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The influence of response mode on learning from a programmed text

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THE INFLUENCE OF RESPONSE MODE ON LEARNING FROM A PROGRAMMED TEXT

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TABLE OF CONTENTS

CHAPTER		PAGE
I.	THE PROBLEM AND DEFINITION OF TERMS	1
	The Problem	2
	Statement of the problem.	2
	Null hypothesis	3
	Importance of the study	4
	Response mode	4
	Setting for the study	7
	Objectives of the school.	8
	Definitions of Terms Used	9
	Program	9
	Frame	10
	Programmed learning	12
	Cooperative English Tests 2A and 2C	12
	Covert response	12
	English 2600.	13
	Programmed text	13
	School and College Aptitude Tests	13
	Speakers.	14
	Stockton College.	14
	Teaching machine.	14
	Writers	15
	Writing plan.	15

CHAPTER		PAGE
II.	REVIEW OF RELEVANT LITERATURE	17
III.	SOURCE OF DATA AND METHOD OF PROCEDURE.	28
	Population from Which the Sample Was Drawn. . .	28
	Selection of the Instructor	29
	Selection of the Class Time	29
	Selection of the Sample	29
	Method of Instruction	30
	Data Treatment Plan	31
IV.	PRESENTATION AND DISCUSSION OF THE DATA	33
	Characteristics of the Total Sample	34
	Means of Scores on Cooperative English, Form 2C, Post-test.	38
	Student Reactions to the Programmed Text. . . .	44
V.	CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY	48
	Summary	48
	Major Findings.	49
	Recommendations for Further Research.	50
BIBLIOGRAPHY.		53
APPENDIXES.		59

LIST OF TABLES

TABLE		PAGE
I.	Means of Scores on the Cooperative English Tests, Form 2A (Pre-test) and School and College Aptitude Tests by Response Modes, Total Sample	35
II.	Means of the Scores on the Cooperative English Test, Form 2A and the School and College Aptitude Tests Achieved by Those Who Completed the Study.	37
III.	Means of the Scores on the Cooperative English Tests, Form 2C, and the School and College Aptitude Tests	39
IV.	Means of Scores on the Cooperative English Tests, Forms 2A and 2C	40
V.	Mean Scores of All Sections Cooperative English Tests, Form 2C	41
VI.	Means of English 2600 Tests.	42
VII.	English 2600 Final Test Scores For All Sections	43
VIII.	Drop-outs, All Classes, English 73	44

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Since 1958, when B. F. Skinner published a report to the Fund for the Advancement of Education titled, "Teaching Machines," programmed learning has taken an increasingly important place in American Education.[1] Earlier, in 1926, Sidney F. Pressey had published a paper titled, "A Simple Apparatus Which Gives Tests and Scores - Teaches," but the "industrial revolution in teaching" he later envisioned did not come about.[2,3] What did come about was a split between the experimental psychologists in the laboratory and the educators in the classroom. Their work was reported in different journals with very little overlap.[4] Most

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[1] B. F. Skinner, "Teaching Machines," Teaching Machines and Programmed Learning, Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C.: National Education Association, 1960), pp. 137-158.

[2] Sidney F. Pressey, "A Simple Apparatus Which Gives Tests and Scores," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C.: National Education Association, 1960), pp. 35-41.

[3] Sidney F. Pressey, "A Third and Fourth Contribution to the Coming 'Industrial Revolution' in Education," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C.: National Education Association, 1960), pp. 47-51.

[4] A. W. Melton, "The Science of Learning and the Technology of Educational Methods," Harvard Educational Review, 96-106, Spring, 1959.

laboratory experiments were concerned with developing a compatible theory of learning; most classroom demonstrations were concerned with the use of programmed learning to augment or supplant other teaching aids.

There had been very little research which has attempted to combine the laboratory approach to learning in a classroom setting to test a segment of a learning theory and to compare the effects of the use of programmed learning, with conventional teaching methodology, at the time this study was conducted.

I. THE PROBLEM

Statement of the problem. The purpose of this study was (1) to compare the test scores of sub-groups within the experimental group who responded to the frames in the programmed text, English 2600, by writing, speaking or thinking; (2) to compare the scores of the experimental group with those of the population from which the sample was drawn on the final test from the English 2600 text; and (3) to compare the scores of the experimental group with those of the population from which the sample was drawn on the Cooperative English Test Form 2c. Approximately two weeks prior to the end of the experiment, permission was given by the administration of Stockton College to administer the final test of the English 2600 programmed text to the

population. The instructors appeared to cooperate because they wished to compare the programmed method to their own instructional method.

The following hypotheses were made:

H-1 The sub-group responding by writing will score higher on the English 2600 achievement tests, and on the Cooperative English Test Form 2c then will the subjects who respond by speaking and thinking (responding covertly), respectively.

H-2 The sub-group responding by speaking will score higher on the English 2600 achievement tests, and on the Cooperative English Test, Form 2C, then will the sub-group responding by thinking.

H-3 The mean of the Cooperative English Test, Form 2C, Total Score, achieved by the experimental group will be higher than the mean of the Cooperative English Test, Form 2-C, Total Score, achieved by the population from which the experimental group was drawn.

Null hypothesis. The study was conducted to test the null hypothesis that there was no difference in efficiency between the response modes, and that there was no difference in efficiency between the experimental class and the classes as taught by the conventional method. A level of significance

greater than .025 was accepted as a rejection of the null hypothesis.

Importance of the study. This study was important because it dealt with different theoretical positions on the efficiency of different forms of responses, was conducted in a school setting, and was directed toward specific needs and goals of the junior college in which it was conducted.

Response mode. The way in which a student responds to a frame and its effect on retention is a matter of controversy. Goldbeck and Briggs, in discussing the form of response, stated:

> It is quite likely, however, that we will find, in many cases, there is no basis for believing that a fixed combination of variables is universally optimum. Consider as an example the form of response required. The response may assume a wide variety of forms. It may be written, spoken, thought, constructed, selected, etc.[5]

Glaser, Homme and Evans write,

> The results produced by utilizing different kinds of responses in a learning sequence e.g. spoken, written, or implicit responses, are a matter of study.[6]

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[5] R. A. Goldbeck and L. J. Briggs, "Analysis of Response Mode and Feedback Factors in Automated Instruction," Technical Report No. 2, Office of Naval Research Contract No. Nonr-3077 (00). (Pittsburg, Penna. : American Institute for Research, 1960.) p. 36.

[6] Robert Glaser, Lloyd E. Homme, and J. L. Evans, "An Evaluation of Textbooks in Terms of Learning Principles," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C. : National Education Association, 1960.) p. 445.

Pressey's first "teaching machine" required the student to select from multiple choice answers. The form of the response was reading, or implicit. Skinner stated that the machine did teach, but it was not designed primarily for that purpose. He disagreed with the multiple choice feature and stated, "The student must compose his response, rather than choose from a set of alternatives."[7] All Skinnerian type programs make provision for the student to construct or write his responses.

Schramm disagreed with the Skinnerian programmers and stated:

> There is very little evidence to prove that the constructed response, which is an important part of Skinner's theory, is in most cases, any better than a selected response, or no measureable response at all.[8]

Crowder has deliberately structured his theory of teaching by auto-instructional devices around the implicit or reading response. His Tutortext or "scrambled book" makes use of the reading response and multiple choice questions to direct the learner to different sequences within the book, depending upon the level of sophistication demonstrated by

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[7] B. F. Skinner, "Teaching Machines," Teaching Machines and Programmed Learning, Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. D.: National Education Association, 1960), pp. 140.

