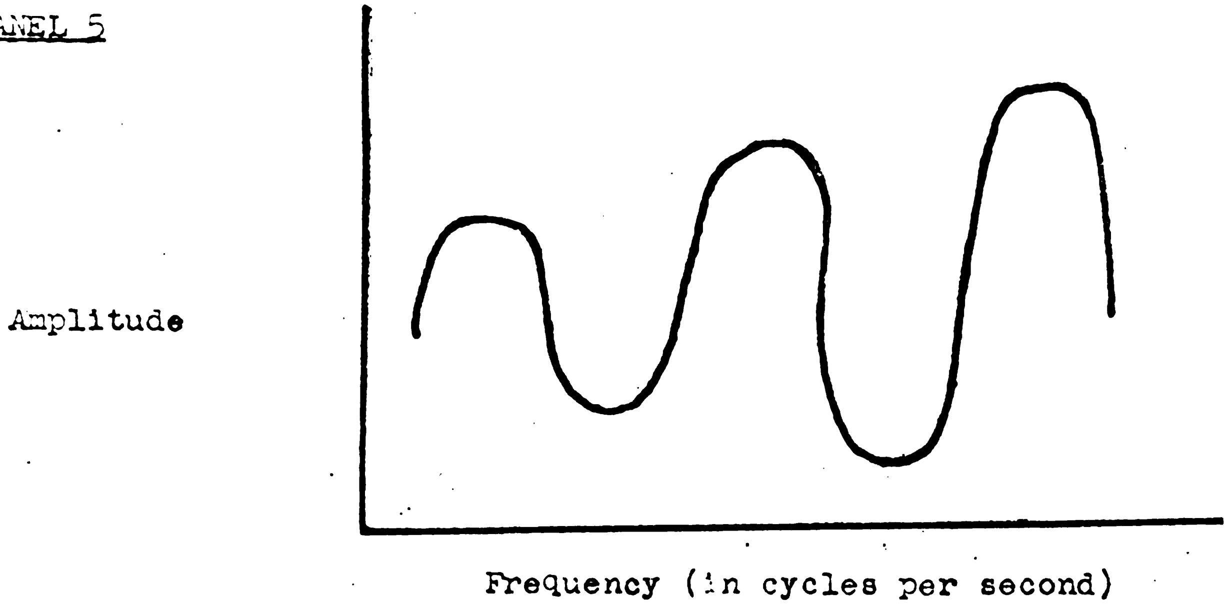

Figure 6. AM BROADCASTING

PANEL C

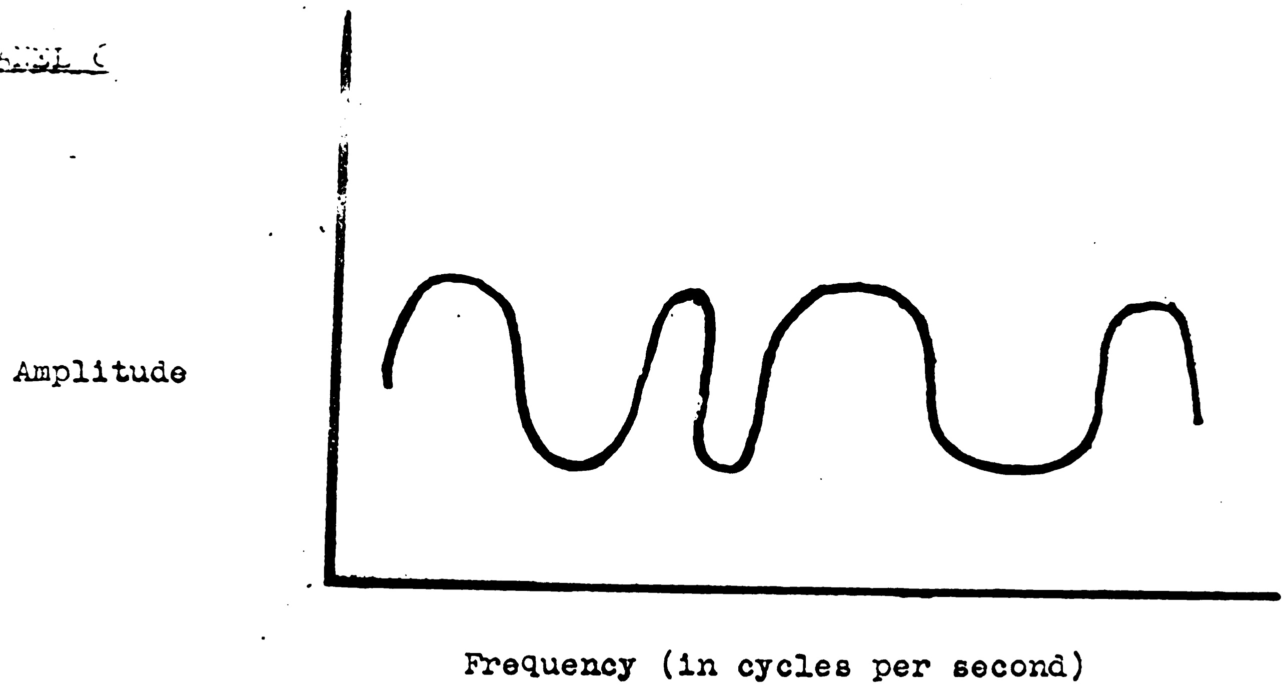

Figure 7. FM BROADCASTING

PANEL 7

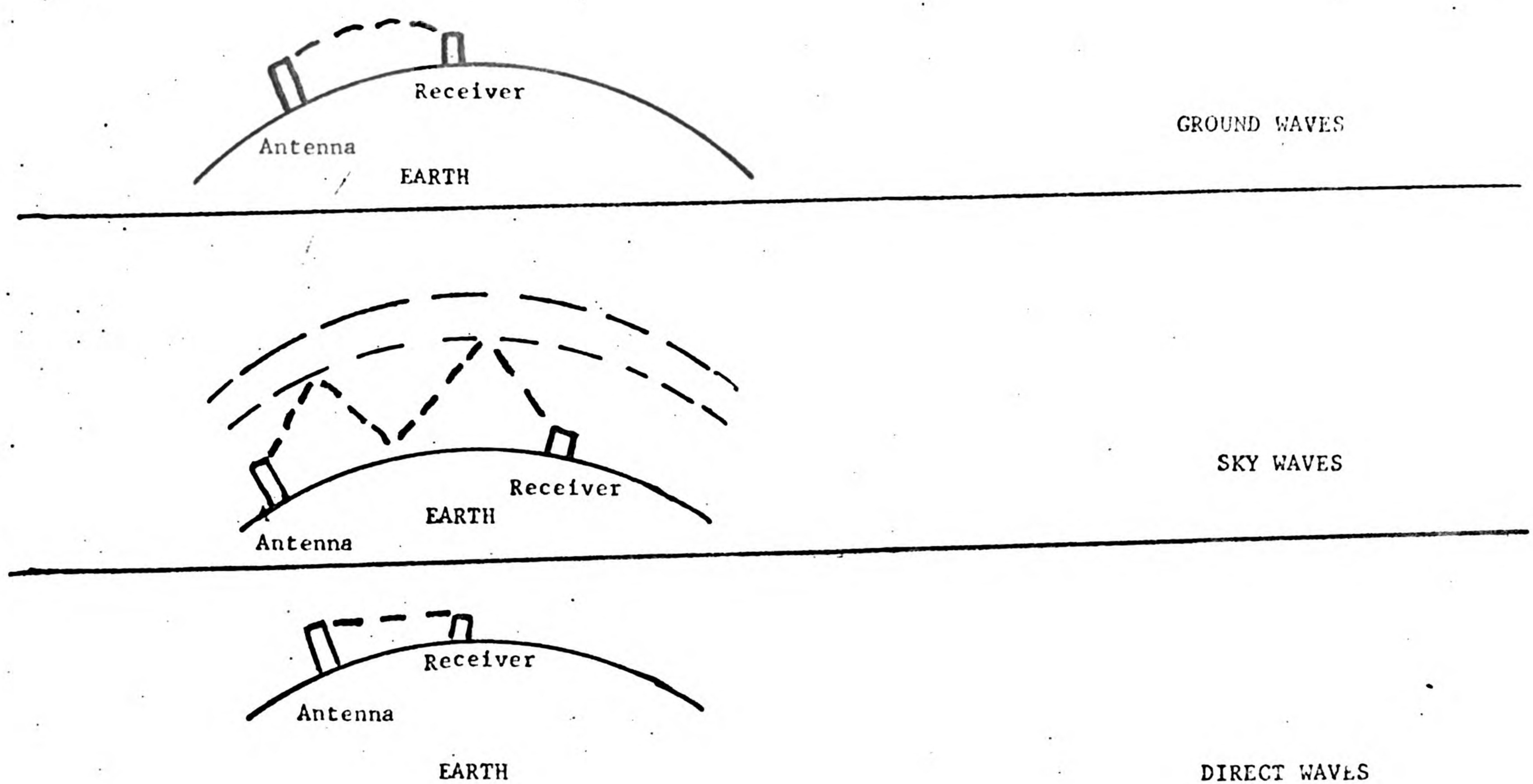

Figure 8. PROPAGATION CHARACTERISTICS OF GROUND, SKY, AND DIRECT WAVES

Panel 8

	Ground Waves	Sky Waves	Direct Waves
Broadcast Frequencies	AM	AM	FM
Distances	Short	Short During Day / Long During Night	Short

Figure 9. EFFECTIVE BROADCAST FREQUENCIES AND DISTANCES FOR GROUND, SKY, AND DIRECT WAVES

CHAPTER VI

CONCLUSION

Summary of Findings

The concept of programmed instruction is still in its infancy. Some valuable research has been done in the last thirty years on this relatively new educational technique, but much more carefully-controlled study is needed. Programmed instruction is not, nor will it ever be, a panacea capable of solving all the problems of education. It has come a long way since Pressey first described its use primarily as a testing device in 1926, and Skinner's boost in 1954 helped considerably, but programmed instruction has a long way to go before it reaches any degree of perfection. Even ardent proponents of programming admit it will never take over the full responsibility of teaching. The question is rather one of degree: How much of the teaching load can be more effectively presented by means of programmed instruction than by conventional methods of teaching? All programming can do is equal a good teacher working within an ideal learning situation. Dr. James Finn has remarked that "any teacher who can be replaced by a machine should be."[117] Programmed instruction will never replace teachers but it is capable of being a valuable educational aid.

