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The Ohio State University, Ph.D., 1974
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AN INVESTIGATION OF THE USE OF THREE PROGRAMMED TEXTS
BY SIXTH-GRADE INNER-CITY CHILDREN

DISSERTATION

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

Virginia Turk Mellott, B.A., M.A.

* * * * *

The Ohio State University
1974

Reading Committee:

Approved By

Alexander Frazier

Charles B. Huelsman, Jr.

Lowry W. Harding, Adviser

Adviser
Department of Early and Middle Childhood Education
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VITA

November 26, 1921. Born—Follansbee, West Virginia

1939-1943 . . . . B.A., West Liberty College, West Liberty, West Virginia

1943-1944 . . . . Secondary Teacher, Steubenville, Ohio

1944-1945 . . . . Physical Testing Laboratory, Chase Brass and Copper Company, Euclid, Ohio

1945-1946 . . . . Secondary Teacher, Saginaw, Michigan

1949-1951 . . . . Secondary Teacher, Belmont, Ohio

1952-1965 . . . . Elementary Teacher, Bellaire, Ohio

1963 . . . . . . M.A., West Virginia University, Morgantown, West Virginia

1965-1968 . . . . Teaching Assistant, The Ohio State University, Columbus, Ohio

1969-Present . . . Assistant Professor, Otterbein College, Westerville, Ohio

FIELDS OF STUDY

Major Fields: Elementary Education
Exceptional Children - Reading

Studies in Elementary Education.
Professor Lowry W. Harding

Studies in Exceptional Children.
Professor Charles B. Huelsman, Jr.

Studies in Curriculum and Supervision.
Professor Alexander Frazier
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CHAPTER I

INTRODUCTION

The history of the growth of the educational system in the United States indicates that the majority of people have valued education. Because of this, they have established, over the years, laws and practices which regulate the minimum requirements for school attendance and the school grade level which each individual must complete.

History also reveals that there has been continual improvement in the educational attainment level of U.S. citizens. Today, of individuals entering first grade, a greater proportion not only finish high school but also continue their education in community educational programs, in technical schools, or in colleges.¹

One reason people have valued education is that there appears to be a cause-effect relationship between the educational level attained by an individual and his position on the poverty-wealth continuum. Sexton points out

that the person with the higher level of education is more likely to have continuous rather than intermittent employment and that his total lifetime income tends to be greater than that earned by those who are less well-educated.\(^2\)

There appears to be a general consensus among parents, employers and many students that the minimum educational requirement for adequate employment and satisfactory standard of living is completion of high school. If we look at the increasing numbers and higher percents of students being graduated from suburban and urban schools today it would appear that the educational system has been increasingly successful in helping people achieve this level. Closer examination, however, seems to indicate that a significant number of children and youth are not meeting with success in their educational endeavors. They are not completing high school—often dropping out of school as soon as it is legally possible for them to do so. The probability that these non-graduates will find employment that will enable them to enjoy as high a standard of living as their graduate counterparts is quite small.

A disproportionately large number of these "dropouts"

are found in inner-city areas. The literature reveals that they, as a group, have little or no motivation to learn, cannot read on grade level and, generally, do not see the value in education for themselves. A particularly distressing observation by Ravitz was that many of these inner-city youth "resign" from school long before they are technically able to cease attending and thus do not profit from instruction even while completing their last years of school.³

Today the public is expecting the educational system to provide more effective education for these inner-city children and youth. While this effort is expected to emphasize academic offerings at the high school levels, a major emphasis should also be made at the elementary school level. There is great need, at this level, to provide each pupil with opportunities to be successful in his attempts to gain understandings of basic concepts and methods of learning.

Teachers in inner-city classrooms who are skilled in whole-group instruction can and do promote a great deal

of learning in classes as large as thirty. But, not all children profit from group instruction, perhaps because of the differences found in their backgrounds, their needs and abilities as well as in their preferred modes of learning. Such pupils often need the individual attention of the teacher. It is economically unfeasible and perhaps educationally unwise to assume that sufficient personnel can or will be made available to carry on a program of individual help if this were to be done on a one-to-one pupil-teacher basis. It seems more practical to suggest freeing the teacher, for a portion of the day, from the necessity of whole-group instruction by making available in each classroom a wide variety of instructional materials some of which could be used independently by some individuals at a time when others receive closer attention from the instructor.

Among the instructional materials which appear to be appropriate for such independent use are those that are programmed. Advocates of this method of instruction claim that programs, correctly constructed, can promote learning

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comparable with or superior to that resulting from typical classroom instruction. Programs in math, art, social studies, language arts and science which are recommended for use at the sixth-grade level have been prepared and are now being sold by commercial publishers and thus are available to those schools which may want to consider their inclusion in the list of instructional materials made available to teachers. The pertinence of these ideas to the present study is stated in the next section.

Statement of the Problem

The purpose of this study is to examine the use of commercially published programmed materials by sixth-grade inner-city pupils in pursuit of workable answers to the following questions:

1. Are the currently available programs instructionally effective when used with the population of this study?

2. Do sixth-grade inner-city pupils require help in order to use programmed materials successfully or can they be equally successful when receiving no help?

3. Does the programming technique (linear or intrinsic) affect student achievement?

4. Can we predict with a degree of accuracy those pupils who can and those who cannot successfully use programmed materials?

In order to organize the data pertinent to these questions so that it could be analyzed statistically, the following null hypotheses are proposed:

1. There is no significant difference in achievement as indicated by Post-test I means, final post-test means, percent of possible gain scores or percent of successful completion scores between the groups studying programmed materials under the Limited Help study condition and those studying the program under the No Help condition.

2. There is no significant difference in achievement as measured by Post-test I means, final post-test means, percent of possible gain scores and percent of successful completion scores between the pupils using:
   a. an intrinsic program and those using either of the two linear programs.
   b. one of two programs, both linear in design.

3. There is no significant difference between the accuracy of the teacher in correctly predicting that a child (a) will achieve at the 70% level or above or (b) will not achieve at that level and the accuracy demonstrated by the application of the prediction formula obtained from a multiple regression analysis in making the prediction.

For the investigation of the instructional effectiveness of programmed materials minimum levels of
acceptable performance are set up as follows:

1. 70% mean on Post-test I and final post-test mean.
2. 50% score for percent of possible gain.
3. a significant difference at the .05 level of confidence between the pre-test and post-test mean.

All the hypotheses in this study are tested at the .05 level of significance. This level, according to Kerlinger, is not accepted by the entire research community as being appropriate for all research but it is the level that represents "a reasonably good gamble" when used for most social scientific research.6

Justification of the Problem

A review of the literature prompted Schramm to make this summation regarding the instructional effectiveness of programmed learning materials:

Programs have been used successfully at all levels of ability from slow learners to the very best students, and to teach a great variety of academic subject matter and verbal

and manual skills . . . We can accept confidently, therefore, the conclusion that programs do teach.

Although Schramm thus attested to the effectiveness of programmed materials when used as teaching devices, he did not claim that everyone learns successfully as a result of this method. There is ample evidence throughout the literature which supports the conclusion that, for some individuals, the use of programmed materials is not an effective method of learning. Meyer reported that several students in her target population performed inadequately during the course of her study. Problems dealing with cheating and boredom were noted by Bassler. Keislar found that "...all except one of the experimental subjects


showed a higher post-test than did their matched controls.

Perusal of the literature clearly indicates a number of similar disclosures of the fact that there are those for whom programmed instruction is ineffective.

Schramm's review included the results of a small number of studies completed at the elementary school level. Most of these were completed with a middle class population and few, if any, used as their subjects children from the inner-city schools. Typically, the inner-city child has difficulties relative to learning which may tend to limit further the number of them who can be expected to profit from instruction via programmed materials.

One such problem has to do with the appropriateness of their using programs which have been published by commercial houses. Companies which are in the business of preparing educational materials for sale have tended to gear their products to the needs of the largest customer which has been, historically, schools in which the enrollments are predominantly from the middle class.

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Concern has recently been voiced over the practice of using some of these educational materials, particularly reading texts and standardized tests, with any population other than the one for which it was designed. It has been contended that the language and content of the written material may be unfamiliar to many possible readers and that the actual background of many children at a given grade level may not be that assumed by the author of the work.\textsuperscript{11}

The same concerns are likely to be equally valid when considering programmed materials for consumption by inner-city children. If such children and youth have difficulty relating to other commercially published educational materials, the conclusion must be entertained that they would have difficulty in successfully using programmed materials similarly produced.

A second problem which needs to be investigated concerns the level of achievement that can be expected when a child works independently with programmed materials and cannot receive assistance when needed. A study by Coulson found that teachers were not able to make any positive contribution to student learning in a programmed

\textsuperscript{11}Ravitz, pp. 15-17.
learning situation. On the other hand, Ryan, who involved a population more closely resembling that of the present study, found that high readers but not low readers were learning in the group who were studying programmed materials independently but that both high and low readers were helped in achieving when assistance by a teacher or a teacher's aide was included in the instructional process. Since many inner-city children are reportedly retarded in reading, as well as in other academic areas, there seems to be some question as to their successful achievement when studying programmed materials without teacher assistance.

These two circumstances—the use of commercially prepared materials and the requirement of independent work—may tend to limit the number of pupils who would be able to make efficient use of programmed instructional


materials. However, the concern voiced or evidence presented by researchers did not indicate that all failed to learn to read when using some of the traditional texts which had been published by commercial firms nor did all pupils have difficulty in taking standardized tests. Neither did all fail in their attempts to use programmed materials without guidance or supervision.

It seems reasonable to assume that there would be inner-city children who would have little difficulty in using commercially published programmed material as an instructional resource and also that some pupils might be found who were able to reach a high level of achievement through its use at a time when no guidance was available.

A third factor which may—and probably does—affect the number of pupils who successfully complete a program of instructional materials is the child himself. The characteristics usually associated with academic success appear to be weaker or less evident in the behavior of inner-city children than in the behavior of the general
school population. In addition, the inner-city child has been described as lacking motivation to learn and generally lacking a positive self-concept in school situations.

The advocates of programmed learning claim that motivation to proceed through a program is inherent in correctly constructed materials. Be that as it may, the child must first begin the program before this source of motivation can start to function. Then, in order to proceed through the program, he must have a reading competency adequate for the task he is asked to undertake. If this is not great enough, the meaning supposedly carried by the program will escape him and its power to motivate will cease.

An additional facet relative to the motivation problem is indicated in Prescott Lecky's theory of person-


According to Lecky, the child will determine which of the incoming ideas are to be accepted and assimilated and which will be rejected. If the incoming idea is consistent with his interpretations of the experience he has assimilated up to that point, the idea will be accepted and will be incorporated into his system of ideas all of which are consistent with one another. If it is not consistent, it will be rejected.

According to Lecky, if the pupil shows resistance toward a certain type of material, this means that from his point of view it would be inconsistent for him to learn it. However, Lecky adds, "If we are able to change (italics by the present writer) the self-conception which underlies this viewpoint, . . . his attitude toward the material will change accordingly . . . "¹⁷ Thus, according to Lecky's theory, the program construction could not supply the motivation which would cause a child to continue work if it included ideas which were inconsistent with those which he had previously internalized. A child's resistance to programmed material would indicate the presence of certain

Inconsistencies which would have to be eliminated by changing either the ideas promoted by the program or the ideas held by the child before programmed instruction could be effective.

There are, however, features associated with programmed material which may very well recommend its use with inner-city children. The slow, steady progression of the instructional sequence, the emphasis on eliciting a successful performance from the pupil, the requirement of response may appeal to one who has a low opinion of his abilities in the classroom. It was for these reasons that Hinds recommended its use with inner-city children.18 Harmon, too, felt it might have more appeal for children who have met with failure there than does typical classroom instruction.19

Although a firm conclusion can be made that programs do teach, the number of pupils that they teach undoubtedly is limited by a variety of factors. With respect to inner-
city pupils, these include the fact that such material is usually prepared for consumption by the general public rather than specifically for the inner-city children, the fact that it is usually used in no-guidance situations and that inner-city pupils tend to have unique difficulties with learning.

Before programmed materials can safely be recommended as appropriate instructional material for independent use by inner-city children, the effect of these possible limitations should be examined further.

If the results of such a study are typical, in that some children will be found to be more successful than others in the use of programmed materials, then it would seem worthwhile to attempt to identify those who were successful in the hope that future assignments to programmed materials might be made more efficiently. This is one of the parameters of the present research.

Procedures Followed in the Present Study

The investigation here reported was conducted in the Columbus, Ohio, Public School System. The 252 sixth-grade pupils who constituted the subject population were drawn from thirty-six classrooms located in eleven inner-
city schools. The seven children who were randomly selected from each classroom roster were randomly assigned to one of three commercially published programmed texts. Each text was used during 6 thirty-minute periods by at least two members of each group. Half the 36 groups were assigned to use the programmed material in situations where no help was given them and the other half were assigned situations where limited help was available. The children were given pre-tests and post-tests from which achievement measures were derived and the efficiency of the programs were computed.

Two of the programs selected for use in the investigation were of linear design and one of intrinsic design. Achievement measures from each were analyzed to determine the effect of the programming format on pupil achievement.

The pupils' official school cumulative folders were entered in order to record the following information for each child: age; sex; prior grade average; results from the California Test of Mental Maturities which yielded a Language, a Non-language and a Total score; and results from the Comprehensive Tests of Basic Skills which yielded Reading subscores of Vocabulary and Comprehension; Arithmetic subscores of Computations, Concepts and
Application; and Language subscores of Mechanics, Expression and Spelling. These figures were compared with each pupil's achievement scores for the purpose of identifying the configuration of characteristics most often held by the child who had achieved successfully when studying programmed materials. The purpose of this phase of the study was to arrive at a conclusion which might help the classroom teacher assign programmed instructional materials to those most likely to achieve successfully.