[8] Wilbur Schramm, Programmed Instruction Today and Tomorrow, (New York: Fund for the Advancement of Education, 1962), p. 12.

the choice of answer.[9]

Lumsdaine, in discussing differences in theory between Skinner and Crowder writes:

> a second difference is the fact that the Crowder programs use longer frames (more verbal expository material for each question to which the student responds); this also means that more of the learning from the program is left up to mediation by implicit rather than overt response.[10]

Goldbeck and Campbell experimented with the inter-dependency of cueing and prompting, and response mode. They stated:

> For highly cued or prompted responses, there is little chance of an error of response occuring. In fact, the overt response may be performed in quite a perfunctory manner, with little or no 'active' responding other than the motor response of writing. Such responses may be considered copied responses rather than constructed responses and may produce an 'illusion of learning.'[11]

Evans, Glaser and Homme concluded, as a result of a learning sequence on the fundamentals of music in which some of the subjects were required to write the response and others were instructed not to make an overt written response:

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[9]Norman A. Crowder, "Automatic Tutoring by Intrinsic Programming," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C.: National Education Association, 1960), p. 286.

[10]A. A. Lumsdaine, "The Development of Teaching Machines and Programmed Self-Instruction," New Teaching Aids for the American Classroom (Stanford University, Calif., The Institute for Communication Research, 1960), p. 136.

[11]Robert A. Goldbeck and Vincent N. Campbell, "The Effects of Response Mode and Response Difficulty on Programmed Learning," Journal of Educational Psychology, 53:111, 1962.

> The analyses summarized in table 1 indicate that members of the Group N (who did not write their answers) did better, but not significantly so, on the performance test. Group N also took less time to complete the sequence. This finding seems to demand some re-examination of procedures which require overt written responses on the part of subjects, as is typically the case in teaching machine work.[12]

A. A. Lumsdaine, editor of Teaching Machines and Programmed Learning, added another dimension, that of the danger of design freeze. He stated, in the chapter entitled "Concluding Remarks":

> The need for flexibility and growth is an obvious one in any infant endeavor. It is important to avoid any tendency to 'freeze' either the design of teaching machines or the methodology of program construction. Innovations in methods of programming and the results of experimentation will lead to the need for revisions in current designs and program formats. For example, experimentation with various forms of branching, response mode, (italics added) cueing and feed-back to the learner may lead to new requirements for device capabilities.[13]

Setting for the study. Laboratory experiments with highly controlled variables are a necessary component of the development of any new device. However, if the device is to be recommended for general use in the classroom it follows

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[12] S. L. Evans, Robert Glaser and Lloyd E. Homme, "A Preliminary Investigation of Variation in the Properties of Verbal Learning Sequences of the 'Teaching Machine' Type," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960.) p. 449.

[13] A. A. Lumsdaine, Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser, (Washington, D.C.: National Education Association, 1960), p. 565.

that it must be tested in the classroom because of variables operating in that setting which are largely uncontrolled. Blyth puts it this way:

> But not all of the important questions can be stated in terms suitable for a tidy little laboratory research project. If we look only for problems which can be so formulated, certain of the most important issues may be ignored. Furthermore, some attempts to use the teaching machine in regular courses will be helpful in determining some of the research problems likely to prove most valuable.[14]

Objectives of Stockton College. Stockton College had the problem shared by most institutions of higher learning -- a rising number of students and a more slowly rising number of qualified teachers. Foltz phrased it differently, saying, "The major problem is too little time to teach so much to so many with so few qualified teachers."[15] He suggested that the teaching machine, in whatever form, might provide a way of extending the services of teachers.

Students who did not pass the entrance examination for the college transfer course English 1A provided a major staffing problem for Stockton College. It was from these students that the sample was drawn. Most English instructors

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[14]John W. Blyth, "Teaching Machines and Human Beings," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association), p. 403.

[15]Charles I. Foltz, The World of Teaching Machines. (Washington, D.C.: Electronic Teaching Laboratories, 1961), p. 56.

felt extensive student failure was an indication that the high schools were not preparing the students properly, and they resented having to prepare the students for the English 1A entrance examination.

The Stockton College administration felt that the study was worth-while in that, if successful, students could be placed in larger classes with the emphasis on programmed learning, or might possibly be able to prepare themselves for the entrance examination on their own outside of class hours, with a minimum of instructor time. These objectives are not antithetical to the shared feeling that research is an accepted responsibility of the college.

This study was important in that it attempted to verify an approach to programmed learning, the Skinnerian constructed response, was conducted in a school setting by a teacher, and was directed toward specific needs and goals of the college in which it was conducted.

II. DEFINITION OF TERMS USED

Program. A program is a sequential series of instructional units planned to meet a specific educational outcome. There are several different kinds of programs but each has, essentially, the following characteristics: (1) A relatively small unit of information is presented at a time. (2) The student is asked to complete a statement or answer a question.

(3) He is given immediate knowledge of the result of his response. (4) Each bit of information builds on the one preceding it. (5) The student works at his own pace and interacts directly with the program without the aid of a teacher. (6) The program may be presented by a "teaching machine" computer or book.

Frame. A frame is the unit of instruction of which a program is composed. In the Skinnerian program, the frame is very small, usually requiring only one response. An example is:

> Here is a complete sentence of only two words:
>
> Birds fly.
>
> We know what this sentence is about. It is not about dogs. or horses. It is about_____.[16]

The student responds and checks his response against the next frame. The next frame builds on the subject in the same manner and requires the student to go to the following frames until the unit is complete. Programs made up of frames of this type in which each student goes through the same sequence are called linear programs.

The multiple-choice frame is usually much larger and contains much more information. The student's response is

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[16] Joseph C. Blumenthal, English 2600. (New York: Harcourt, Brace and World, Inc. 1960) p. 3.

used to guide him to different pages in the program according to the degree of sophistication indicated by his choice of response. The following was prepared by Deterline to illustrate the technique.

> Scores on a test are usually referred to as "raw" scores and each raw score is simply the number of correct answers. A raw score of 34 means that a certain student answered 34 questions correctly. A percentage score is slightly different, since a raw score of 34 could mean 100%, or 50%, or any percentage between 1 and 100. If there were only 34 items on the test, a raw score of 34 would be 100% correct, and if there were 68 items on the test, a raw score of 34 would be 50% correct. A percentage is easily calculated by dividing the raw score by the total number of items on the test. If a raw score of 15 is 25% correct, how many questions were there on the test? 60, of course. If there were 30 items on the test, and the highest score is 27 items correct, and the lowest raw score is 15, the highest raw score is what percentage correct?
>
> | If your answer is: | Turn to: |
> |---|---|
> | 27% | page 2, top half of page |
> | 81% | page 7, bottom half of page |
> | 90% | page 11, bottom half of page[17] |

In this example, if the student selected 27%, he was informed on page 2 that his answer was not correct. He was reinstructed and told to go back to page 1 and work out the answer. If he selected 81% he was told on page 7 his response was incorrect and given a possible explanation for his error. Again he was told to go back to page 1. If he chose 90%, he was told on page 11 that his response was correct. The

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[17] William A. Deterline, An Introduction to Programmed Instruction. (Englewood Cliffs, N. J.: Prentice-Hall, Inc. 1962), p. appendix 1.

formula was re-stated and the concept of range was introduced. Another multi-choice question followed.

Programs made up of frames of this kind are called branching programs. If the program is presented in book form it is called a scrambled book. The term scrambled is used to illustrate the fact that the pages are not read in numerical sequence.