Schramm believes very little of programming's vast potential is being realized today and sums up the current state of programmed instruction with three propositions.

> (1) Although the research gives us little reason to be satisfied with the theories and the standards of today's programing, and every reason to believe that it will be possible some day to make programs vastly more effective than today's programs, nevertheless programed instruction shows signs of hardening, partly under commercial pressure, into a fixed and mechanical technology, with theories and procedures taken for granted.
>
> (2) Although programed instruction has within it the potential to turn the attention of education and educational research more intensively and productively than ever before to the processes by which humans learn, there is very little sign that it is being used productively to test theories of human learning or theories of cognitive process, or to enlighten the teacher concerning the process by which she teaches.
>
> (3) Although programed instruction is essentially a revolutionary device, in that it has the potential to help free man from some of his bondage - the waste of human resources where there are no teachers or where people cannot go to school; the waste of time and talent where all students are locked into the same pace, and all teachers into the same routine; the tyranny of tradition which permits the study of a certain topic to begin only at a certain age, and

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[117] Resources Development Corporation, Programmed Learning, July, 1963, A Monthly Newsletter (East Lansing, Mich.: Resources Development Corporation, 1963), p. 1.

expects a student to accomplish only so much as a questionable test of his ability says he can do; and the inadequacy of outmoded and inadequate curricula - despite this, programed instruction is very slow to rise to such a revolutionary potential.[118]

The recent enthusiasm over the last decade has produced a feeling of optimism towards the future of programmed instruction. As one author has stated in regard to its potentialities:

> What might we legitimately expect of this new technique? We cannot expect that it will make learning painless. We shall never, science fiction not withstanding, be able to put our heads into a gadget that will instantaneously impart to us the wisdom of the ages or fluency in a new language. Learning is behavior, and behavior is work. Programmed instruction will not solve all the educational ills of our society. It will not singlehandedly win the ideological struggle against our enemies. They can use it too. Much more is involved here.
>
> If the student-tutor relationship is an effective teaching situation, then insofar as programmed instruction approximates that relationship, it, too, will be an effective teaching situation. If the best tutors program their knowledge into good programs, the educational gain could be tremendous. Imagine what it could mean to the student in the rural high school or small college to be able to learn in such a setting from the Einsteins, the Pasteurs, the Shakespeares, and even the Toscaninis of our civilization.[119]

Even in its infancy, programmed instruction has already been adopted by many educators to teach many more students. Aside from a few negative comments as to the

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[118] Wilbur Schramm, Programed Instruction Today and Tomorrow (New York: The Fund for the Advancement of Education, 1962), pp. 37-38.