**Definition of Terms**

**Inner-city.---**As used in this study, a term to describe the geographic area in which the present investigation was conducted. The name implies the characteristics attributed to the population referred to as "disadvantaged."

**Disadvantaged.---**According to Passow and Elliott this term disadvantaged "... is one of a number of labels being pinned to a population suffering from a cultural and economic deprivation which 'did not attune them to the demands and opportunities of modern life.' Other terms

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20Tests were published by the California Test Bureau, Monterey, California.
in a new lexicon include: culturally deprived, socially disadvantaged, inner-city child, slum dwellers, minority pupil, ghetto youth, educationally deficient, immigrant, undereducated, and underachiever. . . . Each, operationally, indicates a population for which current planning efforts—educational, legislative, social, economic—are being made. Implicit in each term is a hint of those factors that may contribute to the individual's disadvantage."21

Klopf and Bowman comment as follows on the legal definition of the disadvantaged:

In 1964, the legal definition in Public Law 88-665, section 1101, of 'culturally, economically, socially and educationally handicapped' was interpreted to mean children from families outside the mainstream of American culture; or whose circumstances of poverty precluded their taking advantage of educational opportunities; or who have been discriminated against by American society; or who for external reasons have not been able to develop their potential. Such children could be found in the crowded inner-city schools, in rural schools, and in suburban schools where de facto segregation exists.22


Program.— As used in this study, a program is the written text which is presented to the child to study. Two forms were chosen for this study:

1. Linear.— As used in this study, linear refers to the written material which presents small units of information in a pre-arranged sequence to the pupil. For each unit of the material presented the student is asked to provide a written answer the accuracy of which he can check by comparing it with the one provided within the program.

2. Intrinsic.— Crowder described intrinsic programming in this way:

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.23

Programmed Instruction.—As used in this study, programmed instruction is the "learning experience in which a 'program' takes the place of a tutor for the student, and leads him through a set of specified behaviors designed and sequenced to make it more probable that he will behave in a given desired way in the future."  

Programmed materials or Programmed instructional materials.—As used in this study, the program is presented in the form of a textbook.

Independent use of programmed materials.—As used in this study, is the use of a programmed textbook by a child who relies solely on his own resources as he progresses toward completion of the program.

Limited help situation.—As used in this study, is the study condition under which a child has been assigned to study where he can receive help in pronouncing words, encouragement to continue work, and/or help in manipulating his text with various procedural activities.

No help situation.—As used in this study, is the study condition to which a child is assigned in which he may receive no help whatsoever in studying his program.

24 Schramm, p. 1.
Scope and Limitations of the Study

Certain limitations have been imposed on this study by the programs selected for use, the situation under which they were studied, the pupils who served as subjects, the teachers involved in the investigation, and by the study assistants. These will be described in this section.

In the first place, the variety of programs from which selections could be made was limited by the stipulation that the cost of each program was to be minimal. The primary reason for the stipulation was that the source of funds for the study was limited. It was felt that the requirement was a realistic one since in many classroom situations funds are quite often limited. However, this limitation precluded the selection of those programmed materials that are presented by means of auxiliary mechanical devices and also the selection of the more expensive programs that are presented in booklet form. Although there is evidence indicating that the manner of presentation of the program is of less importance than the program, a number of titles were available that were not offered in alternative forms. This sharply limited the total number of programs from which the final selection was made. Also,

25Schramm, p. 52.
while a determined effort was made to examine all the programmed material available from every source, there was the possibility that a more appropriate program was overlooked.

The second set of limitations related to the situation in which the study was carried out. In the experimental situation, the close proximity of the examiner to the seven children may have affected their work habits in a manner different from that which would be found in those classrooms in which the teacher's presence was farther removed. Pupil achievement could also be affected by the fact that they were working, not in their familiar classroom, but in a less familiar environment and one which, at various times, was not ideal due to the lack of available space in certain schools.

The pupils themselves represented the third set of limitations. They were selected as part of an experimental group which was given the opportunity to leave the classroom and to learn new information through instructional materials which were novel. Some such pupils may have achieved at a level in excess of normal expectations while others, known to be less enthusiastic because they felt themselves to be part of a group needing remedial help,
might have done poorly for reasons other than those considered in this study.

Many of the pupils had never used programmed material prior to this encounter. Although practice in the mechanics of its use was given during the orientation session, there was not time to explain the philosophy or underlying point of view. A few instances of cheating were noted by the examiners and in each case the work of these subjects was eliminated from final analysis. There may have been additional cases of cheating that were not noticed and recorded by the study assistants.

The fourth set of limitations were those imposed by the teachers. No effort was made to ascertain their teaching styles. It is possible that the approach to learning used daily by the teacher might facilitate the student's use of programmed material or it might have had a detrimental effect on it. However, it was felt that this same influence would be felt if children were using programmed material in that particular classroom situation. A more pronounced effect on the experimental situation may have been exerted by teachers who were obviously enthusiastic or, on the other hand, by those who were obviously unenthusiastic in their reaction to this experiment.
Although participation in this study was voluntary on the part of the teachers and the children, there may have been teachers who thought there was indirect pressure to participate because of the reaction of the principal of the building or because of the approval given by the central administration for this study.

The final set of limitations involves the study assistants who had the responsibility of working directly with the children for a five day period and for recording other information needed in the study. These study assistants were all qualified by education and experience to function within an inner-city school situation. Hopefully, the care that went into their selection was rewarded by the professional level of behavior required of them in this study. However, although the mechanics and purposes of the study were explained and demonstrated to them, the assistants might have inadvertently given some help to children which served to affect the results. The possibility also exists that mistakes were made in copying information from the cumulative records.

Because of the fact that several of these limitations have the potential of either positive or negative influences on the findings of the study and because of the
size of the sample, it was thought that the chance influences were likely to cancel each other and that any results obtained from this study would be fairly representative of the interactions being examined.

Summary

In this chapter, the need for more effective instruction in the inner-city schools was demonstrated by presenting evidence of the cause-effect relationship between the educational level attained by the individual and his total lifetime income and by indicating that a disproportionate number of school "dropouts", i.e. those who did not finish high school, occur within the inner-city population. It was proposed that more effective instruction might be possible if materials could be obtained which would facilitate the individualization of instruction. The value of the use of programmed materials in this context was developed and the difficulties which might be faced by the inner-city child in (1) learning, (2) using commercially prepared materials and (3) working independently on the program were set forth.

It was anticipated that some children would be successful in the use of programmed materials and, for the
purpose of efficient assignment, it was proposed that a method of identifying these children would be worthwhile.

The statement of the problem indicated the intent to examine the use of commercially published programmed material by sixth-grade inner-city children relative to (1) its instructional effectiveness and (2) the pupil's achievement as affected by (a) independent study condition and (b) linear and intrinsic programming techniques. Also included in the statement of the problem was the intent to investigate the accuracy of two methods of identifying the child who would achieve via programmed instruction at the 70% level.

The limitations of the study were acknowledged in the area of (1) program location and selection, (2) student reaction to programmed material, (3) the environmental influence under which the experiment was conducted, (4) uncontrolled teacher influences, and (5) possible deviations from the prescribed behavior of study assistants.

**Arrangement and Nature of the Later Chapters in this Dissertation**

Chapter I has served to introduce the topic which will be more fully developed in the chapters which follow. In Chapter II, a review of the literature pertinent to
this study will be presented. The procedures under which the experiment was carried out will be fully described in Chapter III. The data collected in this investigation will be presented in Chapter IV. Chapter V will include the summary, conclusions and recommendations of the investigation.
CHAPTER II

A REVIEW OF THE LITERATURE

One of the major purposes of this study was to investigate the use of certain commercially available programmed texts by sixth-grade inner-city children. In the first section of this chapter, a review of the literature relevant to the topic of programmed instruction will be presented. The review includes: (1) a description of the sequence of events that led to the concept, (2) description and comparison of the two most common types of programs, i.e., linear and intrinsic, (3) lists of advantages and disadvantages of programmed instruction, and (4) a summary of the criteria that have been proposed for the selection of a programmed text.

A second major purpose of the study was to investigate the relationships between achievement via programmed material and the learner characteristics of this population for the purpose of identifying those relationships which were significant. In the second section of this chapter correlational studies between achievement via
programmed texts and (1) learner characteristics or 
(2) conditions imposed during study are reported for 
students in grades four through eight.

Machines That Teach

The use of mechanical devices in the instructional 
process apparently is not a recent development. Green has 
provided a description of an interesting apparatus, the 
quintain, which was used in the training of knights in 
medieval times:

The response appropriate to this device was 
striking a shield directly in the center with a 
lance. If the blow was correct, the device fell 
over. If the blow was struck off center, the 
device would pivot and deliver feedback by 
striking the horseman a blow with a flail or 
some other instrument as he rode by.1

Ibert Mellan reported that the first patent for an 
apparatus used in the instructional process was issued in 
1809 to H. Chard for "A Mode of Teaching to Read."2

Another device, described by Stolnrow, was used as 

1Edward Green, The Learning Process and Programmed 
Instruction (New York: Holt, Rinehart and Winston, Inc., 

2Ibert Mellan, "Teaching and Educational Inventions," 
Teaching Machines and Programmed Instruction, eds. A. A. 
Lumsdaine and Robert Glaser (Washington: Department of 
Audio-Visual Instruction of the National Education 
early as 1918 in training soldiers to squeeze a rifle trigger correctly. It included a manometer with a visible liquid column which moved upward when the trigger was pulled. The soldier was able to see, in effect, the pressure he applied to the trigger and, as a result, was able to improve his technique.\(^3\)

Whether these or some of the other mechanical devices used in the educational processes during earlier times were true teaching machines—according to currently-accepted definitions—is doubtful. The teaching machine has been defined by McKeachie as "... a device for presenting a content and questions in a pre-determined sequence and providing immediate knowledge of results to an active learner."\(^4\) Some of the earlier devices appeared to lack one or more of the essential components of a teaching machine so defined.

**Work of Sidney Pressey**

It is generally recognized that Sidney Pressey was


the first to demonstrate the potential of teaching machines in an educational setting. In 1926, after a decade or more of work, Pressey published an article describing "a simple apparatus which automatically gives and scores a test, and which will also, automatically, teach—and teach informational and drill material more efficiently, in certain respects, than the 'human machine.'"5 The machine consisted of (1) a drum which contained the test questions or drill material and (2) a keyboard with four keys. When giving and scoring a test, the drum revolved to the subsequent item as soon as the student had pressed one of the keys which indicated his choice of a multiple-choice alternative answer. When teaching, the mechanism was adjusted so that the drum would not revolve until the correct answer to the item had been recorded.6 When presenting "drill" the apparatus could be modified so that it would automatically omit a question from further presentation once the correct answer had been identified a predetermined


6Ibid, pp. 36-37.
Pressey found support for his utilization of machines in the teaching process in the learning theory subscribed to at that time.

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 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" also can be made, automatically, to aid in the establishing of the right answer.

For several years, Pressey and his students at The Ohio State University continued to develop, modify, and experiment with new techniques, apparatus, and applications suggested by the idea of mechanization in the field of education.


education. However, in 1932, Pressey announced that because of apparent lack of interest in the educational community he was discontinuing his work in this area.9

Although Pressey reluctantly abandoned his experimentation before the teaching machines were generally accepted, his work did illustrate several ideas that were subsequently to become a part of the concept of programmed instruction:

1. Mechanical devices could be used in the educational process for testing and for teaching.

2. Because each person used his own machine, i.e., the student-machine ratio was one to one, the rate of progress through the material carried by that machine was individual.

3. The device enabled the learner to get immediate feedback as to the correctness of his response.

Use by the military during World War II

From Pressey's announcement in 1932 until the early 1940's, little experimentation with teaching machines was recorded. Then, the unique demands placed upon the

military after the entrance of the United States in World War II caused a revival of interest in the use of mechanical aids in teaching. Harding commented on the situation:

A strong need for learning aids, to standardize instruction and relieve men for more direct war service, arose in the 1940's. Simple machines were developed to teach codes, mechanical skills, and present various materials for rote learning.10

At the end of the war, the military continued to develop and to use similar aids and also to experiment with the development of instructional devices and techniques.11

Perhaps a greater influence prompting the increased interest in teaching machines which was to follow in time was not in the kinds of machines or programs used during World War II but in the experience of the thousands of the men and women who had been taught, in part, by them. To these people it had been demonstrated that machines could be used in the learning process. Pressey, ten years earlier, had demonstrated this to his college classes which represented a quite small and homogeneous group. In dramatic


contrast, many thousands of military personnel from all parts of the country and from all walks of life had been introduced to "machines that teach" and eventually, upon returning home, their experience was disseminated nationwide. This was perhaps a significant factor in cultivating the more generally receptive climate for the work of B. F. Skinner and others in the 1950's.

Contributions of B. F. Skinner

B. F. Skinner has generally been credited with the renewal of interest in mechanical devices which "teach."¹²

The primary impetus for this rapid expansion of activity has unquestionably been the writing of Skinner. Though some of this work was initiated shortly after the publication of Skinner's 1954 paper, there were at first few published articles to indicate the widespread interest that had been generated. During 1958, however, numerous papers began to appear, and the trend has continued to increase during 1959 and 1960.¹³

¹²Schramm, in Wilbur Schramm, Programed [sic] Instruction Today and Tomorrow (New York: Fund for the Advancement of Education, 1962), pp. 44-45, pointed out that army research in training films investigated precisely those same variables used in experiments on programed [sic] instruction and that the results of these studies were published in 1949 thereby actually antedating the Skinner influence.