Programmed learning is learning from a program. It is also called continuous discourse in that the student carries on a dialog with the program in the manner of the Socratic tutorial method.

Cooperative English Tests 2A and 2C. Cooperative English Tests 2A and 2C are alternate forms of a group test that yields scores in Expression, Vocabulary, and Total Score. These gross scores are composed of sub-scores in Expression, Vocabulary, Level of Comprehension, and Speed of Comprehension. The tests are published by the Cooperative Test Division of the Educational Testing Service, Princeton, New Jersey.

Covert response. A covert response is one in which there is no obserable overt behavior. It is often used synonymously with "implicit" and "reading" responses. It could be argued that reading is an overt response, but the verifying information would have to come from an overt

response such as speaking or writing the response. In this study, the thinking response is synonymous with covert response.

English 2600. This text was written by Joseph C. Blumenthal and was published in 1960 by Harcourt, Brace and World, Inc. It is a programmed text and gets its name from the fact that it contains 2600 frames. It was the experimental text used in this study.

Programmed text. A programmed text is a textbook consisting entirely of programmed educational objectives. In the case of the linear text, the frames are in panels and each panel goes on to the next page, so that the student does not read a complete page at a time. The panels are usually shaded so that the student may easily follow the sequence of the frames. In a branching text or a scrambled book the student is directed to different pages in the book according to his choice on the multiple choice question. The pages are not in sequence in order that the students who learn more rapidly may skip the instructional units not needed. (See page 11 for example.)

School and College Aptitude Tests. This is a group intelligence test administered routinely to entering Stockton College students. It yields Verbal, Quantitative and Total

I.Q. Scores. It is published by the Cooperative Test Division, Educational Testing Service, Princeton, N. J., hereafter referred to as S.C.A.T.

Speakers. Speakers were the members of the experimental group who were instructed to speak the responses to the frames in the English 2600 text.

Stockton College. Stockton College was a junior college located in Stockton, California, in which this study was conducted. It is now called San Joaquin Delta College. It serves an extended district but the scope of the instruction remains essentially unchanged.

Teaching Machine. The term "teaching machine" is misleading in that the machine does not teach but rather provides a mechanical means of presenting a program. It takes many forms from simple cardboard slide devices to electronic computers, characteristics, as described by Lumsdaine.

> .....they present the individual student with programs of questions and answers, problems to be solved, or exercises to be performed. In addition, however, they always provide some type of automatic feedback or correction to the student so that he is immediately informed of his progress at each step and given a basis for correcting his errors. They thus differ from films, TV, and most other audio visual media as ordinarily utilized because of three important qualities:
>
> First, continuous active student response is required, providing explicit practice and testing of each step of

what is to be learned.

> Second, a basis is provided for informing the student with minimal delay whether each response he makes is correct, leading him directly or indirectly to correction of his errors.
>
> Third, the student proceeds on an individual basis at his own rate--faster students romping through an instructional sequence very rapidly, slower students being tutored as slowly as necessary, with infinite patience to meet their special needs.[18]

The concept of what is and is not a teaching machine is somewhat confusing to the person who meets it for the first time. Porter has devised an excellent classification system which has been published in tabular form. It was first printed in the Educational Review, Vol. 27, No. 2, 1957. It has been reprinted, with minor editorial changes in Teaching Machines and Programmed Learning, pages 116-117. An alphabetical listing of types of devices indexed to the references contained in the original article was deleted.

Writers. The writers in this study were the members of the experimental group who were instructed to write the response to the frames in the text, English 2600.

Writing plan. This chapter has dealt with the problem and justification for the problem. Relevant literature is

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[18] A. A. Lumsdaine, "Teaching Machines: An Introductory Overview," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960) pp. 5-6.

reviewed in Chapter II. Chapter III discusses the design and how the experiment was carried out. The data are presented in Chapter IV. Chapter V contains conclusions from this study and recommendations for further study.

CHAPTER II

REVIEW OF RELEVANT LITERATURE

Programmed instruction is a relatively new field which makes a search of relevant literature both rewarding and frustrating. It is rewarding in that many of the studies which are available have been collected in such excellent works as Teaching Machines and Programmed Learning, edited by A. A. Lumsdaine and Robert Glaser, and published in 1960 by The National Education Association. It is frustrating in that much research is being done or has been done by the Armed Forces, or by contractors for the Armed Forces, and is of limited circulation. There are hints and rumors that other significant experiments have been conducted by commercial agencies who have expected to profit by the sale of machines to classrooms of the future. Homme stated:

> .....I will go so far as to predict that classrooms of the future, their walls lined with exotic machines, will resemble nothing so much as the emporiums of Las Vegas. I am even willing to bet that the players will be equally intense in their pursuit of reinforcement.[1]

The Editors of Teaching Machines and Programmed Learning, (hereinafter referred to as "T.M.P.L."), have made an excellent contribution to the solution of the problem by

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[1]Lloyd E. Homme, "The Rationale of Teaching by Skinner's Machines," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), p. 403.

providing an annotated bibliography of papers of limited circulation, together with a code describing the availibility of original papers or reprints. T.M.P.L. contains many of the original papers, which have been brought up to date by the authors, particularly those of Pressey and Skinner. Where changes have been made the nature and extent of the changes have been noted. Original articles have been prepared especially for inclusion in T.M.P.L.

There is very little literature directly relevant to the problem discussed in this paper and few that are peripherally informative, which attests to the relevancy of the problem. Therefore, this review of the literature has not attempted to review the total field, but rather has attempted to discuss only those studies illustrating the etiology of the problem, and some of the conclusions from those studies.

In the early 1920's, Sidney L. Pressey, of Ohio State University, became concerned with the amount of time spent by teachers in the administration and scoring of objective tests. He reasoned that much more of their time could be spent in preparation for their classes if they could be relieved of these more or less routine tasks by some mechanical means of test administration and scoring. By 1924 he and his students had developed a machine which would give and score tests. In December of that year, he exhibited the machine at the American Psychological Association meeting in Washington,

D. C. and delivered a paper on its use as a test giving and scoring device.[2]

By 1927, experiments in the laboratory and the classroom had convinced Pressey the machine could also teach--particularly informational and drill material. The testing machine, with slight adjustments, could be made to retain the material only when the response was incorrect, and advance the material when the correct response was made. It gave the student immediate knowledge of the result of his response and kept the question in front of him until he made the correct response. It also provided drill by permitting the student to run through the material as many times as he wished. Pressey explained the machine's relationship to learning theory by stating:

> The somewhat astounding way in which the functioning of the apparatus seems to fit in with the so-called "laws of learning" deserves mention in this connection. The "law of recency" operates to establish the correct answer in the mind of the subject, since it is always the last answer which is the right one. The "law of frequency" also cooperates; by chance, the right response tends to be made most often, since it is the only response by which the subject can go on to the next question. Further, with the addition of a simple attachment, the apparatus will present the subject with a piece of candy or other reward upon his making any given score for which the experimenter may have set the device; that is the "law of effect" can also be

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[2]Sidney F. Pressey, "A Simple Apparatus Which Gives Tests and Scores," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), pp. 35-41.

made, automatically, to aid in the establishing of the right answer.[3]

This machine is considered to be the ancestor of all teaching machines. It was cumbersome and bulky, and often had mechanical problems. No manufacturer felt it was of sufficient merit to invest the time and money necessary to improve it technically, and to produce it in quantities large enough to get the cost down.