[119] Edward J. Green, The Learning Process and Programmed Instruction (New York: Holt, Rinehart and Winston, Inc., 1962), pp. 212-213.

"mechanization" of education and potential unemployment of teachers, overall reaction to programming has been favorable. As techniques improve and research becomes more refined, the outlook seems to indicate more and varied uses of programming in the schools of tomorrow. Yet in light of even the limited research already completed, it seems safe to assume two major conclusions concerning programming.

1. Programmed instruction is an effective method of teaching--in most cases more effective than traditional instructional methods.

2. More experimentation is needed into different subject-matter areas where programming might enhance learning.

The experimental program presented in this thesis is an attempt to broaden the potential scope of programmed instruction. It is only a pioneer effort to try to develop a programmed unit concerned with television and radio training. The basic physics of radio broadcasting is only one small piece of the total broadcast education pie, but if programmed instruction proves successful in teaching this one segment, it is possible it would prove effective in other areas of broadcast training.

Suggestions for Further Research

One type of research which might be undertaken is to experiment with programmed instruction in other phases of broadcast education. In selecting the following areas of broadcast education as being potential for programmed instruction, the same criteria are used as for the experimental program on radio physics. These criteria are: (1) the subject matter be basically factual in nature; and (2) it be the type of material on which a more complete discussion of the topic is based. It is important to remember here that the author envisions programmed instruction as a supplemental aid to conventional teaching, not a replacement for it. In light of these criteria, the following areas of broadcast training might possibly lend themselves to programming.

1. A second unit could be developed on the physics of radio broadcasting. This section could build upon the experimental program presented here and possibly include the problems of frequency and power allocation in relation to wave propagation. A unit could also be written to cover the physics of television broadcasting.

2. Programming could possibly be employed in a broadcast regulations course to outline the structure and function of the governmental and self-regulating agencies concerned with overseeing radio and television in America.

3. A programmed unit could be developed for use in a radio production course. This unit could contain material dealing with the nature of sound, microphone characteristics, control board operation, etc.

4. A similar manual could be programed for use in teaching television production. Material included in such a unit might be areas such as lens characteristics, lighting and set requirements, and scanning.

5. Programming might be used beneficially in an international broadcasting course to help demonstrate comparisons between the different broadcast systems throughout the world.

6. Programmed instruction might be utilized where a specific vocabulary or "jargon" is necessary to classroom discussion. Examples of courses of this type would be broadcast advertising or broadcast programming.

7. One rather unique possibility for programmed instruction is in preparing a specially programmed pamphlet for incoming students in television and radio. This unit could present an overview of the whole field of broadcasting which might help put all its specific parts into perspective before the student begins to study the subject.

The above list of areas in broadcast training which might lend themselves to programmed instruction is by no means exhaustive. These are merely possibilities where programming might be employed on an experimental basis.

The experimental program presented in this thesis is of the linear type. A future research project might attempt to compare this program on the basic physics of radio broadcasting with a similar branching program on the same subject. The material included in the present program could be rewritten into a branching format and the relative effectiveness of each type of program could be measured.

This thesis is part one of a two phase project. The purpose of this part has been to survey the field of programmed instruction in order to determine if any relavance existed for broadcast education. An experimental program was developed and validated for one area of television and radio training and suggestions for the possible use of programming in several other areas were made. Although the experimental program was validated, research is now needed in actual classroom situations in order to determine the program's effectiveness in relation to conventional teaching methods. This comparative evaluation will be the function of part two of this project.

If programming should prove an effective teaching aid in broadcast education, perhaps much more advanced and creative work could be accomplished in the short space of a college education. Furthermore, if programmed instruction could undertake effectively a large share of the teaching responsibility, instructors would be able to devote more time and energy to individualized student attention--a problem which is becoming more acute as college enrollments increase.

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