In his 1954 paper, Skinner described his efforts to produce learning of simple tasks in a variety of laboratory animals. He found that through the judicious use and strategic placement of reinforcement he was able to shape and to maintain certain desired behaviors in animals. He was also able to teach more complex tasks by teaching a sequence of simple tasks each of which represented one component of the predetermined terminal behavior.¹⁴

To establish a need for the translation of his laboratory findings into practices which could be used in the education of elementary school children, he investigated the provisions for reinforcement commonly used in school classrooms and found them to be aversive, infrequent, and not "contingent" (Skinner's term) to the response given by the child. He acknowledged the difficulty a teacher would have in attempting to supply proper and continual reinforcement to each student at an optimal time during a learning sequence and suggested that the use of a mechanism or an

electrical device could serve this purpose.15

The device suggested by Skinner resembled that of Pressey in three respects: (1) each accommodated the individual with regard to the speed with which he proceeded through the material, (2) each provided immediate knowledge of the correctness of the answer, and (3) each assured active participation by the student by requiring frequent responses.16

But Skinner's work was not limited to the design of appropriate hardware. He was also credited with having contributed to the transition from Pressey's "teaching machine" with its testing-teaching origin to the concept of "programmed instruction" as a result of his extensive work with the "program"—that is, with the material which was to be presented by the device.

15 Ibid., pp. 103-109.

Programmed Instruction

Phil Lange, in the introduction to the N.S.S.E. Yearbook, Programed Instruction pointed out that programmed instruction has different meanings for different people. Lumsdaine suggested that these differences stemmed from the influences derived from the historical origins of the concepts of programmed instruction. He identified these as (1) the influence of physical-science technology which included work done by those interested in motion pictures, T.V., computers, or audio-visual devices; (2) the influence of those concerned with individual differences with which he placed the work of Pressey, the military, and Crowder's intrinsic programming devices; and (3) the influence of behavioral science and learning theory as demonstrated by Skinner.

According to Lumsdaine, the concepts of programmed instruction held by members of these groups differed from


18Lumsdaine, "Educational Technology, Programed Instruction, Learning, and Instructional Science," . . ., p. 384. A model plotting these three influences is given.
one another in several ways:

(a) stress on the notion of reproducibility or control of learner behavior; (b) degree of individualization of rate and/or sequence of instruction in accordance with the responses of the learner; (c) theoretical vs. empirical bases for program development; (d) the need for, and feasibility of, specifying instructional objectives in behaviorally stated terms; (e) the extent to which a program purports to take responsibility for managing the attainment of specified objectives vs. leaving it largely up to the student to manage his own learning activities; and (f) stress on instrumentation vs. stress on program content. 19

Reflecting these differences, the 1962 Interim Report of the Joint Committee of Programed Instruction and Teaching Machines contained this description of programmed instruction:

As used herein, programed instruction refers to the use of materials or procedures which incorporate an "auto-instructional" (or self-instructional) program. Such a program commonly attempts to provide conditions under which a student can learn something efficiently with little or no outside help. Current programs typically employ a pre-arranged sequence of material that is presented to the student one small unit at a time (e.g., a sentence or paragraph). Most programs require the student to respond actively at least once for each unit (or "frame") of material—for example, by composing or selecting an answer to a question. Programs also commonly provide prompt confirmation or correction . . . for each response the student makes. In some cases, the program is

19 Ibid., pp. 384-385.
presented by a mechanism or device called a "teaching machine"; in other cases it is presented by a specially designed form of book.\(^{20}\)

Of particular interest to this study are the programmed texts the authors of which followed the programming techniques developed by B. F. Skinner and the programmed texts whose authors followed the plan developed by Norman A. Crowder. These two men presented contrasting techniques for program construction in the late 1950's. Each had supporters and opponents and considerable effort was spent at that time in defending a position or in trying to convince the opposition of the merits of a particular programming technique.\(^{21}\) Subsequent research showed that a well-constructed program using either technique could result in learning.

In the following sections a description of a Skinner linear program and the Crowder intrinsic program will be


given. The unique characteristics of each type will be identified by presenting the position and rationale of its author. This will be followed by a discussion in which the common views and concerns of those interested in programmed instruction during the late '50's and early '60's will be presented.

**Linear programming**

The four most important features of linear programming are included in the descriptions which follow. They are (1) fixed sequence, (2) small steps, (3) constructed response and (4) immediate and frequent reinforcement.

1. **Fixed order—position and rationale.**—Skinner's first requirement for a linear program was that the order or sequence of the teaching items be fixed so that all students would be required to complete the entire sequence in the order presented.²²

The task of the programmer in arriving at the sequence of items which would be appropriate for all students

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required that he first identify the component parts of the learning task and then arrange these parts in such a way that "one problem can depend upon the answer to the preceding and where, therefore, the most efficient progress to an eventually complex repertoire can be made."\textsuperscript{23}

In the first step of program construction, the programmer worked alone (or with a person knowledgeable in the subject area) but in the second step the help of a student was required. He was asked to work through a short series of items, or frames, as soon as each had been constructed. Based on the student's response to the frames, revisions or modifications were made so that eventually the student had no difficulty in completing that portion of the program. This revised edition was then tried out with a group and other modifications were made as required\textsuperscript{24}

Ultimately, as Skinner theorized, the "perfect" program could be constructed—one in which the "answers of the average


child will almost always be right."  

Each pupil, because he was studying his own copy of the program, was able to proceed through it at his own rate of speed. Skinner argued that the needs of all children—the slow, the average, and the gifted—were accommodated since each was not expected to maintain an unrealistic rate of learning. However, every child was expected to complete the entire program frame by frame.

**Fixed order—discussion.**—Lumsdaine interpreted the method of program construction advocated by Skinner in this way:

This concept of empirically developed programs meant not only that the progress of any one student through a program could be regarded a successive approximation to mastery of the subject but also that successive revisions of the program, based on feedback from students to the programmer [sic], could be regarded as successive approximations to an ideal learning sequence.

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However, the ideal learning sequence as described by Skinner and Lumsdaine did not appear to others to be either necessary or ideal for all students. Gagné theorized that a complex learning task consisted of a sequence of subordinate capabilities each of which the learner must possess before being able to master the learning task. He also hypothesized that the learner often brought with him certain capabilities that would permit him to begin the sequence of learning at some point other than at the lowest level.28

In order to test these theories, Gagné first selected the learning task and identified its subordinate capabilities which he laid out in a hierarchical design. He then tested his pupils' capabilities. With each pupil he began at the highest level of the hierarchy and proceeded backward step by step until the learner successfully answered the test item. He began instruction at the next higher level and continued it until the final task was achieved. Thus, some students with more background were instructed at a level near the final task while others with

less foundation began instruction at a point more remote. All achieved the final learning task.

The placing of learning tasks in a hierarchy suggested support for Skinner's sequencing of the learning material but his idea that all must proceed through the complete program was not supported by the data Gagné collected.

2. "Small steps"--position and rationale.--The second characteristic of linear programming is that the learner must proceed through the information presented by the program in relatively "small steps." Skinner said:

The whole process of becoming competent in any field must be divided into a very large number of very small steps, and reinforcement must be contingent upon the accomplishment of each step . . . By making each step as small as possible the frequency of reinforcement can be raised to a maximum, while the possibly aversive consequences of being wrong are reduced to a minimum.29

In this statement, Skinner emphasized not only the importance of reinforcement in a learning process but also his idea that more efficient learning occurred when errors were minimized or eliminated. As he indicated, the small step facilitated both of these.

"Small step"—discussion.—Green explained the mechanics of learning when small bits of information are sequenced into a program.

A series of frames may be viewed as a sequence of stimuli or stimulus elements sharing some elements from frame to frame. One may regard learning as the conditioning of behaviors to the elements within a frame. Through reinforcement, the probability of a correct response is increased to those elements within a specific frame; one then moves to the next frame. The probability of response to the next frame is higher than it otherwise would be because some intercept elements are shared with the previous frame or frames, to which the response has already been conditioned. Thus, the organism proceeds from the known to the unknown. . . . Clearly, it is redundant to have too large an overlay between successive frames. At the same time, a certain minimal overlay must exist in order that the probability of response to succeeding frames be high enough.  

Some of the studies which have attempted to test Skinner's position relative to the necessity for small steps have done so by using his definition of step size in


31 Other definitions given by Leslie J. Briggs, "Learner Variables and Educational Media," Review of Educational Research, XXXVIII (April, 1968), pp. 165-166 include (a) how difficult a response is to make, (b) how large a reading segment is presented before a response is required, (c) how long it takes the learner to make a response, (d) whether or not the student responds correctly, and how frequently reinforcement occurs.
constructing programs which differ from each other with respect to the number of frames offered to the learner. Fewer frames per program were determined to contain larger steps while a greater number of frames used to present the same content represented smaller steps. Three such studies completed in the early 60's are reported here.

Support for Skinner's position was given by Coulson and Silberman. They found that the small group of 10 college students enrolled in a course in elementary psychology who were given a 104 frame program received higher scores on a criterion test than did those students who had been given a program of similar content but which contained only 56 frames.  

In a similar study with graduate students, Evans, Glaser, and Homme found that smaller steps contained in a program were associated with significantly fewer errors on immediate and delayed performance tests. However, because of the findings of their study, they also suggested that the optimal size of step may not be the smallest step

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that it is possible to construct.\textsuperscript{33}

Whereas these two studies offered support for Skinner's position on the need for smaller steps to insure learning, the third study did not. Smith and Moore involved 96 fifth-grade students in a spelling program which carried the year's spelling list. Three versions of the program were constructed to include 546, 830 or 1128 frames. They found no significant differences in gains as measured by pre- and post-tests nor were there significant differences in performance among the groups assigned to one or another of the three versions of the program.\textsuperscript{34}

Whether the difference in the findings of this study as compared to the findings in the two studies cited previously was the result of differences in the (a) educational level of the population used, (b) difficulty of the


content studied; (c) length of the program, (d) the number of students in the study, or some other factor, the inconsistency of the findings was typical of the many studies which attempted to investigate this factor.

Nonetheless, after reviewing a number of studies in which size of step was investigated, Schramm concluded that when significant differences in learning were found, the findings have favored smaller step size.\textsuperscript{35}

3. \textbf{Constructed response--position and rationale.}\textsuperscript{35}---
The third characteristic of linear programming was the requirement that the learner compose a correct response for each "step" in the program. Skinner presented the rationale for this requirement by explaining that an individual must do more than receive information, that he must do more than hear or read information and "associate" it with something he already knew. Skinner asserted: "To acquire behavior \textit{the student must engage in behavior.}" He illustrated this point by describing the behavior of a person memorizing a poem. More was needed than reading and rereading. The student had to attempt to say the poem unaided by referring

to the text only for fragmentary help or for confirmation, until memorization was complete.  

Skinner felt that the best way to insure that the learner was "engaged in behavior" was to require him to compose his response.

The student must compose his response rather than select it from a set of alternatives, as in a multiple-choice or self-rater. One reason for this is that we want him to recall rather than recognize—to make a response as well as see it is right.  

**Constructed response--discussion.** Wallen and Travers list as Principle 6 of a comprehensive set of widely accepted principles of learning:

The learner will learn more efficiently if he makes the responses to be learned than if he learns by observing another make the responses or makes some related responses.  

This statement offered support to Skinner's contention that the learner needed to be actively engaged in the learning process. There was, however, a question in some quarters that active participation needed to be demonstrated by the act of composing an answer. Schramm reported

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36 Skinner, "Why We Need Teaching Machines," ... p. 103.

37 Ibid., pp. 102-103.

38 Skinner, "Teaching Machines," ... p. 140.
the findings of research on this topic:

There has been 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 a subvocal response, or no measurable response at all.\(^3\)

Perhaps Stolurow has suggested the reason for this finding:

The "active responding" necessary for learning is not the writing or the button pushing or the page turning or any other motor response required by a program, but consists of the covert verbal behavior that the student goes through when he becomes actively and intellectually involved with the concepts that he reads.\(^4\)

Deterline admitted that if a programmer could be sure that covert responses would actually occur, the requirement of the overt response would probably not be needed.\(^5\)


Skinner used the response as one component of the learning cycle. He had to insure that a response was elicited from the learner. He apparently was unwilling to assume that the response would be made covertly.

4. Immediate and frequent reinforcement—position and rationale.—The fourth characteristic of linear programming is that immediate reinforcement of a correct response be given the learner. The idea of reinforcement is based on Thorndike's Law of Effect which states, "When a modifiable connection between a situation and a response is made and is accompanied by a satisfying state of affairs, that connection's strength is increased."

Skinner, in his laboratory experiments, had studied learning and the conditions under which it had been demonstrated. He had found that "once we have arranged the particular type of consequence called a reinforcement, our technique permits us to shape the behavior of an organism almost at will."42 Thus, in his laboratory, Skinner's animals learned certain behaviors in an effort to find food. The stimulus was hunger; the response, the desired behavior; and the reinforcement, food.

Skinner believed that reinforcement had to follow the correct response immediately if the law of effect were to be applied.

It can easily be demonstrated that, unless explicit mediating behavior has been set up, the lapse of only a few seconds between response and reinforcement destroys most of the effect.43

His laboratory work also showed him that reinforcement assumed a role traditionally assigned to the field of motivation when it was applied after the initial learning to maintain the desired behavior. This was done by preparing for an intermittent schedule of reinforcement in the learning program.44

Skinner realized that the combination of hunger and food was not appropriate for use in producing the desired behavior in the classroom. He listed reinforcements available to the pupils as (a) those inherent in the content of the program, (b) those obtained by answering questions correctly, (c) the satisfaction of knowing immediately that the answer was correct, (d) those obtained by manipulation of the device which held the program, and (e) the avoidance of elements of aversive control which might be evident

43Ibid., p. 105.
44Ibid., p. 100.
In classrooms when programmed material is not in use.45

In his program design, Skinner arranged for reinforcement to occur at frequent intervals through the use of his "small steps." A response given after a very small amount of information was presented was apt to be a correct response. The knowledge that his answer was correct, was thought to provide reinforcement to the learner.

Thus, for Skinner, reinforcement was the crucial part of the learning process. To be effective it had to occur immediately after the desired behavioral response. To be useful in changing behavior, it had to be awarded frequently.