H. J. Peterson, a student of Pressey's, later developed a chemical marking pen which reacted with a spot beside the multiple choice question. If the answer was correct, the spot turned to a predetermined color, if incorrect, it turned another color.[4] In this manner the basic functions of Pressey's machines were duplicated without the mechanical problems. Following the chemical pen, Peterson developed a method of sandwiching an answer sheet between two pieces of heavy cardboard upon which holes had been punched according to a key. If the response was correct, the pencil perforated the answer sheet, if incorrect, it marked the sheet and

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[3] Ibid., p. 37.

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

provided an error for item analysis and grading.[5]

These, and other variations of the self-instruction devices, were not widely accepted in the two decades that followed Pressey's first paper in 1924. Lumsdaine suggested that:

> This may be partly because the times were not ripe for their acceptance and partly because they were conceived primarily as testing devices and only secondarily as teaching devices. Also, it may have been due in part to some of their inherent limitations. One of these limitations is that, as multiple choice devices, they appeared to be limited to recognition responding, rather than permitting the student to construct his own response.[6]

Skinner stated "Pressey's Machines succumbed to cultural inertia; the world of Education was simply not ready for them."[7]

The importance of these studies to the present study is that they established the patterns of multiple choice and reading the response. B. F. Skinner believed that the

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[5]George W. Angell and Maurice E. Troyer, "A New Self-Scoring Test Device for Improving Instruction," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), pp. 66-68.

[6]A. A. Lumsdaine, "Teaching Machines: An Introductory Overview," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), pp. 9-10.

[7]B. F. Skinner, "Teaching Machines," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), p. 139.

multiple choice answer and the reading response allowed for too much error in the learning process. He felt that the learning sequences should be carefully broken down into small items in which the chance of error was minimized in order that the student be reinforced by getting the right answer. He felt that the candy reinforcement suggested by Pressey was unnecessary for humans. The mere fact of making the correct response was reinforcement enough.

Skinner's learning theory came out of the laboratory where he had rather remarkable success in teaching complex series of behavioral patterns to pigeons. They were taught intricate dances and even a modified form of basketball by a method called operant conditioning and successive approximation. By reinforcing a pigeon with a food pellet each time he turned to the left, for example, the pigeon began to associate left turning with the reinforcement of the food pellet. By making the pigeon turn a little farther before receiving the reward, it was possible to teach him to turn around in circles. Once the pattern of associating the reward with behavior was established, the pigeons could then be conditioned to execute many complex maneuvers.[8]

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[8] James G. Holland, "Teaching Machines: An Application of Principles from the Laboratory," Teaching Machines and Programmed Learning. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D. C.: National Education Association, 1960), pp. 219-220.

Skinner's machines did teach, and the learning theory behind them had come out of demonstrated laboratory experiments. It is true that much of the work had been done with infra-human species, but Skinner, reviewing a series of experiments with both animal and human subjects, concluded:

> In all this work, the species of the organism has made surprisingly little difference. It is true that the organisms studied have all been vertebrates, but they still cover a wide range. Comparable results have been obtained with pigeons, rats, dogs, monkeys, human children, and most recently--by the author in collaboration with Ogden R. Lindsley--with human psychotic subjects. In spite of the great phylogenetic differences, all these organisms show amazingly similar properties of the learning process. It should be emphasized that this has been achieved by analyzing the effects of reinforcement and by designing techniques which manipulate reinforcement with considerable precision. Only in this way can the behavior of the individual be brought under such precise control. It is also important to note that through a gradual advance to complex interrelations among responses, the same degree of rigor is being extended to behavior which would usually be assigned to such fields as perception, thinking, and personality dynamics.[9]

It must be emphasized that central to Skinner's theory of operant conditioning through successive approximation, was the assumption that behavior must be reinforced <u>after</u> it was evoked. For that reason, Skinner felt that the student must <u>compose</u> or write the response, and the reinforcement must come immediately after the response in order that the

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[9] B. F. Skinner, "The Science of Learning and the Art of Teaching," <u>Teaching Machines and Programmed Learning</u>. Edited by A. A. Lumsdaine and Robert Glaser. (Washington, D.C.: National Education Association, 1960), pp. 99-113.

reinforcement become associated with the response.

He objected to the multiple choice frame because he felt that too much information was to be assimilated; the selection of an incorrect response could reinforce the incorrect response, and reading the response did not require the student to compose the response.

Skinner's 'teaching machine' used large paper discs on which frames were printed, with blanks to fill in the response. When the student responded in the blank, he moved a lever which advanced the disc and exposed the correct response along with the next frame. The student checked his response and continued until the disc was completed. By installing a time delay on the advancing mechanism, Skinner could vary the schedule of response in addition to the amount of information contained in each frame. Through laboratory tests using, for the most part, Harvard and Radcliffe students, he developed his method of programmed instruction.

In the spring of 1958, 187 students from Harvard and Radcliffe were subjects in an experiment in which Skinnerian teaching machines were used as adjuncts to the regular program of lecture and outside reading. The experiment was concerned with the practical problems of design and use of the machine, and the testing and revision of sample programs. The studies were financed by a grant from the Fund for the Advancement of Education. The results, as evaluated from

student questionnaires and analyses of responses to the programs, confirmed for Skinner et. al. their estimates of the efficiency and desirability of programmed learning and in particular, the written response mode. They also brought about renewed interest in programmed learning and were, in large measure, responsible for the great expansion in programmed learning research.

In some ways, Skinner's research resembled what O'Dell called the "snaggle-toothed experiment,"[10] in which the experimenter becomes concerned with only the teeth that meet, but the snaggle teeth have much more effect on the bite. In these experiments no attempt was made to use the verbal or sub-vocal responses as controls. In fact, those who read the program before it was inserted in the machine were considered to be cheating. The effect of the programs could not be isolated because they were only a part of the total instructional package. In addition, much of the evaluation was based on student responses to questionnaires and subject to the usual self-report bias.

The relevancy of the work by Skinner to this study is that it was solidly based on an accepted theory of learning (operant conditioning,) emphasized the constructed or written

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[10]William O'Dell, remarks made in a lecture at a seminar on programmed learning, San Francisco State College, Summer, 1961.

response and the linear program.

The form of the response, written or read, became a matter of controversy between the advocates of the Skinnerian linear program and the Crowder branching program. Others became interested in the range of possible responses and their effect upon retention. The subjects could write, speak, read, or "think" (compose the response sub-vocally) before going on to the next frame.

Goldbeck and Campbell performed two separate experiments using 63 seventh grade students in one and 62 eighth grade students in the other. The seventh grade students were divided into six cells of nine each. They were randomly assigned to three levels of difficulty and three response modes, reading, overt (written,) and covert (think). The study tended to show that requiring overt responses for material for which constructing a response was comparatively easy resulted in significantly poorer learning. As the constructed response became more difficult, the overt response improved significantly. When the efficiency of learning was obtained by dividing the test score by the learning time score, the reading response proved most efficient, at the .01 level. The overt response was least efficient and the covert response fell in between.[11]

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[11] Robert A. Goldbeck and Vincent N. Campbell, "The Effects of Response Mode and Response Difficulty on Programmed Learning," Journal of Educational Psychology, 53:3, 1962 - pp. 110-118.

The second experiment with the eighth grade students paralleled the first with the addition of a fourth response mode in which the subjects were given the option of not responding if they did not feel confident of the accuracy of their response. The programs consisted of 35 and 32 frames, respectively.