**Immediate and frequent reinforcement—discussion.—**

In a review of the literature, Lumsdaine noted that although much had been written about "feedback," "reinforcement," and "knowledge of results," few studies had experimentally manipulated the reinforcement factor as it operated in practical instruction.46 Skinner had identified two roles


of reinforcement: 47 (1) in acquiring desired behavior and
(2) in the maintenance of that behavior.

Two other aspects of reinforcement were thought to
be present in research studies and to contaminate the
results:

1. Knowledge of results offers the learner addi-
tional information.

Annet included a historical review of the investiga-
tions which led to this conclusion. In addition, he
pointed out the impossibility of separating the informa-
tional aspect of knowledge of results from its motivational
aspect. 48

2. Knowledge of correct results (KCR) statements
offer different amounts of information.

Lumsdaine organized his report to demonstrate that
the amount of information included in the KCR statement
affected the success of the learner. In the studies cited,
it was found that more learning accrued when the correct

47 Although Skinner listed several reinforcers avail-
able for use in the classroom (see page 54) the one referred
to in this section is knowledge of correct results.

48 John Annet, "The Role of Knowledge of Results in
pp. 279-286.
answer was given than when only a "right" or "wrong" statement appeared. Most learning occurred, however, when the correct answer was given in the context of the question.49

Another problem discussed by Lumsdaine concerned the kind of feedback provided by KCR statements. He spoke of "differential" feedback or an invariant feedback which might occur if the KCR statement appeared to one learner as a confirmation and to another as a correction. The KCR statement would be the same but the interpretation made by the learner would be different. He hypothesized that this ambiguous role of KCR-feedback would figure in the theoretical interpretation of experiments.50

Despite the confounding elements that tend to make research studies in the area of reinforcement inconclusive, the reinforcement feature of linear programming as proposed by Skinner continued to be used. Deterline summarized:

Although there are many other kinds of mechanical and non-mechanical devices, many different kinds of auto-instructional formats, and even different theories to how and why the materials function, the one common feature of all of these different approaches

49 Lumsdaine, "Instruments and Media of Instruction," . . ., p. 620.

50 Ibid.
to classroom technology is the immediate feedback given the student.\textsuperscript{51}

\textbf{Intrinsic programming.}

The late 1950's appeared to be an important period in the history of programmed instruction for several reasons, the most important being that during that period a second form of programming was introduced. Its spokesman, Norman Crowder, applied the term "intrinsic" to this programming technique to describe the direct relationship between the behavior of the learner and the subsequent program sequence.\textsuperscript{52} Crowder perfected intrinsic programming while designing training programs for the Air Force Personnel and Training Research Center.\textsuperscript{53}

In a Crowder program, a unit of the material to be learned is presented in an expository passage that is usually a paragraph or less in length. This passage is


\textsuperscript{53}Lumsdaine and Glaser, Teaching Machines and Programmed Learning . . . ., p. 260.
followed by a multiple-choice question. The learner, after making his answer selection, is referred to a page in some other portion of the book where he is informed as to the correctness of his answer. If the student selected the "correct" answer he is thought to be ready for the next portion of the learning material. If, on the other hand, he has selected a "wrong" alternative, he is directed to material designed to correct his misunderstanding and from there back to the original passage with instructions to select another alternative. In this way, the student is exposed only to that portion of the program found to be necessary for his understanding. 54

The alternative sequencing, the expository passage, the multiple-choice question and the scrambled text are unique characteristics of Crowder's programming technique. A brief discussion of them will be presented in the following section.

Alternative sequencing.—The sequence of the material presented via an intrinsic program was organized prior to

publication so that the learner could progress logically toward certain pre-determined learning objectives. In this sense the intrinsic program followed a fixed sequence. However, Crowder's material provided the alternative sequencing pattern by the addition of looping sequences branching from and returning to the direct route toward the program objectives.\(^5\) Crowder felt that by providing students with different amounts or kinds of learning materials he would be more successful in accommodating the individual differences among learners.\(^6\) Although Crowder claimed to make no assumptions about how people learn, he did say, "... we suspect that human learning takes place in a variety of ways and that these ways vary with the abilities and present knowledge of different students, with the nature of the subject matter, with a number of interactions between these sources of variation, and with other

\(^5\) There are linear programs which have a "branching" feature. However, they retain other features of the linear program.

\(^6\) Crowder, "On the Difference Between Linear and Intrinsic Programming," ... p. 149.
sources of variability of which we are not even aware.\textsuperscript{57}

\textbf{Alternative sequencing--discussion.--Crowder}

suggested several of the kinds of alternatives needed in constructing a frame.

One alternative may be provided to catch a particular procedural error and lead to a single corrective presentation; a second may lead to a corrective subsequence; whereas a third alternative may detect an error of interpretation on a point made previously and lead the student back to that point in the program to work his way up again.\textsuperscript{58}

The major problem relative to the construction of alternative sequences arose in the identification of the most valuable of those possible. Green, in discussing the relative difficulty encountered in constructing the linear and branching (intrinsic) programs noted:

The branching program creates a small set of straw men that are easy for the programmer to demolish because he tends to select those straw men which are demolishable.\textsuperscript{59}

\begin{itemize}
\item \textsuperscript{58}Crowder, "Intrinsic and extrinsic programming," . . ., p. 60.
\end{itemize}
The intrinsic programmer sometimes arrived at the selection of alternative sequences by anticipating errors. Crowder, in the context of explaining the similarities between the functions served by completion and multiple-choice questions, pointed to the fact that for some questions the number of sensible answers is quite limited. In such a case, the programmer likely would be successful in using the technique of anticipation.

Markle, however, pointed out that sometimes the "logical" errors determined by the programmer were not those experienced by the student. She suggested that students be asked to construct answers (rather than make multiple-choice responses) to the program's first draft in order to help identify the needed alternative sequences.

Expository passage.—The purpose of the expository text was to communicate the material to be learned to the learner. As explained by Crowder, such communication was

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60 Crowder, "Intrinsic and extrinsic programming," . . . , p. 60.

usually attempted by presenting small logical units of learning material in the form usually found in conventional expository texts. At other times, a writer might arbitrarily choose to use (1) a leading question, (2) a formal definition followed by examples, (3) a series of examples leading to a formal definition or (4) an analogy to effect communication.

Crowder objected to the practice of including only minute amounts of instructional material in each frame on the grounds that it would not be suitable for any but the poorest student.

We can produce virtually error-free programs if we are careful never to assume knowledge that the most poorly prepared student does not have, never to give more information per step than the slowest can absorb, and never to require reasoning beyond the capacity of the dullest.

Crowder made the point that the expository passage was only one of the sources of instruction available in an intrinsic program. Others were the question, the answer choices provided, and the remedial material provided. See Crowder, "On the Difference Between Linear and Intrinsic Programming," . . . , p. 148.


Crowder, "On the Differences Between Linear and Intrinsic Programming," . . . , pp. 149-150.
He concluded that the result of such a program would waste the time of the average and the above average student. He argued that "... the pressure of the program should be upward, allowing the student to deal with the material on the highest level of abstraction of which he is capable."  

Expository passage—discussion.—Much of the discussion with regard to the intrinsic programmer's use of the expository passage appeared in debates on the relative merits of smaller or longer units of instructional materials. Skinner, as explained in a previous section, advocated the "small step"; Crowder made use of the longer expository passage.

Perhaps some insight into the different positions held by these men on this point can be gained by examining their backgrounds. Skinner, of course, had been engaged in teaching laboratory animals through a process of conditioning. This process with these subjects necessitated his use of rather small steps or increments of instruction.

65 Ibid., p. 50.

The technique that he perfected in teaching them provided the format for his programming efforts for classroom students.

Crowder, on the other hand, was engaged in the education of adults in the armed services. These subjects were likely to be highly motivated to learn and did learn when the relatively larger amounts of material were given them at one time.

Multiple-choice response.—The student's response to a multiple-choice question following an expository passage served several purposes: (1) it kept him actively involved with the instructional materials, (2) it served to direct the student to subsequent portions of learning material deemed to be appropriate for him, or (3) it could, when the occasion demanded, be used in an instructional sense.

By far the most important of these for the intrinsic programmer was the use of the response to direct students


through the program. If the student answered all the questions correctly, he could proceed through a program by the shortest possible route. Those making one kind of incorrect response would be directed to an alternative route where instructional material designed to overcome a particular misunderstanding would be found. A different incorrect response would direct the learner to a different alternative route where he, too, would find appropriate material to correct his problem before allowing him to return to the main route toward program completion.

A less-frequently recognized purpose of the multiple-choice question was one in which it was used to satisfy an instructional need. Crowder suggested three situations in which this use was appropriate: (1) in directing the student's attention sharply to a key point of a paragraph, (2) in suggesting solutions to problems and (3) in providing practice when needed.\(^69\) Crowder also believed that occasionally the multiple-choice question could be used to determine whether a student could omit an entire block of material.\(^70\)

\(^69\)Ibid., pp. 147-148.

\(^70\)Crowder, "Intrinsic and extrinsic programming," ... , p. 60.
Multiple-choice question—discussion.—Crowder worked under the assumption that a correct answer to the multiple-choice question indicated understanding of the expository material on which the question was based. In reality, the correct answer may have been selected as a result of other processes as shown by this list prepared by Calvin: (1) the answer may have been guessed, (2) it may have been reached by the process of elimination, or (3) it may have been the nearest approximation to one constructed by the learner although that one was badly wrong.  

Crowder planned to use the act of selecting one of the alternatives of a multiple-choice question as the mechanism to direct the student to the instruction for which he demonstrated a need. The assumption made here was that the learner would follow instructions and attend the instructional material offered. A mis-use of this mechanism would allow the participant to skip the explanations and continue to select other alternatives until the correct one was finally located thereby side-stepping the remedial provision included in the test.

Concerns relative to the use of the multiple-choice

question included that of providing erroneous material for perusal by the student. Green spoke to this point:

One well-known objection to the multiple-choice examination has been that the student may learn... an incorrect answer to a question. Presenting three times as much erroneous material as correct material to the student raises the likelihood that this erroneous material will ultimately be retained instead of the correct associations that the student should establish.\(^{72}\)

Another point about the multiple-choice question that stimulated discussion in the early 60's involved the level of thinking evoked in arriving at an answer. It is commonly regarded that to recognize a given answer as being correct requires a lower level of thinking than that needed to recall an answer with no prompts given. The multiple-choice question requires recognition. The assumption that the multiple-choice question necessarily stimulated only the lower level of thought was not shared by Crowder. He stated that he could design questions for the students which would evoke any desired level of thinking.

... the questions set for the student may be of any level of difficulty we judge to be desirable... since we have a means to deal specifically with errors.\(^{73}\)

\(^{72}\)Green, p. 144.

Deterline, too, argued that the degree of learning was not always a function of the type response required. He concluded that many of the available Crowder-type programs required active problem solving behavior before any of the listed alternatives appeared plausible.\footnote{Deterline, p. 42.}

Green concurred by saying that the degree of reasoning required of a student was a function of the frame construction rather than a characteristic of either the linear or intrinsic programming technique.\footnote{Green, p. 145.}

Scrambled text.—The programmed text is arranged in "scrambled" or random order. Although the page numbers appeared in consecutive order, the content did not. On one page, the learner was provided with the expository passage which was followed by a multiple-choice question to which several alternatives were provided. Following each alternative was a referral to a numbered page. The student was expected to read the instructional material, to select
one alternative answer and to turn to the page indicated. The page references were typically to non-consecutive pages and the learner would be asked to move back and forth in the text to continue his sequence of instruction.\footnote{Stolurow, pp. 38-40.}

Crowder reasoned that by arranging the instructional material in this way that learning was insured since the only way the learner could complete the program was by demonstrating initially or after remediation that he understood.\footnote{Crowder, “On the Differences Between Linear and Intrinsic Programming,” \ldots , p. 147.}

**Comparison of Linear and Intrinsic Programs**

The objective of both schools of programming, linear and intrinsic, was to produce materials that permitted efficient individual study by a student without the continuous intercession of a live instructor. The programs developed by each school displayed similarities as well as differences. A brief summary of these follows:

1. Fixed sequence vs. alternate sequence--The format of the linear program provided for the completion of the total program in a direct sequence from beginning to end. The intrinsic format made it possible to divert the learner to branches only when he had demonstrated a need for them.
2. Size of step—Although both provided relatively small amounts of informational material per frame, the linear's size of step, on the average, was considerably smaller than that of the intrinsic program.

3. Response—Both demanded frequent and overt responses from the learner in order to keep him actively involved with the program. Because of the larger size of step, the intrinsic program required less frequent responses than did the linear.

The linear program required a constructed response to a completion question while the intrinsic required a selected response to a multiple-choice question.

The linear program expected to elicit a correct response so that it could be confirmed. In the intrinsic program a correct response was not necessary since provisions had been made for dealing with errors.

The reason for the response in a linear program was to allow the correct answer to be practiced but, more importantly, it allowed reinforcement to be brought into play. The reason for responding in an intrinsic program was primarily to direct the student to the next portion of the program.

4. One of the ways in which reinforcement could be brought into play was to inform the learner that his answer was correct and in both programs the student was given an indication of the correct response. Reinforcement, however managed, was a far more important concept to the linear program than to the intrinsic one. It was the raison d'être for the small step, frequent and correct response with immediate confirmation. It completed the conditioning process through which learning was thought to take place.
Advantages of Programmed Instruction

Although programmed instructional material can be presented by various mechanical devices, the primary concern of this study involves the use of programmed texts. The list of advantages which follows includes those attributed by experts in the field to the use of well-constructed programmed texts.