In discussing the two experiments the authors commented:

> In nearly every comparison on the amount learned measure, the performance of the overt response group failed to exceed that of the reading groups. When learning responses were at the easiest level for factual material the inferiority of the overt response mode was most marked.[12]

They also stated:

> The further question of whether this mode of auto-instructional can maintain its high level of efficiency over long periods of time needs further clarification.[13]

Goldbeck and Campbell anticipated the criticism which this investigator feels is the most important; the small number of frames in each program. While the data treatment was statistically respectable and the generalizations valid within their context, the small number of frames in those experiments had much to do with the implementation of the present experiment. It was felt that there was sufficient doubt as to the relative efficiency of response modes that this experiment, containing 2600 frames, was justified.

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[12] Ibid., p. 116.

[13] Ibid.

CHAPTER III

SOURCE OF DATA AND METHOD OF PROCEDURE

Population from which the sample was drawn. Each entering student at Stockton College was required to take group aptitude tests and English placement tests. The tests used at the time of this study were the School and College Aptitude Tests and the Cooperative English Tests, form 2A. The School and College Aptitude Test yielded Verbal, Quantitative and Total Scores which were used to help the student plan his total program. There was no cut-off score. The Cooperative English Test yielded Expression, Reading and Total Scores; a combination of Expression and Reading.

The Cooperative English Test Total Score was used as a screen for English placement. Students scoring below 157 were required to take English Laboratory 73, described in the Stockton College catalog as a preparatory course for those who planned to take English 1A or other transfer English courses. Units earned in English 73 were not transferable toward the Bachelor of Arts degree but were accepted toward the Associate of Arts degree. The subjects in this study were students who had scored below 157 on the Cooperative English Test, form 2A. The data were taken from each subject's IBM card.

Selection of the Instructor. The Chairman of the Department of Communication discussed the experiment with his staff and asked for volunteers. Three instructors volunteered and their names were placed in a hat. The instructor's name was drawn by the experimenter.

Selection of the class time. Nine sections of English 73 were held during the experimental period with classes beginning every hour from 8:00 a.m. until 2:00 p.m. The experimental class was held from 10:00 to 10:50 a.m. Monday, Wednesday and Friday. The class time was decided by a flip of a coin since the instructor also taught a class from 9:00 to 9:50 a.m.

Selection of the sample. Neither the students nor the counselors who helped the students plan their programs knew that the experimental class would be conducted any differently from the other classes. They were not aware that the class would be larger than the others since a running tally of the registered students was not posted. When the class was full it was closed. The class was planned for 45 students but 46 actually were registered.

The students were ordered on the basis of their Total Score on the Cooperative English Test, form 2A, the pre-test, and divided into three groups. Numbers 1, 4, 7, 10, etc. formed the first group. The second and third groups were

selected by the same process, beginning with the second and third names on the list. See appendix A for a table of the ordered scores.

The response modes "write", "speak" and "think" were written on separate slips of paper and placed in a hat. "Think" was drawn first and assigned to group 1. "Write" was drawn second and assigned to group 2. The remaining group was assigned the "speak" response.

Method of instruction. The classroom was arranged with three rows of tables. The subjects were all seated facing the front of the room. The Speakers were placed in the first row, Writers in the second and the Thinkers in the third in an attempt to minimize the distraction between groups. The programmed texts, English 2600, were kept in a locked bookcase. Each subject picked up his copy at the beginning of the class and returned it to the case at the end of the class period. No books were permitted to be taken out of the classroom.

The experiment was explained to the students and they were given the option of withdrawing from the class. None chose to withdraw, but two students wanted to transfer from the speaking response to the written. This was not permitted and, after an explanation of the danger of introducing bias to the sample, both agreed to continue in the assigned group.

The experimenter stayed with the class during the first period in order to answer questions and see that the subjects were responding as assigned. After the first period the experimenter did not attend class sessions for fear of introducing experimenter bias.

The students were permitted to proceed at their own rate. The instructor was available for help during class time at the student's request. Each student took the English 2600 tests whenever he wished. After each test the instructor went over the test with him and suggested review if it appeared warranted. The student was permitted to go back over the lesson but he was not given a second test on the same material. There were eleven lesson tests, a mid-term and final, which covered the whole text. After the student had completed the text he took the Cooperative English Test, 20, the post-test, at his option. The post-test was administered by the experimenter.

Data treatment plan. Since this experiment was concerned with the achievement of groups, the means of the groups' scores were compared by using the "t" test for significance. In some instances the means were so close as to make formal testing unnecessary. Differences in means at the .025 level of confidence were accepted as a rejection of the null hypothesis.

The means of the scores on the Cooperative English Tests, form 20, and the English 2600 tests were compared to test the hypotheses. The percentage of dropouts for each section of English 73 was compared between sections and with the total number for the semester. Comparisons were made between the S.C.A.T. and Cooperative English Tests as measures of the similarity of the groups.

One of the useful contributions of a study in a practicum field would seem to be the determination of what research design adaptations and what statistical tests do serve and which do not serve. Exploratory use was made of statistical tests as confirmatory measures to elicit possible hypotheses for later studies. Techniques explored included standard correlation procedures and certain non-parametric ones. Correlations between the School and College Aptitude Tests Verbal scores and the Cooperative English Test scores tended to be in the high sixties and seventies because both tests involved reading comprehension and contained similar vocabulary items. Correlations between School and College Aptitude Verbal test scores and gains or losses on the Cooperative English Test form 2C post-test scores tended to run in the low twenties and thirties. Non-parametric tests included the Wilcoxon Matched-Pairs Signed Ranks test and the Mann-Whitney U test. These were no more productive and seemed, from certain basic assumptions in each, to be less appropriate than Fisher's "t" test, and so the latter was used.

CHAPTER IV

PRESENTATION AND DISCUSSION OF THE DATA

This study was designed to compare groups of remedial English students who were instructed by a programmed text, with each other and with the population from which the sample was drawn. The means of their scores on the Cooperative English Tests, forms 2A and 2C, English 2600 achievement tests, and the School and College Aptitude Tests were the measurements used for comparison. Differences between the means of these scores were accepted as evidence of dissimilarities between the groupd when these differences were at the .025 level of significance. The .025 level of significance was selected as being relatively rigorous and also appropriate to this kind of sample size and distribution. The "t" test with "Student's" distribution.were selected as determining significance.

With an infinitely large sample a "t" of 1.96 is required for the .025 level of significance, using a one-tailed test. In this study the smallest number of degrees of freedom in any test of means was 17, which required a "t" of 2.11 to be significant at the .025 level. The largest number of degrees of freedom was 44, which required a "t" of 1.96. In this study all "t" values had to be greater than 1.96 to be significant.

Characteristics of the total sample. The method of selecting the sample from the population and ordering subgroups provided groups that were fairly unbiased. An examination of Table I, page 35, shows that there were no significant differences between the means. The reading scores of the Writers and Thinkers provided the greatest difference. A comparison of those means by the "t" test yielded a "t" of 1.9, with 28 df, which was not significant.

Tests were not run between the reading scores of the Thinkers and Speakers and the reading test scores of the Speakers and Writers, because even the greater differences between the scores of the Writers and Thinkers did not prove significant.

Tests were not run on the means of the Writers' Total and Speakers' Total since they were identical and would provide a numerator of zero in the formula for the "t" test. Tests also were not run between the Expression scores, since the differences of one and two points were obviously too small to show significance.

The difference between the means of the Writers and the Thinkers on the S.C.A.T. Quantitative Test appeared to be quite large, but comparison yielded a "t" of 1.54, which was not significant.