1. The learner can progress through a programmed text at an individual rate.

It was reported that the time which an individual took to complete a program was affected by his (1) work habits, (2) ability to master the program content,78 (3) rate of learning, (4) preferred mode of learning,79 and (5) attendance record.80


The linear program with its constructed responses, fixed sequence, and small steps to program completion was found to take more time to complete than was an intrinsic program of similar content and difficulty.\(^{81}\)

2. The program can hold student attention.

This reportedly was the result of (1) frequent responses required of the student and the immediate feedback or knowledge of the correctness of the response.\(^{82}\)

3. As illustrated by Gagné, progress through the program could begin at the highest level at which the student had demonstrated understanding.\(^{83}\)

4. The use of the programmed text made it possible to offer constant encouragement and reinforcement to each student as he progressed toward the prescribed goal of the program. The instructional sequence was described as being patient, impartial, and predictable and constant in its requirements for each student.\(^{84}\)


\(^{83}\)Gagné, pp. 115-131.

\(^{84}\)Phil C. Lange, "Introduction, Section III," Programmed [sic] Instruction, The Sixty-Sixth Yearbook of the
5. It offered an alternative means of instruction\textsuperscript{85} which could be used (1) with students who preferred to learn in this way, (2) with content which could be taught more efficiently through its use, or (3) according to Hartley, with all students for short periods of time\textsuperscript{86}

6. Through the wise and judicious use of programmed texts, teacher time could be used more productively\textsuperscript{87}

7. Included in the program description was the validation data accumulated during the construction and the testing of the program. The use of this information could facilitate the wise expenditure of funds for instructional materials\textsuperscript{88}

8. If teachers were instrumental in developing programmed materials, the process of programming, according to Lindvall and Bolvin, could


\textsuperscript{88}Markle, "Empirical Testing of Programs," .....

p. 134.
contribute to the understanding of the process of instruction. 89

9. The attitude toward programmed instructional materials of students engaged in short term studies tended to be positive.

After reviewing the literature, Hartley concluded that (1) findings of most of the short term studies indicated that 70 to 90 percent of the students responded favorably to programmed instruction while in the remainder of the studies students took a more neutral position and (2) students using programmed materials preferred to receive instruction not from the program alone but in combination with that of the teacher. 90

Disadvantages of Programmed Instruction

On the other side of the ledger, some problems or difficulties which have arisen as a result of efforts to include programmed materials in the instructional program have been reported in the literature. Some of these reviews point out limitations of the programs themselves while others note problems which might arise as a result of using a program—presumably even a well-constructed one. In the text which follows, problems associated with the first group will be labelled Limitations of programs while

89 Lindvall and Bolvin, p. 218.

90 Hartley, p. 4.
those problems arising from the use of programmed materials will be labelled Problems of program use.

Limitations of programs.--

1. Many needed programs have not been developed.

Whether the purpose of the program in the curriculum was to supply (1) the content for a unit or for a total course, (2) material for remedial work, or (3) enrichment for selected pupils, the procurement of programs to teach defined objectives was often impossible. 91

2. Of the programs developed, some were of inferior quality.

Lindvall and Bolvin observed, "Some [programs] . . . are poor in terms of quality of content they teach, others are deficient in their teaching effectiveness, while many are inadequate in both respects." 92

91 Lindvall and Bolvin, pp. 224 and 242.
92 Ibid., p. 224.
3. Individual differences were only partially accommodated by programmed instructional materials.

The claims that programmed materials accommodated individual differences usually referred to (1) the amount of time spent or (2) the amount of material covered by the student before reaching the program's objective.

Other differences between individuals such as learning styles, work habits, etc. were not specifically considered. For example, some gifted students reportedly were irritated by the overt response requirement and by the slow progress through the instructional material. Other students appeared to require an instructional situation in which they could interact with the "live" teacher periodically. Some procrastinators were not sufficiently motivated to complete the program.

Pressey questioned whether linear programs accommodated individuals even with respect to time taken to complete. He claimed that programs were bulky and wasteful of student time. To illustrate his point he reduced a 1,110 word linear program to a 360 word statement and, through its use, was able to reduce the time required

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93 Hartley, p. 4.
for student learning from 23 to 1½ minutes. 94

4. Some children did not learn from programmed materials.

Ofiesh and Meirhenry reported that during construction a program was "debugged" or revised until it could "teach" 95 to 98 percent of the target population. 95 This level of effectiveness appeared to be the level generally accepted by programmers since these figures appeared frequently throughout the literature. Using this impressive degree of effectiveness, one tends to overlook as insignificant the 2 to 5 percent of the pupils who did not learn satisfactorily via programmed materials.

One must keep in mind also that the particular 95 to 98 percent of the students who reportedly learned when using programmed texts were in most cases, the students who comprised the target population, that is, the student for


whom the program was designed. Markle found that the pro-
gram on etymology which she had constructed and found to
be satisfactory for her target population in New England
was too difficult for a group of children of the same age
group from the New York City's urban area.96

One of the reasons that some children fail to learn
from programmed texts was given as their inability or un-
willingness to use correctly the features of the program
format. Gotkin reported that some of his subjects made
many errors in comparing their answers with those provided
in the program.97 The literature contains numerous refer-
ences to the practice of the child "cheating" by looking
at the answer given in the text before producing one them-
selves. The seriousness of this with respect to learning
has not been fully determined. Calvin reported that learn-
ing loss did not seem to be significant if cheating was
intermittent. He pointed out that the occurrence of


97 Lassar G. Gotkin and Joseph F. McSweeney, "Learn-
ing from Teaching Machines," Programed [sic] Instruction,
The Sixty-sixth Yearbook of the National Society for the
Study of Education, Part II, eds. Herman G. Richey and
Merle M. Coulson (Chicago: The University of Chicago Press,
"rote cheating" was minimal.98

5. The cost of constructing a program is comparatively high.

Coulson reported:

Another inherent feature of programmed instruction is that it represents an investment in production time and money far greater than that required for textbooks and the usual courses of study.99

6. The use of the programmed text for study purposes of clarification, reinforcement, or review was difficult.

Pressey suggested that programmed materials had no use except for the initial "go through." Study skills such as the skimming for main ideas and those tactics employed in reviewing could not be used when the material being studied was programmed.100


Because of its scrambled arrangement the intrinsically programmed text would appear to provide a greater disadvantage in this respect than would one of linear design.

Problems of program use.—In the following section the problems arising from the use of programmed texts in an institutional setting will be presented.

1. Teachers may have had little understanding of programmed materials and may not use them efficiently.101

2. The attitude of teachers with regard to programmed materials was thought to affect student achievement.

Tobias found that teachers had a more favorable attitude toward terms which described traditional educational devices such as Flash Cards, less favorable attitudes toward terms stressing programming and least favorable attitudes toward terms connoting technology such as Automated Instruction.102

101 Lindvall and Bolvin, p. 228.

Archer found that the more positive the teacher's attitude toward programmed instruction the higher the achievement level of the students.\textsuperscript{103}

Markle, in discussing the differences which were apparent in a laboratory situation as compared to that of the classroom stated:

\ldots There is little doubt that the teacher's attitude toward the materials is a significant factor in both student attitude and student performance.\textsuperscript{104}

3. The role of the teacher may need to be redefined.

With the assignment of programmed materials, the duties of a teacher might be redirected toward (1) working with individual students rather than with groups of students, (2) administering a program of initial and ongoing assessment so that programmed materials could be adapted specifically to student needs, (3) preparing and securing a variety of additional instructional materials for use by


\textsuperscript{104}Markle, "Empirical Testing of Programs," \ldots, p. 136.
students who finish their study early, and (4) utilizing efficiently the services of the non-teaching aide when such services are provided in a program of individualized instruction.105

4. The objectives of the programmed text and those of the teacher might be in conflict.

Markle discussed the possibility of conflict arising between the teacher and the program (1) when the teacher disagreed with "some definition or principle or procedure" promoted by the programmed material, (2) when, in the period of curriculum revision, conflict between the "new" and the "old" occurred, (3) when a different emphasis was given to coverage of the various areas within a subject or (4) when different levels of understanding were thought to be required.106

5. Difficulties were sometimes encountered when an attempt was made to incorporate programmed instructional materials into a traditional graded organization.

Lindvall and Bolvin explained that:  

105Lindvall and Bolvin, p. 229.

The use of programs on an individual basis... leads to problems in advancing students from grade level to grade level or from class to class. It may well demand a much more flexible organization than is afforded by a graded plan as well as some procedure for organizing the curriculum sequence that is not geared to having everyone complete a set amount of content in one grade or in one course.

**Criteria for Program Selection**

The rapidly growing interest in programmed instructional materials in the late 50's prompted several responsible groups to provide educational personnel with a list of criteria which could aid them in their selection of suitable instructional programs. In the following section five such lists will be reviewed. These were chosen for inclusion here because they were the work of reliable and responsible groups and because their recommendations represented a comprehensive coverage of items to consider when choosing programmed material. They will be presented in chronological order.

The first list of criteria—**The Interim Statement of Policy on Criteria for Programmed Materials** was prepared by a committee whose membership included representatives from the American Educational Research Association, the

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107 Lindvall and Bolvin, p. 225.
American Psychological Association, and the Department of Audio Visual Instruction of the National Education Association. The release contained brief statements about the nature of the teaching machine and the characteristics of the programs they carry. The authors recommended that the prospective purchaser (1) assess the availability and quality of programs, (2) inspect the content of programs in order to identify objectives and scope of coverage, (3) examine data made available by the producers of the program by noting the characteristics of the population for which it was produced and the conditions under which the data were gathered, and (4) experiment with the program in the school before making the decision to adopt self-instructional material on a large scale.

The following year the Joint Committee issued a second report which received immediate acceptance and continued to be recognized as the most important document of its kind. The report elaborated on the descriptions of teaching machines and programs and added a section dealing expressly with criteria for assessing programs. The

Committee recommended that internal and external characteristics of a program be studied. Internal characteristics were those which were revealed by visual inspection. For instance, by inspection, an educator could estimate how well his own instructional objectives would be supported by the content of a program and could ascertain the relative emphasis given to the various subtopics within it.

External characteristics, on the other hand, referred to features not readily determined by inspection. These included: the source of the content; the author's qualifications; information about program development, tryout, and revision; and test data relative to program effectiveness as judged (1) by its ability to produce gains in student achievement and (2) by the time required by the student to achieve these gains.

Again, recommendations were included regarding the advisability of experimentation with the program before expending large sums of money for it. They advised those in school systems where large purchases were anticipated to equip themselves with a technical consultant who could interpret the testing and measurement data supplied with the programmed material by the publisher.

They recommended to the publisher that a manual be
prepared for each program released. The information which
the committee hoped would be placed in the manual included
(1) a description of the population for whom the program
was designed, (2) a description of the physical and social
conditions of the program's use, such as the supervision
employed or incentives used, in such detail that the
essential features could be replicated by other investi-
gators, (3) a description of the students' use of the
program relative to time to complete, effect of ability on
program performance, or level of performance on pre- and
post-tests.109

In July of 1963, the Standards Committee of the
National Society for Programmed Instruction issued a check-
list to be used by the teacher or training director in
evaluation of a particular program. It directed attention
to four major categories: (1) curriculum, (2) student
characteristics, (3) economics, and (4) program effective-
ness. In addition to the curricular considerations of
time allocations necessitated by the use of programmed
materials and the "fit" of the educational objectives, the

109 "1962 Interim Report of the Joint Committee on
Programed [sic] Instruction and Teaching Machines," The
Journal of Programed [sic] Instruction, II (Spring, 1963),
p. 57-67.
teacher was asked to consider any changes that would have to be made in her present teaching methods and to determine whether such a change would be justified by the adoption of the program.

In the area of student characteristics, in addition to questions relative to the student's meeting prerequisite skills, the teacher was asked, "Is there a provision for a well-prepared student to enter the program at some place other than the beginning?"

The most unique portion of this checklist was that dealing with the practical aspect of economic cost. The question was asked, "Is the purchase, use, and maintenance of the programmed course within the economic means of your school or training program?" The teacher was asked whether the materials could be used more than once, or, in the event that a machine was required, could it be used to carry additional programs and could it be maintained in a satisfactory condition.

Teacher attention was also directed to examine supplementary materials for remedial or enrichment purposes which the publisher had included with the program.

The teacher was advised to get the recommendation of one who had previously used, in an instructional setting,
the program under consideration.110

In 1963, the NEA utilized a filmstrip and an accompanying booklet to explain programmed material to teachers and to give them some direction for implementing its use in the classroom. The teacher was encouraged to develop her own criteria for the selection of a program. Frame 40 suggested that a satisfactory list might include "Is the program worth learning, relevant, compatible, effective, and efficient?"

After finding a likely program, the teacher was directed to construct a test over the contents. The test could then be given as a pre-test and post-test for three volunteer students who represented the range of abilities in her class. The results of their interaction with the program and the gains in achievement occurring during their work could then be used in her decision to continue use of the program.111,112


111The Selection and Use of Programed [sic] Materials (Washington: Department of Audiovisual Instruction of the National Education Association of the United States, 1964), Film Strip, 63 frames, color, with LP record.

In 1964, the State Department of Education of New York issued a handbook for the state's educators which included a list of criteria useful in evaluating programmed material. It, of course, leaned heavily on previously reported criteria lists. Its unique contribution was that it urged consideration of the physical construction of the programmed texts. The prospective purchaser was asked to note the binding, the outside covering material, the size and shape for convenience in student handling, and whether the masking device was an integral part of the bound unit.\textsuperscript{113}

In 1966, The Joint Committee on Programmed Instruction issued its third report which contained a reprint of its 1962 Interim Report and three additional sections. Two of these contained supplementary recommendations to publishers for the reporting of data relative to program effectiveness. Of interest in developing criteria for the evaluation of programmed material was the portion entitled "Recommendations for the Prospective Purchaser or User" which summarized the important considerations suggested in previous releases. They offered additional advice to

consult reviews published in professional journals and to locate reports of studies conducted by school systems or national organizations regarding their proposed purchase.\textsuperscript{114}

The final item in this section is included to emphasize the absolute importance of obtaining student evaluation in terms of performance and acceptability of a program. Although the teacher may have many valuable lists of criteria which help her make a wise selection, the decision may not be infallible as the following study may illustrate.

Rothkopf asked twelve educators who had just completed a three week course on programmed instruction to predict the effectiveness of seven programs that had been devised and tested in a previous study. Each member of the group was asked to (1) read through each program and (2) at each completion assign a grade A through F according to "whether they felt the treatment to be effective in inculcating the required test skills." The results of their ratings were compared with the actual

\textsuperscript{114}The Joint Committee on Programmed Instruction and Teaching Machines, Recommendations for Reporting the Effectiveness of Programmed Instruction Materials (Washington: National Education Association, 1966).
performance of students who had completed the program study. Rank correlations between the ratings and the performance was -.75. The author concluded, "Although the magnitude of the negative correlation is somewhat surprising, the observed failure to predict instructional effectiveness from simple inspection of the training material is not."**5

Student Interaction With Programmed Material, Grades Four Through Eight

This final section of the review of the literature contains findings of correlational studies in which characteristics of the learner and his interaction with programmed instructional materials are examined.

The studies selected for inclusion here are those in which (1) instruction was presented to the student by means of a programmed text, (2) a correlation was made between a measure of achievement in learning and some characteristic of the learner himself or the condition under which he worked, and (3) the grade placement of the students approximated that of the children being

examined in the present study—grades four, five, six, seven and eight.

The decision to include these grade levels was based on several factors. Grade Four was selected as the lower limit of the study since it is generally accepted as the beginning of the intermediate grades where the level of reading skills and concept development makes possible the development and use of study skills. Grade Eight was selected as the upper limit to provide a range of plus-or-minus two from the sixth-grade target population. It was concluded that this span would likely approximate the range of abilities found in a typical classroom.

The studies selected for review are presented chronologically by grade level with those of the fourth grade being presented first. A summary of these investigations concludes the section.

**Studies involving pupils on the fourth-grade level**

In 1962, Gotkin and Goldstein completed two studies in which they attempted to test the effect of two different environments on achievement via a commercially available 100 word spelling program. In both studies the work was
completed satisfactorily but the group assigned to complete their programs at home took more time to complete it than did the second group who completed theirs in the classroom. Two hundred five children were involved in the two studies and both groups studied a linear program.  

Woodruff, et al., in 1965, investigated the relationship of the learner's reading ability and his responses to a commercially available spelling program. Pupils were matched on the basis of IQ and grade level. One subject of each pair read at least one grade level above his school grade and represented the high reading group. The other read at least one grade below his school grade and represented the low reading group. They found a significant difference in favor of the high reading group in the number of correct responses (performance) each group made to the 999 frame program.


Glaser, *et al.*, reported two studies in 1966 in which commercial programs were used with fourth grade students. In the first an attempt was made to assess the extent to which learning via programmed materials was influenced by the intelligence of the learners. A multiplication and division program of linear design was given to 173 students who worked in class for approximately 3 hours a week throughout a six-week period. Correlations between the IQ scores as measured by the Otis Quick Scoring Mental Abilities Test and post-test scores was .19 which caused the authors to conclude that "intelligence as measured accounted for very little of student achievement." 118

The second study was designed to explore the hypothesis that incidental classroom stimuli would facilitate or inhibit learning. A three hundred fifty-four word commercially available spelling program was studied by each of three treatment groups. The first group worked in the regular classroom which was described as one in which all subjects including spelling were studied.

Members of the second group worked on their programs in a special room in which only spelling was studied but they returned to their own classroom for the testing segment of the program. For the third group, study and testing were completed in a special room. Analysis of scores at the end of the year indicated that the 169 students of the three treatment groups did not differ appreciably in achievement and the authors concluded that in this study different environmental stimuli had no effect upon learning.119

Carswell, in 1968, designed a linear program to teach six map reading skills to a group of 15 classes composed of fourth, fifth, and sixth-grade children. Each of the groups made significant gains in their map reading skills. Correlations between a post-test measure and several variables resulted in the following: MA and post-test, .63; grade level and chronological age and post-test, low significant relationships; and no correlation between sex of student and his post-test scores.120

119Ibid.

In 1969, Dutton and Riggs conducted a study using 68 fourth- and 74 fifth-grade students and a program they had prepared for the teaching of graphs. The study took seven days—five for study and two for testing. They found that (1) student reaction to the programmed learning situation was favorable, (2) predictions of pupil performance on the post-test could be made from IQ scores or from prerequisite skill test scores and (3) the sex of the pupil was irrelevant to improvement in the skill of graphic interpretation produced by the programmed text. Of interest to this study was their report that 37 of 68 fourth-grade students (54%) asked for help with words while 39 of the 74 fifth-graders (49%) asked for similar service.121

Studies involving pupils on the fifth-grade level

In 1968, Herr and Tobias completed a study in which 197 fifth-grade and 23 sixth-grade pupils drawn from low and middle socio-economic backgrounds were given Latitude and Longitude, a commercial program of linear design, as

part of their regular curriculum. They found correlations between post-test achievement measures and reading to be .55, and with pre-test scores to be .57. A multiple correlation of both these variables with the post-test was .66. Differences in achievement between socio-economic levels did not reach an acceptable level of significance when reading ability differences were held constant.

They concluded that the differentiating variable in determining the amount a pupil gained from a program was reading level, not SES level. They found no support for the claim that programmed materials were especially advantageous for disadvantaged youngsters.

After a discussion of readability level of the programmed text, the authors suggested that one should determine the minimum reading level required by a particular program so that necessary adaptations could be made to accommodate the learner.

They also cautioned that the placement of pupils in one of the two socio-economic levels was not made on the basis of the individual but on the basis of the type of school attended. Those youngsters classified as "low
socio-economic attended schools receiving special services in poverty areas.\textsuperscript{122}

In 1968, Mueller compared the effectiveness of an experimental programmed approach with that of a traditionally programmed text when teaching a mathematical concept to 478 fifth and sixth-graders. He found that children with a high reading ability performed significantly better than did those of low reading ability. This was true with either method of teaching.

His subjects were drawn from low and middle socio-economic levels. Prior to instruction, he found significant class differences favoring middle class boys in both instructional groups and with girls in the experimental treatment group. After instruction, class differences were no longer significant on the post-test criterion for the experimental group while with the traditionally programmed text group class differences were unchanged.

No significant differences were found when sex differences were investigated on pre- or post-tests for either treatment group.  

Fanning, in 1969, attempted to study the efficiency of two methods of using a commercial program to teach latitude and longitude to two sets of eighteen randomly selected classes of fifth-grade subjects. In the first method the teacher was provided with a manual and was permitted to interact with the program. In the second method, no teacher interaction was permitted. Classes were held 30 minutes per day for three days a week until the ten chapter sequence was completed.

In his analysis he found that while the teacher-supplemented method of program use tended to be less efficient than the program-alone method, it was significantly superior in terms of pupil achievement.

He also found a "marked" relationship between pupils' standardized reading scores and their Modified


124 Efficiency was defined as the ratio of Modified Gain Scores to time to completion.
Gain Scores which he said offered some evidence that good readers perform well with programmed materials and poor readers perform poorly.

Pupil's sex appeared to have no effect on pupil performance in either control or experimental groups.

Analysis revealed that while the classes from schools with lower socio-economic designations appeared to achieve significantly lower mean pre-test and post-test scores than did the classes from the higher socio-economic designation (Non-Special Service), these differences did not appear when Modified Gain Scores and efficiency ratios were used for either the experimental or control method of program use.  

In 1969, Hoch used two different techniques described as "scheduled and non-scheduled" in presenting an identical programmed text to all the fifth-graders in two school buildings. His subjects were divided into two ability groups designated as high and low ability. A comparison of post-test scores of the two groups caused him to conclude that both methods of presenting the

materials were equally effective with the high and low ability groups and that sex differences did not influence achievement. He did find that the high ability level group scored significantly higher than did the low ability group on the post-test measure.126

In the Draper project, a commercial program was given to two groups of fifth-grade pupils divided into high and low ability levels on the basis of scores made on the Lorge Thorndike Intelligence Test (low group mean was 105.6 and the high 118.6). The researchers found that members of the high ability classrooms consistently achieved higher scores and took more time to read the program than did those of the lower ability classrooms.127

Studies involving pupils on the sixth-grade level

A commercial program was used to teach spelling to 60 students in Columbus, Ohio, in 1962. It was found that


the first students to complete the program did so in four weeks with the last finishing during the eighth week. The control group completing a similar amount of work took 12 weeks. The experimenters were led to conclude that students—particularly average and above (IQ)—saved time when using programmed materials for spelling instruction.

In 1968, Bassler completed three studies in which he attempted to assess the relative effect of two methods of instruction which purportedly involved varying the amount of guidance offered by two sets of programmed learning materials. He found that for both methods of instruction, mean scores for the high ability group were significantly higher than were those of the middle group which, in turn, were significantly higher than those of the lower ability group. Significant differences favoring the maximal guidance group were found. It was concluded that when mathematics instruction was provided by means of a linear program a relatively high level of guidance should be provided.

128 "A Comparative Study of Spelling Test Scores Involving Teaching Machine and Textbook Methods of Teaching Spelling to Sixty Columbus, Ohio, Sixth Grade Students," Columbus Public School System, Columbus, Ohio. (Xeroxed)
In his discussion, he relayed the observations of his proctors who noted that during the first three class periods the students appeared to be interested in learning and concerned if the answer differed from that given in the program. Later, "perhaps the novelty effect wore off or the program content became more difficult" but some children stopped learning or looked ahead for answers. This change in behavior was noted in some children in each ability group but was more prevalent among those in the low group, that is, for those whose ability was below the mean for the group.

He also noted the relatively low level of performance on criterion measures scored by his group. He anticipated achievement scores of at least 70% on the post-test measure but his sixth grade group averaged only 54%.129

Roach, a music educator, constructed a program designed to facilitate elementary school children's aural-visual perception of music notation. The program contained

six rhythm, five melody, and four review or practice lessons and was given to sixteen students. A pre-test which also served as a post-test was composed of two standardized music tests and a test which he authored. He found significant correlations between the pre-and post-tests and a positive relationship between mental ability and aural-visual perception as determined by the experimental subjects. 130

Studies involving pupils on the seventh-grade level

Klemm, in 1969, compared achievement in spelling of two groups of seventh-grade students many of whom were from Spanish-speaking families. One group of students used a commercial program while the control group was taught in the conventional manner. He found that students of low ability and below-average intelligence made significantly greater gains in spelling achievement when taught in the conventional manner. No difference was found in this respect for the average and above-average student. No significant differences were found in corre-

lations of achievement in spelling with sex of the student, chronological age, language spoken in the home, or the ratio of Language IQ with Non-language IQ as measured by the California Short Form Test of Mental Maturity.\textsuperscript{131}

Aven, \textit{et al.}, constructed a programmed geography unit on China for use with 78 seventh-grade students of average ability. They found that the experimental group finished their programs in about half the time that was used to instruct the 85 member control group by conventional procedures. The experimental group was assumed to have learned more since the mean post-test score for that group was greater than the mean score achieved by the control group—a difference which was significant at the .001 level.

Of interest to this study was the information that

on a 50 point post-test, mean scores for the experimental group were 32.61 (65%) and for the control group 22.47 (49%).

Gildea compared the effect of two methods of instruction on achievement of seventh, eighth, and ninth-grade students in map reading skills. The experimental group used a commercial self-instructional programmed text while the controls received instruction in the "traditional lecture" method. He found that (1) the control group, using 200 minutes, showed significant gains in achievement while the experimental group spending only 85 minutes did not, (2) with the increase in grade level the achievement of the control group rose while that of the experimental group declined, (3) IQ was found to affect achievement gains significantly, and (4) no significant differences were found in attitude toward map reading skills with either group.

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Studies involving pupils on the eighth-grade level

In 1960, Meyer, involving a total of 44 students, investigated the effect of self-scoring on achievement of groups using a vocabulary program. She found that the amount learned by those students who scored their own answers was significantly greater than that of the group whose answers were teacher-scored. She also found that ability in reading as measured by the Stanford Reading Achievement Test showed little relationship to the handling of the materials. The students in her group were drawn from two classes of superior readers and an honors group. Her suggestion that these low correlations be taken in relation to the classes involved seemed advisable. Correlations between gain from pre-to-post-test and pre-test was -.52. She concluded that students who knew little at the start gained more than those whose initial knowledge was more sophisticated.\(^{134}\)

Eigen, in 1962, used the vertical and horizontal formats of a programmed text and the teaching machine to compare the relative effectiveness of the three modes of presenting a commercial program. Correlations that were found appeared to depend on the presentation mode. IQ and reading level were significantly related to post-test scores for the machine and the horizontal programmed text groups whereas no such relationship was found for the vertical programmed text group. The range of IQ for his group of 77 students was 73-142 with a mean of 118, a factor which needs to be considered in interpreting the results of his study.135

In 1965, Woodruff, Shimabukuro and Frey involved 74 eighth-grade students in a year-long programmed course in general science which was commercially available. They tried to ascertain the effect of (1) environment, (2) progress control, and (3) certain learner characteristics on achievement resulting from the use of this program. They found no significant differences in achievement between the groups who completed the program.

in in-class or out-of-class environments or under student or teacher regulation of progress through the course. It was called to the reader's attention that out-of-class students were held accountable to their teachers for their work on the program. They met daily with their teachers during their regularly scheduled science periods.

When all Ss were considered together, first semester and total year achievement scores correlated significantly with accumulated grade point average, reading ability and IQ. In an analysis of second semester achievement scores, these correlations failed to appear, and the authors observed that the loss in correlation appeared to be due to the drop in achievement of the higher ability students. There was also a negative shift in attitude toward programmed instruction during the second semester which was felt to be a contributing factor to the second semester findings.\(^\text{136}\)

Summary of studies involving student interaction with programmed material, grades four through eight

Twenty-one separate studies were reported for the five grade levels four through eight. Among these twenty-one, one involved pupils of three consecutive grade levels and four were carried out at two grade levels. For the purposes of this summary, the findings of these multi-grade studies will be reported only once. In the first section of the summary will be a description of the programs and of the conditions under which they were studied. In the following section the information pertaining to the learner's characteristics and his achievement resulting from the use of programmed material will be summarized.