Those who dropped out of the study did not introduce serious bias in the composition of the groups that completed

TABLE I

MEANS OF SCORES ON THE COOPERATIVE ENGLISH TESTS, FORM 2A (PRE-TEST) AND SCHOOL AND COLLEGE APTITUDE TESTS

BY RESPONSE MODES
(TOTAL SAMPLE)

	COOPERATIVE ENGLISH, FORM 2A						
Response mode	N	Total	S.D.	Expression	S.D.	Reading	S.D.
Writers	14	146	5.9	146	7	145	7.7
Speakers	15	146	7.1	145	8	147	8
Thinkers	16	149	6.1	147	7.2	150	6.8

	SCHOOL AND COLLEGE APTITUDE TESTS				
Response mode	N	Verbal	S.D.	Quantitative	S.D.
Writers	14	281	12.1	283	20
Speakers	15	281	13	290	16.4
Thinkers	16	281	12.1	292	13

the study. Comparisons of the means of scores on the pre-test, Cooperative English, Form 2A, and of the S.C.A.T. tests indicated there were no significant differences. Table II, page 37, shows that the largest differential in the Cooperative English, Form 2A, tests was in Reading, between the Writers and Speakers, as it was in the group that began the study. However, the four-point differential provided a "t" of 1.36, with 17 df, which was not significant. The Speakers did have a greater difference within the group as indicated by the larger standard of deviation, 8.2 against 3.4 for the Writers.

Comparison of the S.C.A.T. verbal means of the Writers and Thinkers yielded a "t" of .85, with 20 df. The 20 point differential in the S.C.A.T. quantitative scores between the Writers and the Speakers appeared quite large, but comparison yielded a "t" of 1.65 which was not significant.

The groups which completed the study closely resembled the groups that began in those characteristics measured by the School and College Aptitude tests, as shown by these comparisons:

	S.C.A.T. V				S.C.A.T. Q				
Response	N	Began	N	Finished	dif	N	Began	N	Finished	dif
Writers	14	281	8	280	-1	14	283	8	275	-8
Speakers	14	281	11	282	+1	14	290	10	295	-5
Thinkers	16	281	11	277	-4	16	292	11	288	-4

TABLE II

MEANS OF THE SCORES ON THE COOPERATIVE ENGLISH TEST, FORM 2A, AND THE SCHOOL AND COLLEGE APTITUDE TESTS ACHIEVED BY THOSE WHO COMPLETED THE STUDY

		COOPERATIVE ENGLISH, FORM 2A					
Response mode	N	Total	S.D.	Expression	S.D.	Reading	S.D.
Writers	8	146	3.6	147	7.1	144	6.1
Speakers	11	145	7	144	7.1	147	8.2
Thinkers	11	148	6.7	147	7.2	148	6.7

		SCHOOL AND COLLEGE APTITUDE TEST			
Response mode	N	Verbal	S.D.	Quantitative	S.D.
Writers	8	280	11.5	275	15
Speakers	10	282	13.6	295	15.2
Thinkers	11	277	12.4	288	10.9

Tests again indicated that there were no significant differences between the groups. The largest "t", .97, with 20 df, was obtained by comparing the means of the S.C.A.T. Quantitative scores it would have been difficult to assign any importance to them since the Cooperative English 2600 program is essentially verbal instruction, with few, if any, quantitative responses required.

Means of scores on Cooperative English, Form 20, Post-test. Table III, page 39, shows that both the Speakers and Thinkers achieved a Total Score mean of 151 on the post-test, Cooperative English Test, Form 2C. The Writers achieved a Total Score mean of 149. Tests comparing the means of the Writers and Speakers yielded a "t" of .71, with 17 df. Comparison of the Thinkers with the Writers yielded a "t" of .98, with 17 df. Neither of these values was significant.

Since there were no significant differences between the scores on the post-test for all three response modes, the null hypothesis could not be rejected. Therefore, one response mode did not demonstrate any efficiency over the others in this study.

Another measure of the relative efficiency of the response modes was the difference between the scores on the pre-test and post-test for each response mode.

TABLE III

MEANS OF SCORES ON THE COOPERATIVE ENGLISH TESTS, FORM 2C, AND THE SCHOOL AND COLLEGE APTITUDE TESTS

COOPERATIVE ENGLISH, FORM 2C							
Response mode	N	Total	S.D.	Expression	S.D.	Reading	S.D.
Writers	8	149	6	147	6.1	150	6.2
Speakers	11	151	7.7	149	8.9	151	7.2
Thinkers	11	151	4.3	150	4.3	151	6

SCHOOL AND COLLEGE APTITUDE TESTS					
Response mode	N	Verbal	S.D.	Quantitative	S.D.
Writers	8	280	11.5	275	15
Speakers	10	282	13.6	295	15.2
Thinkers	11	277	12.4	289	10.9

Table IV, below, shows that the largest mean gain in total score, six points, was made by the Speakers. Comparison of the means of gains yielded a "t" of 1.86, with 20 df. The limited gains that were made could have happened by chance.

TABLE IV

MEANS OF SCORES ON COOPERATIVE ENGLISH TESTS, FORMS 2A and 2C

RM	N	Total Score			Expression			Reading		
		2A	2C	Dif	2A	2C	Dif	2A	2C	Dif
Wr.	8	146	149	3	146	147	1	144	150	6
Sp.	11	145	151	6	145	149	4	147	151	4
Th.	11	148	151	3	147	150	3	150	151	1

The null hypothesis that the Experimental group would score no higher on the Cooperative English, Form 2C, than would the population was not rejected. Table V, page 41, shows that the scores were very close together. There were no significant differences. The total scores ranged from 149 to 153, the Reading scores from 149 to 154, the Expression scores from 148 to 153.

TABLE V

MEAN SCORES OF ALL SECTIONS COOPERATIVE ENGLISH TESTS, FORM 2C

	Exper.	1	2	3	4	5	6	7	8	Pop.
N	30	16	31	33	9	17	24	20	37	217
Total	150	152	151	149	153	153	153	152	153	151
Reading	151	151	150	149	153	152	153	151	154	151
Express.	149	153	151	148	153	153	153	152	153	151

It is interesting to note that the scores in Table V suggest that none of the instructional methods used was very effective. The mean for the population was 151, six points below the cut-off line. Fifty out of 217 passed the test for admission to English 1A, the college transfer course.

Means of the scores on the first, mid-term and final English 2600 Tests. Three English 2600 tests, the first, mid-term and final, were selected for comparison to test the null hypothesis that there would be no significant difference in efficiency between the response modes. Table VI, page 42, shows that the largest differential was between the Speakers' and Thinkers' mid-term tests. Comparisons yielded a "t" of 1.79 with 20 df which was not significant. Comparison of the Writers' first test mean, 88, with the Speakers' first test mean, 80, yielded a "t" of 1.56 with 17 df which was not

significant. Since all other differences were smaller it followed that none of them was significant, and the null hypothesis could not be rejected.

TABLE VI

MEANS OF ENGLISH 2600 TESTS

	N	First	S.D.	Mid-term	S.D.	Final	S.D.
Writers	8	88	9.7	80	9.1	88	4.8
Speakers	11	80	12.2	77	13.8	87	8.4
Thinkers	11	84	14.2	87	12.3	87	12.7
Total	30	84	12.6	82	12.2	87	9.2

It could be argued that comparisons between the means of scores made by the Experimental group and the means of the scores made by the eight regular sections of English 73 have little relevance, since the regular sections did not have access to the English 2600 text. However, they did cover similar grammar material. Table VII, page 43, shows that the Experimental group did score higher than any of the eight groups.