Program content.—The content of the programs categorized by subject are as follows:

- 6 geography including topics of map reading (2) and longitude and latitude (2)
- 5 spelling
- 4 math including graphs (1)
- 1 science
- 1 vocabulary
- 1 music
- 3 topics not reported

Program source.—The source of the program is identified as either produced by the researcher or obtained
commercially from a publisher. Of the twenty-one studies reviewed:

3 were constructed by the researcher
11 were obtained commercially
7 source not identified

This ratio reflects the interest of this study in examining those programs that can be obtained commercially and should not be interpreted as representing the ratio of program sources that can be found in the literature. Several studies in which the researcher had authored his own program were not included in this review because no description of any efforts of program validation were included in the report.

The program content identified by source is as follows:

1. Commercially available
   
   3 geography including longitude and latitude (2) and map reading (1)
   1 science
   1 math
   1 not identified

2. Researcher produced

   1 math
   1 vocabulary
   1 music

The observation made by Deterline, that programs seem to be generated from subject-matter areas where
objectives are easy to identify, seems to be borne out by these lists.

**Program format.**—The format of the programs was given in eight instances and eight reported using the linear format, none reported using the intrinsic format. One of these studies reported comparing the vertical and the horizontal arrangement of the linear form. In the vertical format the student was asked to complete all the frames on one page before he turned to the next while the person following a horizontal format was required to turn the page after each frame.

**Guidance.**—Of the twenty-one studies reviewed only six investigated the guidance factor directly and an additional one provided useful information concerning the need for teacher assistance during a period of programmed instruction.

Of the six:

1 reported that if students scored their own answers achievement was enhanced

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2 said guidance had little effect or accounted for no significant difference in achievement.
1 found that with guidance pupils took less time to complete the program.
1 concluded that achievement was enhanced by the teacher direction.
1 found that "maximum guidance" from the program improved achievement.

Other information that sheds some light on the need for teacher assistance was given by Dutton and Riggs. At the fourth-grade level, 54% of the youngsters asked for help with words and at Grade Five 49% asked for similar help.

The evidence cited above does not clearly indicate whether teacher guidance correlates significantly with pupil achievement in learning from programmed material. However, if reading the words contained in a program poses a problem for students, some kind of teacher assistance would appear to be necessary. The information provided by the researchers indicated that 37 youngsters asked for help in pronouncing words. Whether each child asked for help for only one word or for a dozen was not revealed but one can expect that comprehension of the reading material will suffer if too many words are unknown.

Program length and student reaction.--The length of the programs ranged from 5 days to 1 year and the
reactions from favorable to negative. Consistent with other reports in the literature, the positive attitude was recorded for the study of short duration. The Woodruff study at the eighth-grade reported favorable reaction to the first semester's work but negative reaction to the second. They also found that student performance, especially that of the superior student, declined during the second semester. They did not investigate the reasons for the second semester performance.

Learner characteristics.—As indicated on the first page of this chapter the second major purpose of this study was to investigate the relationships between achievement via programmed material and the learner characteristics of this population for the purpose of identifying those relationships which were significant. The learner characteristics of interest in this investigation are those recorded on the child's permanent record which include: sex; age; prior grade; IQ; and reading, language, and arithmetic abilities. The summary will continue by reporting the findings for these areas.
Learner characteristics: IQ.—Although one study reported a correlation between achievement and IQ of only .19, the remaining found more significant and positive relationships. Dutton and Riggs, on a short term study, claimed that the post-test score could be predicted from the IQ score; Gildea found that IQ "affected achievement significantly"; while O'Reilly found a "positive relationship between achievement and verbal IQ." Eigen found a significant relationship between post-test scores and a horizontal form of a linear program but not for one of vertical construction and Woodruff found a significant relationship between IQ and the first semester achievement but not for that of the second. Hoch and Bassler observed that high ability students scored higher on post-test measures than did lower ability youngsters. This same observation was made in the report of the Draper project. Bassler noted that lower ability children tended to look ahead at the answers more than did the higher ability group and Klemm found that lower ability children achieved more under conventional classroom teaching while no significant differences in the responses to two modes of teaching were recorded for the average or above-average group.
The majority of the ten studies in which IQ was a factor subjected to examination have indicated that there was a positive relationship between achievement and IQ. However, the evidence presented also pointed up the likely possibility that other factors relative to (1) presentation form of the program, (2) duration of the study or (3) teaching method may interact with IQ and achievement scores to influence correlations found.

Learner characteristics: MA.—Only two studies investigated MA and both found positive relationships with student achievement. Roach found a positive relationship between MA and aural-visual perception in music and Carswell found a .63 correlation between MA and achievement on post-test measures.

Learner characteristics: CA.—Carswell, in his study involving the fourth, fifth and sixth-grades found a low significant correlation between CA and achievement. On the other hand Klemm, working with seventh-graders found none.

The difference in findings might be explained in terms of readiness or prerequisite knowledge necessary for successful use of the program. The fourth-grader could
be expected to have less background knowledge of any subject than one would normally expect of the sixth-grader. This would be particularly true in the content of Carswell's programmed text—map reading skills. The Klemm study used a spelling topic for which the members of the seventh or the eighth-grades are as well-prepared as they are likely to be.

**Learner characteristics: sex.**—In all six of the six studies in which the effect of sex on achievement in the study of programmed materials was examined, the verdict was the same—no relationship.

**Learner characteristics: prior grades.**—Woodruff, the only investigator to report on this variable, found a significant relationship with the first semester and the year's achievement but not for the second semester. As was explained previously, the performance of his group declined during the second semester.

**Learner characteristics: reading ability.**—Six studies reported the results of their investigations of the relationship of reading skills of learners with their achievement on programmed study materials. Only one of
these, Meyer, reported that the reading skills of her students had little effect on their achievement. Two facts need to be considered in the interpretation of this finding: (1) her subjects were drawn from the eighth-grade and had been building their reading skills for eight years and (2) they were identified as being drawn from either a superior group or from an honors group. Their placement in these groups implies above-average reading ability and a homogeneous grouping where the effect on achievement would be of no consequence.

Herr and Tobias, using low class and middle class SES groups from the fifth-grade reported a .55 correlation of reading with achievement.

Fanning and Mueller concluded that those having high reading scores performed better on programmed material than did those having low reading scores and Woodruff, using pairs matched on reading ability reported that the high group had a greater number of correct responses to frames on a spelling program. With his study at the eighth-grade, Woodruff found significant correlations between reading ability and first semester and year's achievement but not for the second semester where
achievement fell.

It is apparent that most investigators found a positive correlation between reading ability and achievement with programs. It seems logical to assume that the reading skills of those children who are in the process of learning to read will represent many levels. Those who are able to read well are more likely to be prepared to cope with learning material that is presented in a form that requires the exercise of reading skills. Since the normal definitions of reading includes comprehension, the understanding of the written material by the more skilled reader will likely prepare him to respond correctly to more questions on the content read. Marked correlations can be expected.

Learner characteristics: socio-economic status.—This variable was investigated in three studies. Mueller found that the experimental program he constructed for his study was instrumental in dissolving those class differences favoring the middle class youngsters that were identified prior to instruction. After instruction with a traditional program, the class differences noted prior to instruction remained.
Fanning chose, as his study population, groups of children from "Special Services-Poverty" schools to represent the low SES and groups from "Non-Service" schools to represent the middle SES. He noted that the lower SES groups scored lower means on both the pre- and the post-test measures than did the middle class groups. He further noted that these differences disappeared when Modified Gain Scores or efficiency ratios were used in the calculations. This could be interpreted to mean that the lower SES youngster learned proportionately as much and as fast as his middle-class counterpart. He also found that teacher guidance resulted in higher achievement but was less efficient in terms of time to complete.

Herr and Tobias examined achievement via programmed instruction and socio-economic status for correlations. They used the data accumulated in the Fanning study above. They found that "the small amount of achievement variance accounted for by SES level was entirely the function of the SES differences in reading ability." They found no support for the contention that instruction via programmed materials was especially advantageous for the disadvantaged child.
Summary for Chapter II

In this chapter programmed instruction was placed in its historical perspective by (1) describing the work of Sidney Pressey in which the potential of "machines which teach" was demonstrated, (2) commenting on the continued use of teaching machines by the military during and after World War II, and (3) crediting B. F. Skinner, who with the publication of the historically significant paper "The Science of Learning and the Art of Teaching," not only created a renewal of interest in "mechanical devices which teach" but also provided much of the impetus which led to the transition from the concept of the "teaching machine" to that of "programmed instruction" when he placed primary importance on the composition of the instructional program rather than on the machine which carried it.

The concept of programmed instruction was found to include the provision for self-instruction by the learner made possible, in part, by presenting in small units a pre-arranged sequence of instructional material. Active participation of the learner was insured by requiring him to respond frequently to questions and learning was promoted by providing immediate confirmation or correction.
of his response.

The rationale for two contrasting techniques of programming—the linear developed by Skinner and the intrinsic developed by Norman Crowder—was presented. The linear programming technique which was based on the results of laboratory experiments in which animals had been conditioned to emit desired responses was characterized by instructional materials which were presented in small steps and in a fixed sequence. Correct and frequent responses by the learner were followed immediately by confirmation of the correct answer by the program. The intrinsic programming technique which was developed on the basis of the learning demonstrated by adult humans was described as one in which the instructional material was presented in larger units, in which frequent and eventually correct responses were required from the learner, and, in which alternative sequences designed to more nearly accommodate individual differences were provided.

Advantages attributed to programmed instruction included reference to instructional qualities and to efficient use of time. Disadvantages were described relative to (1) the limitations of programs in terms of supply,
quality, cost of production and instructional attributes and (2) problems of program use in terms of implementing it into the ongoing curriculum.

A review of the criteria suggested for use in the selection of programs was found to include recommendations relative to inspection of internal and external characteristics. Internal characteristics included those which were revealed by visual inspection, such as content, objectives, and emphasis. External characteristics included features not seen by visual inspection such as information about program development, tryout, and revision; test data concerning program effectiveness; and qualifications of the author.

In the final section of the chapter, the findings of studies in which the correlation between achievement via programmed material and (1) learner characteristics and/or (2) conditions under which he worked were presented. A summary of these studies revealed that all the programs reviewed were of a linear format and that program content of geography, spelling, or math was most often found. Inconsistent findings relative to the relationship of student achievement and (1) effect of teacher assistance,
(2) IQ, (3) chronological age and (4) reading ability were seen. There were no significant correlations found between the learner characteristic of sex and achievement via programmed materials in any of the studies in which this factor was examined.

Chapter III will present the procedures which were followed in order to accomplish the objectives of this study.
CHAPTER III

METHODS OF PROCEDURE

As stated before, the central purpose of this study was to examine the feasibility of including commercially published programmed material among the instructional resources which should be made available to sixth-grade inner-city pupils. It was of interest (1) to determine whether programmed material could be used by this population independently or whether help would be required during its study and (2) whether children would use all programs with equal success.

A second purpose of this study was to investigate two methods of predicting those children who would be likely to achieve at a satisfactory level in their use of materials that were programmed.

In order to accomplish these purposes it was necessary to (1) locate suitable programmed materials, (2) develop a plan for initiation of the study procedures, (3) conduct the study, (4) analyze the data, and (5) report
the findings and conclusions.

The remainder of this chapter is organized to present these topics in the order indicated above.

**Location of Suitable Programmed Materials**

The problem of locating programmed instructional materials that were available from commercial publishers entailed: first, identifying the criteria to be used in the selection process; second, initiating a search for the materials; and finally, selecting the programs to be used.

**Identification of criteria for program selection**

A review of the criteria recommended for use in the selection of programmed instructional materials was included in Chapter II. The most authoritative lists were found to be those proposed by the Joint Committee on Programmed Instruction and Teaching Machines. Other useful information was found in releases from (1) the


National Society of Programed Instruction,\(^3\) (2) the Division of Audiovisual Instructional Service of the National Education Association,\(^4\) and (3) the State Education Department of New York.\(^5\)

After studying the criteria mentioned in the literature in terms of the particular needs of this study, the following criteria were selected as guides:

1. The content must be reasonably accurate and the coverage given must be appropriate for instruction at the sixth-grade level.

2. The program must be recommended by the publisher as appropriate for use by students at the sixth-grade level.

3. Provisions for a pre-test and a post-test must be included for each program.

4. The tests should require a minimum amount of reading and at a level not to exceed that of the sixth-grade.

5. The program must include stated objectives and must have been developed as a result of the trial-and-revision process recommended by authorities in the construction of programs.


6. The information accompanying the program must include a description of the audience with whom the development of the program was completed.

7. The program should be of such length that either the entire program or at least one chapter of a larger program could be completed in a total time of 100 minutes.

8. It must be possible for the child to complete the program without requiring the services of the teacher.

9. At least one program selected must be of a Skinner (linear) format and at least one of a Crowder (branching) type.

10. Only one program from the selections offered by a publisher could be selected for use in this study.

11. Because of limited funds, the maximum amount to be spent for a single program must not exceed three dollars ($3.00).

Search for programmed instructional materials

After selection and organization of the criteria, a search was initiated for commercially available instructional programmed materials which would meet them. Although listings were found in Programs, '62 and Programs, '62 . . . .