Groups 1 and 5 were compared first with the Experimental group for significance since their means were closest to the mean of the Experimental group. Comparison of group 1 yielded a "t" of 1.94 with 44 df which was not significant. Comparison of group 5 yielded a "t" of 2.08 with 34 df which

was significant at the .025 level. Compared with remaining groups, the Experimental group scored significantly higher. This may have been, in part, an artifact of the testing situation since the Experimental group was accustomed to taking tests in the English 2600 format. It also may have been an example of testing what had been taught since we cannot be certain that specific information covered in the test had been presented by other instructors.

TABLE VII

ENGLISH 2600 FINAL TEST SCORES FOR ALL SECTIONS

Section	Exper	1	2	3	4	5	6	7	8
N	30	16	26	29	16	9	21	18	18
Mean	87	80	72	72	71	79	75	74	73
Range	51-98	63-93	53-96	45-95	58-83	63-91	58-91	49-91	52-95
S.D.	9.2	9.1	11.1	12.8	9.1	7.5	8.8	13.5	11.5

One of the advantages stressed in programmed learning is that the book or teaching machine is never critical of the student. His errors are corrected without emotional overtones and he can go over the material as much as he wishes. As a crude measure of the relationship between the student and the programmed text, and the student and the live teacher, the drop-out rate was compared for all sections. Table VIII, page 44, shows that the drop-out rate for the Experimental

group was 26%, while the rate for the total sample was 39.5%. The rate ranged from 6.4% to 66.6%. No superiority could be claimed for the programmed learning group since five of the eight conventionally instructed groups had a lower percentage of drop-outs and three had a higher percentage. Also, group six had the highest rate, 66.6 percent, which accounted for much of the high percentage for the total of the conventionally instructed groups.

There were many variables other than instructional methodology. Among these might have been the level of economic activity; student tendency to drop out more often as jobs become available, failure in other classes, and excessive cuts which resulted in expulsion. The students were not followed up to determine their reasons for dropping out.

TABLE VIII

DROP-OUTS, ALL CLASSES ENGLISH 73

Section	Exper.	2	3	4	5	6	7	8	9	Tot
Registered	46	28	32	38	24	27	32	25	25	277
Completed	34	16	30	34	17	9	25	22	20	207
Drop-outs	12	12	2	4	7	18	7	3	5	70
Percentage	26	42	06.4	10.5	29	66.6	21.9	12	20	39.5

Student reactions to the programmed text. Student reactions were sought in order to compare them with comments

often made by programmed learning theorists. On the last day of the experiment the students were asked to comment on the program. They were requested to be quite candid, since their comments would provide additional information which would help to make changes in future programs. They were also told that they could sign their comments if they wished. Of the twenty-four students who attended the last day and made comments, only one did not sign his name.

The following letters have been copied exactly as they were written by the students. No corrections or deletions have been made.

> The new 2600 book, was much more effective than the book I used last semester. This semester, it was more less up to the student wheather he are she wanted to advance or if they wanted to remaind where they were. This is what I liked about the new 2600 method. I beleived that I learned more this semester.
>
> ---
>
> What I liked: The book helped me in some subjects. Also it raised my ego with the high grades (Nothing under 89). What I didn't like: I didn't like the monotony of the simple frames.
>
> ---
>
> The course was quite helpful to me. It made me consentrate on what I was doing. I feel that more teacher student relationship is needed. The organization of the book was very helpful. I can easily say that the book taught me more than my previous English teacher. I enjoyed the course.
>
> ---
>
> I think that the book is very interesting, and helpful. They go over the parts of the speech over

and over, and you have to learn something after reading and repeting to yourself the same, so many times.

A good thing about the book is, that you can check on your answer right away, and you can see why it is right or wrong or where did you make you mistake.

I believe this book would be an excellent source for home study, for students desiring to prepare for college at home, but I would prefer a course a little more condensed and taught by an instructor. An instructor adds his own personal opinions and comments which helps me to remember facts.

The book in some places goes along in a very elementary way, which makes it impossible for the student to answer the questions in the book without understanding why things are done a certain way.

I feel that I haven't really gained very much from this book.

The book seemed to be to easy. It was so easy that you could just read right through it and not really think about it. On some questions they gave you the answers.

The tests seemed to be much harder than what the book contained. While taking the test you had to think some, but while reading the book it took no thought at all.

It is interesting to note that many of the comments made by the students after one experience with a programmed text were similar to those commonly found in the literature and given below. However, these students were all members of a remedial class. It is entirely possible that the comments would have been different if the text had been used by students of average or above ability.

Comments made by programmed learning theorists. Some of the favorable comments made by programmed learning theorists about the linear program and programmed text are that the student can proceed at his own rate; the high probability of a correct response is rewarding; errors are corrected without emotion; the student can review as much as he wishes; he has immediate knowledge of the result of his response.

Some of the adverse comments are: that the programs are monotonous; frames are so easy that responses become perfunctory so that little or no learning takes place; the programs are too impersonal since there is no interaction with a human teacher.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDY

Summary. This was a study to determine the relative effectiveness of the written, spoken or thought response to the frames of a programmed text. The subjects were taken from a population which scored below the cut-off line on the English placement test, Cooperative English Test, form 2A, and were assigned to the remedial English class, English 73, at Stockton College. Forty-six subjects were assigned to the experimental group by couselors who had no knowledge that the experimental class would be conducted any differently from the other remedial English classes. The subjects were ordered on the basis of their Cooperative English, Form 2A, total scores, and separated into three groups. Each group was assigned one of three options, to write, speak, or think, the response before proceeding to the next frame in the text, English 2600. The subjects proceeded at their own rate and took English 2600 tests and the Cooperative English Test, Form 2C, at their option. The means of each group's scores on the first, mid-term and final of the English 2600 tests and the means of the scores on the Cooperative English, Form 2C, tests were compared by means of "t" tests. There were no significant differences between the means. It was therefore concluded that there were no significant differences in the

relative effectiveness of the written, spoken or thought response modes.

Major findings.

1. There was no difference demonstrated in the efficiency of the written, spoken or thought response in this programmed learning study.
2. This was a program which made an adaptation to local needs in the local context. It demonstrated that the experimental method did no better or no worse than the method used in the other remedial classes for this rather representative remedial population.
3. Another major conclusion is that more variables are evidently operating in this complex field setting than have been identified in the light of this study.
4. It is probable, in view of the above, that standard nomothetic designs, that is, studies using groups, may be inappropriate in investigating this kind of problem; group studies may be less productive than individual comparisons.
5. Alternatively, it very strongly appears, in view of the possibility of many unidentifiable variables, that idiographic designs, that is,

individual case analysis, might be a more productive recourse for this particular evaluative task.

It may well be that the conclusions made cannot be generalized beyond this study because of certain difficulties in carrying out the design of the experiment. For example, the instructor reported that he had difficulty in persuading the speakers to speak the response. Instead, it appeared that a majority of the Speakers chose to read the response rather than to speak it. In addition, there was no way to determine that the Thinkers actually attempted to compose the response covertly by thinking before proceeding to the next frame. It may well have been that the only difference between the responses made was between the Writers who constructed the response and those who used the other two response modes.

Some of the limitations might have been avoided by setting up a more precise laboratory situation. But it would not have been known whether results from that study could have been translated meaningfully to conditions outside laboratories.

Recommendations for further research.

1. Students in this study were not selected from a randomly distributed general population in terms

of I.Q. and achievement. In addition a different program with the same students, or the same program with different students, might provide entirely different results.

2. Elimination of the "spoken" response as a variable in college classroom programmed learning experiments might well be considered, since the subjects in this experiment tended not to respond vocally.

3. A study in which more diagnostic instruments, such as the Stanford-Binet or the Wechsler Adult Intelligence Scale, rather than group intelligence tests, are used might show a more clearly defined relationship between intelligence and the mode of response. This could prove of significant value.

4. The programmed text might be useful as the principal method of instruction in grammar for remedial students who work independently. The instructor then could concentrate on other remedial aspects of the program such as spelling, composition and interpretation of literary writings, as well as on supervision of the programmed-learning grammar. Controls should be relatively easily designed using methods of

this kind.

5. Because programmed learning seems as effective as conventional instruction, as shown in this study, the remedial English class might be eliminated for a number of students. An independent study course for remedial English, of which the programmed text would be an integral part, might be developed. The student, working independently, could cover the required material, including the programmed learning, and then take the qualifying examination at his option.

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APPENDIXES

APPENDIX A

TOTAL SAMPLE RAW SCORES ORDERED BY THE

COOPERATIVE ENGLISH TESTS FORM 2A

TOTAL SCORE AND ASSIGNED

TO RESPONSE MODES

	COOP. ENG. TESTS 2A			SCHOOL AND COLL. APT. TESTS	
	Total	Exp.	Read.	Verbal	Quant.
Writers Sub. #1	155	151	158	295	311
2	153	150	156	275	294
3	151	146	156	283	266
4	151	149	153	302	284
5	150	161	138	271	258
6	148	149	146	284	281
7	147	143	151	275	305
8	146	151	140	266	272
9	144	144	143	269	286
10	144	142	145	277	288
11	143	139	146	287	284
12	141	141	140	281	247
13	140	142	138	269	272
14	133	131	135	ACE TEST	
15	No test on record			304	320
$\bar{X}$	146	146	145	281	283
S.D.	5.9	7	7.6	12.1	20.

APPENDIX A PAGE 2

	COOP. ENG. TEST 2A			SCHOOL AND COLL. APT. TEST	
	Total	Exp.	Read.	Verbal	Quant.
Speakers					
Sub. #1	156	159	153	295	311
2	155	156	154	290	288
3	151	156	146	293	294
4	151	146	156	286	296
5	150	153	147	269	276
6	150	144	156	283	299
7	149	145	152	302	292
8	148	143	153	No test on record	
9	146	140	151	290	310
10	146	144	147	287	281
11	144	140	148	275	302
12	141	142	140	263	292
13	139	138	139	271	305
14	136	135	137	269	260
15	130	131	128	260	260
$\bar{X}$	146	145	147	281	290
S.D.	7.1	8	8	13	16.4

APPENDIX A PAGE 3

	COOP. ENG. TEST 2A			SCHOOL AND COLL. APT. TEST	
	Total	Exp.	Read.	Verbal	Quant.
Thinkers Sub. #1	156	159	152	283	289
2	156	149	162	292	278
3	156	154	157	294	305
4	155	154	156	277	294
5	154	152	155	284	311
6	153	153	153	294	283
7	151	145	156	284	308
8	151	147	154	292	276
9	150	145	154	296	314
10	148	147	148	266	288
11	147	146	147	279	278
12	146	144	147	287	296
13	144	142	145	273	297
14	142	142	142	273	288
15	140	139	141	273	291
16	136	135	137	251	270
$\bar{X}$	149	147	150	281	292
S.D.	6.1	6.2	6.8	12.1	13

APPENDIX B

RAW SCORES ON POST-TEST COOPERATIVE ENGLISH TESTS FORM 2C AND SCHOOL AND COLLEGE APTITUDE TESTS

	COOP. ENG. TEST 2C			SCHOOL AND COLL. APT. TEST	
	Total	Exp.	Read.	Verbal	Quant.
Writers Sub. #4	157	156	158	302	284
5	141	137	145	271	258
6	147	141	156	284	281
8	144	147	140	266	272
9	150	146	153	269	286
10	149	149	148	277	288
11	153	152	154	287	284
12	149	151	146	281	247
$\bar{X}$	149	147	150	280	275
S.D.	6	6.1	6.1	11.5	15

APPENDIX B PAGE 2

	COOP. ENG. TEST 2C			SCHOOL AND COLL. APT. TEST	
	Total	Exp.	Read.	Verbal	Quant.
Speakers					
Sub. #1	160	158	161	295	311
3	151	147	155	293	294
5	158	160	156	283	299
7	155	151	158	302	292
8	154	156	151	No tests on record	
9	154	153	154	290	310
10	152	152	152	287	281
11	153	155	150	275	302
12	146	142	150	263	292
13	144	141	146	271	305
15	132	130	134	260	260
$\bar{X}$	151	149	151	282	295
S.D.	7.7	8.9	7.2	13.6	15.2

APPENDIX B PAGE 3

	COOP. ENG. TEST 2C			SCHOOL AND COLL. APT. TEST	
	Total	Exp.	Read.	Verbal	Quant.
Thinkers Sub. #1	153	156	149	283	289
4	151	150	152	277	294
5	158	158	160	284	311
6	155	154	156	294	283
8	156	154	157	292	276
10	154	152	155	266	288
12	151	151	151	287	296
13	149	148	149	273	297
14	149	146	152	273	288
15	143	146	140	273	291
16	143	143	142	251	270
$\bar{X}$	151	150	151	277	289
S.D.	4.9	4.3	6	12.4	10.9

APPENDIX C

COOPERATIVE ENGLISH TEST FORMS 2A and 2C

TOTAL SCORES, GAINS AND LOSSES

	COOPERATIVE ENGLISH TEST 2A	2C	Dif.
Writers Sub. #4	151	157*	6
5	150	141	-9
6	148	147	-1
8	146	144	-2
9	144	150	6
10	144	149	5
11	143	153	10
12	141	149	8
Speakers Sub. #1	156	160*	4
3	151	151	0
6	150	158*	8
7	149	155	6
8	148	154	-6
9	146	154	-10
10	146	152	6
11	144	153	11
12	141	146	5
13	139	144	5
15	130	132	2

* Qualified for English 1A.

APPENDIX C PAGE 2

	COOPERATIVE ENGLISH TEST 2A	2C	Dif.
Thinkers Sub. #1	156	153	3
4	155	151	-4
5	154	158*	4
6	153	155	2
8	151	156	5
10	148	154	6
11	147	151	4
13	144	149	5
14	142	149	7
15	140	143	3
16	136	143	7

* Qualified for English 1A.

APPENDIX D

RAW SCORES ON ENGLISH 2600, FIRST, MID-TERM AND FINAL TESTS

Writers	First	Mid-term	Final
Sub. #2	61	-	-
4	74	88	85
5	82	68	88
6	96	77	92
7	95	-	-
8	100	88	88
9	87	87	95
10	79	73	-
11	98	91	83
12	88	70	83
13	47	-	-
14	72	-	-
15	66	89	83
	N=13	N=9	N=8
$\bar{X}$	80	81	88

APPENDIX D PAGE 2

Speakers	First	Mid-term	Final
Sub. #1	95	88	78
3	94	89	77
4	78	-	-
6	72	78	91
7	85	80	82
8	88	87	-
9	83	92	85
10	54	48	70
11	70	69	80
12	75	79	97
13	96	77	88
14	72	-	-
15	73	57	62
	N=13	N=11	N=10
$\bar{X}$	79	80	81

APPENDIX D PAGE 3

Thinkers	First	Mid-term	Final
Sub. #1	87	-	-
2	77	-	-
3	100	94	98
4	95	100	97
5	100	100	96
6	94	90	91
7	94	73	-
8	66	60	-
9	95	-	-
10	93	96	97
11	87	-	-
12	95	93	87
13	53	77	51
14	86	97	88
15	81	87	90
16	79	76	-
	N=16	N=12	N=9
X	83	87	88