6The Center for Programed [sic] Instruction, Inc., Programs, '62 . . . .
'63\(^7\), the most useful resources found were (1) *Programmed Learning: A Bibliography of Programs and Presentation Devices*\(^8\) and (2) *Programmed Instructional Guide*.\(^9,10\)

The titles of programs thought to be promising were extracted from these sources. Requests for these particular titles were then made.\(^11\) Additional names and addresses of publishers whose names or editorial tradition suggested that they might have some recently completed program that should be considered were also noted and


\(^10\)Not used in this study but also available were Center for Programed Instruction, *Programed Instruction Materials 1964-'65: A Guide to Programed Instruction Materials Available for Use in Elementary and Secondary Schools as of April 1965* (New York: Columbia University, 1965), and a later edition of Hendershot's *Programmed Learning: . . .* (Bay City, Michigan: Carl H. Hendershot, 1970).

\(^11\)A copy of the letter form used to request specific materials is included in Appendix A.
letters requesting likely materials were dispatched. 12

Another valuable avenue to information about available instructional programs was the book fair held in conjunction with the meeting of the Elementary School Principals, held in the Lausche Building on the Ohio State Fairgrounds in Columbus, Ohio in the Spring of 1968 and again in 1969. Sales Representatives for many publishing houses attended the meeting to display the newest of their companies' wares to the principals and to others in attendance. Among the texts displayed were some which were programmed. 13

Subsequently, as a result of the search, materials were received from the following publishers: 14

12 A copy of the letter form used to request material that might be useful in this study is included in Appendix A.

13 The investigator wishes to express her appreciation for the helpful materials, suggestions and encouragement received from the following sales representatives: Gene Wolanin of Follett, William Smith of Ginn, Roger Conover of D.C. Heath, H. Lester Rupp of Grolier Educational Corporation, and Richard Bingham of World Book Company.

14 A complete list of the titles received and the names and addresses of the publishers supplying them is found in Appendix B.
Selection of Programmed Material for this Study

After the criteria were applied to the materials received, much of the content was found to be inappropriate for use in this study due to one or more of the following factors: (1) cost, (2) the need for the services of the teacher either in a teaching or in a testing function, (3) no provision for pre-testing or post-testing, (4) lack of information about program construction, or (5) the unsuitability of the content for sixth-grade pupils. Ultimately, the following linear programs were identified as best fulfilling the requirements for this study:
1. The Coronet Learning Programs\textsuperscript{15}
   a) Your Heart and Circulation
   b) David Discovers the Dictionary
   c) Understanding Problems in Arithmetic
   d) Grouping Animals: What is a Mammal?
   e) Latitude and Longitude
   f) Westward Expansion of Our Nation
   g) How We Forecast the Weather

2. McGraw-Hill Book Company—Webster Division's\textsuperscript{16}
   Reading Longitude From Maps

Two other programs met fewer of the criteria but were of interest because, unlike those listed above, the entire program could have been completed during the course of the experiment. These were:

1. Programmed Instructional Press's\textsuperscript{17}
   Using the Library

2. Division of Trade and Industrial Education
   How to Read a Rule\textsuperscript{18}

\textsuperscript{15}Coronet Learning Programs, Coronet Instructional Films, 65 East South Water Street, Chicago, Illinois 60601.

\textsuperscript{16}McGraw-Hill Book Company—Webster Division, Manchester Road, Manchester, Missouri 63011.

\textsuperscript{17}Programmed Instructional Press, Box 117, Addison, Illinois 60101.

\textsuperscript{18}Division of Trade and Industrial Education, University of Alabama, PO Box 2847, University, Alabama 35486.
Arrangements were made to field test these programs with seven sixth-grade pupils. After working with at least two programs, the pupils were asked to indicate the one they found to be most acceptable in terms of (1) content, (2) level of difficulty, (3) ease of manipulation and (4) feeling of achievement in learning.

The final decision regarding the selection of the programs for use in this study was made by the investigator on the basis of (1) student reaction, (2) analysis of student work with the programs, (3) observations made of the behavior of the group during their work on the programs and (4) the information regarding program construction supplied by the publishers.

The two linear programs selected were How We Forecast the Weather and Reading Longitude from Maps.

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19 The investigator wishes to thank Mr. Joseph Goldsberry, principal of the Lexington Avenue Elementary School, Columbus, Ohio, Public School System and Mr. John Stone, Teacher, and the sixth-grade pupils who made it possible to field test the programs.

20 Frances Unger Meade and Sheila Levinsky, programmers and Theodore W. Munch, consultant, How We Forecast the Weather (Chicago: Coronet Learning Programs, 1964).

The weather program was constructed for use with children in the 4th through 6th grades and, thus, should represent an easier content for the sixth-grade student. The longitude program was constructed for use primarily by children in the sixth-grade but, according to the publisher "can be used with fifth-, seventh-, eighth-, and ninth-grade classes." and, thus, might be expected to be more challenging.

It was not necessary to go through an elimination process to select a program representing the branching format. The programs from the California Test Bureau were the only ones received that followed this programming technique. The selection of Following Directions C-D was made since it was designed for use with the fifth- or sixth-grader.

**Preparation for Initiating Study Procedures**

Prior to the initiation of the experimental test of the programmed materials, it was necessary to (1) secure access to the schools, (2) to select the study participants,

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22Ibid., p. iii.

23Miles Midlock, Following Directions C-D (Monterey, California: California Test Bureau, 1965).
and (3) to obtain study assistants to help during the study experiment. These activities are described in the following sections.

**Permission to implement study procedures**

The proposal and a request to carry out this study in the Columbus, Ohio, Public Schools was sent to Miss Hortensia Dyer, Executive Director of the Department of Elementary Education. Miss Dyer subsequently arranged for the writer to appear before several members of the administrative staff to explain the goals of the project and to secure final approval from them. Attending the meeting were: Miss Dyer; Mr. L. W. Huber, Assistant Superintendent, Instruction; Mr. Calvin M. Smith, Jr., Title I (ESEA) Supervisor from the Department of Evaluation, Research and Planning; and Mr. Lucien C. Wright, Director of the Department of Human Relations.

Permission to proceed was given and assignments to thirty-six classrooms in twelve Title I (ESEA) schools

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24 A copy of the request can be found in Appendix C.

25 Elementary and Secondary Education Act, Title I schools were identified according to ESEA formulas as those which served children from families suffering severe poverty.
were received.

Arrangements were then made to meet separately with the principal and with the sixth-grade teachers of each building to explain the project, select the students who were to participate, and to schedule the time and place for meeting with the students. Each principal, teacher, or student contacted during this study had the opportunity to decline to participate. One principal did decline with the result that the two classrooms lost to experimental use in that building were replaced by increasing from four to six the number of classrooms in another school in which it was already agreed that the study could be conducted.

Selection of study participants

The seven students from each classroom were selected randomly, according to the following procedure. Each teacher was asked to supply his/her grade book in which the names of the pupils were recorded on numbered lines. Cards equaling the total number of pupils in each classroom were numbered consecutively and presented face down to each teacher. After choosing seven cards, the teacher made a comparison of the card numbers and the
grade book numbers and thus the study participants were identified.

**Study assistants**

Permission for access to each group of study participants was limited to a period of six consecutive school days and was scheduled to occur at some point between the dates of March 12th and March 28th. Because of the time element at least six groups of study participants were working simultaneously. Consequently, it was necessary to secure the services of study assistants to work directly with pupils in the schools. It was decided that those selected for these responsibilities should have had classroom teaching experience at the elementary school level so that working with children would not pose undue problems.

Of the six chosen, three had Bachelor's degrees and the other three Master's degrees. Each holder of the Master's degrees had in excess of five years of teaching experience. Of those having B.S. degrees, one was in a Master's program and had had one year's experience in teaching, and two had just completed student teaching in which each was given an excellent rating by her supervisor.
Each study assistant was scheduled to meet daily with six groups of seven pupils. The day was divided into three AM sessions and three PM sessions. During one-half day the study assistant was permitted to facilitate the pupil's progress through a program by pronouncing unknown words, offering praise for work done, or encouraging children to continue work. The term used to describe this study condition was Limited Help. During the remaining half of the day a condition termed No Help was followed in which the study assistant was prohibited from offering any such help to the youngsters. Three of the study assistants followed the Limited Help condition in the AM switching to the No Help in the PM.

The assignment of the AM and PM conditions was made randomly according to the following procedure: The first study assistant was asked to draw one slip from the six which carried the various schedule assignments. The five remaining were then offered to the second study assistant, and so on until the last study assistant took the one remaining assignment.

26For assignment of each study assistant see Appendix D.
The In-School Project

In the preceding sections of this chapter the details of the selection of the materials and personnel preparatory to beginning the in-school project were presented. The following sections are organized to present in sequences those additional activities that occurred as the study progressed into the schools. The activities include the orientation sessions, the uses of name cards, and the responsibilities of the study assistants.

Orientation sessions

During the first meeting of each group of pupils with its study assistant, an orientation session directed by the writer was held. This orientation session made it possible to provide a similar background in the area of programmed learning to each group and to allow all groups to begin study under similar circumstances.

The orientation session was designed to:

1. introduce the study assistants and the study participants,

2. complete name cards which would be used throughout the project,

3. introduce the concept of programmed instruction and provide the study participants with practice in working with programmed materials,
4. establish the expectation for the pupils in the remaining days of the experiment,
5. make program assignments,
6. allow the children to begin work on their programs, and
7. demonstrate to each study assistant the mechanics of handling the student materials.

**Uses of name cards**

The name cards, while serving the customary function of providing a ready identification of students' names, also served two bookkeeping services. The first was to provide a permanent student identification number of three digits which appeared on each pupil's card. The first digit indicated the study assistant; the second, the period of the day; and the third, the individual participant in that particular period. The second bookkeeping function of the name cards served the study participant by providing a space to record the last frame attempted in his work for one day thereby facilitating his attempt to "find his place" the following day.

In addition to these two functions, the name cards were used to assign the study participants to the instructional program he was to use. As recorded in a previous
section of this chapter, two linear programs: Reading Longitude from Maps and How We Forecast the Weather and one branching program, Following Directions, were selected for use in this study. The experimental design called for the assignment of each of the three programs to at least two pupils each period of the day with one program being assigned to three pupils. These assignments were rotated in subsequent periods so that by the end of the third period (one-half day) each program had been assigned to seven children. A typical day for program assignments was graphed as follows:

<table>
<thead>
<tr>
<th></th>
<th>Ss1</th>
<th>Ss2</th>
<th>Ss3</th>
<th>Ss4</th>
<th>Ss5</th>
<th>Ss6</th>
<th>Ss7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Period 1</td>
<td>D</td>
<td>D</td>
<td>L</td>
<td>L</td>
<td>W</td>
<td>W</td>
<td>W</td>
</tr>
</tbody>
</table>
| Period 2 | L   | L   | W   | W   | D   | D   | D   | **Limited Help**
| Period 3 | W   | W   | D   | D   | L   | L   | L   |
| **Noon** |     |     |     |     |     |     |     |
| Period 4 | D   | D   | L   | L   | W   | W   | W   |
| Period 5 | L   | L   | W   | W   | D   | D   | D   | **No Help**
| Period 6 | W   | W   | D   | D   | L   | L   | L   |

Study assistant's duties

During each of the thirty-minute session with the children the study assistant had several duties to perform.

27 Koehrer, Peterson and Paul, Reading Longitude from Maps.

28 Learning Incorporated, How We Forecast the Weather.

29 Midloch, Following Directions C-D.
She provided each incoming pupil with his name card, the program with which he was working, and the corresponding answer sheet. During the session, she was directed to oversee the group. That "overseeing" included classroom management, keeping order, seeing that pupils were manipulating their programs correctly, providing students with pre-tests or post-tests when necessary and conducting other similar procedural activities. She also made and recorded daily observations of the work habits of each of the pupils. At the end of the session, she reminded the pupils to note the number of the last completed frame of their programs and to record it on their name cards. She collected all the materials and permitted the children to return to their classrooms.

In addition to the above, the study assistant was also charged with securing certain data needed for the correlational studies from the classroom teacher and from the cumulative record of each study participant. The assistant provided the classroom teacher with the names of her pupils studying each of the programs and the study condition under which they were performing. The teacher was asked to predict for each youngster whether he would achieve a passing score of 70% or above on the post-test
measure. Later, this prediction would be compared with the score the child actually made to determine its accuracy. From the cumulative records, the study assistant recorded information with regard to each study participant's sex, age, prior grades, and results from standardized tests which gave an indication of the pupil's intelligence, reading, language and arithmetic ability.

Analysis and Presentation of the Data

The data which were collected were analyzed with reference to the purposes of this study. The following steps were used to complete it:

(1). An indication of the instructional effectiveness of each program was presented by (a) compiling a percentage of pupils receiving a satisfactory score which for this study was arbitrarily set at 70% or better on the post-test measure, (b) computing the average gain between pre-test and post-test means, and (c) comparing the recorded gains with those that were possible (100 percent minus the pre-test scores.)

(2). A two-way analysis of variance was selected to test the significance of the differences between the means of post-test results which could be attributed to
(a) the commercial program or (b) the study condition under which the post-test results were obtained.

(3). Coefficients of correlation between various learner characteristics and post-test means were computed for each program and the significance of each determined.

(4). After dropping those learner characteristics with which achievement correlated the least, the characteristics which remained were subjected to a multiple regression analysis and from the results a prediction equation was constructed.

(5). The multiple regression prediction formula was applied to the required characteristics of each of the individuals comprising a sample group in an effort to identify those who scored at least 70% on the Post-test I measure and those who scored below 70%. After comparing the results with the actual scores made by the pupils, a percentage of correct predictions was computed.

(6). A similar percentage of correct predictions was computed as a result of comparing the teacher's predictions of those pupils who would score at least 70% on the Post-test I measure with the scores the pupils actually made.
(7). The results of the two prediction efforts were compared statistically by applying a test of the difference between the proportions.

Summary

This chapter included the methods of procedure followed in examining the use of commercially available programmed instructional material with school children from the inner-city of Columbus, Ohio.

The subjects for this study were 252 sixth graders randomly selected from thirty-six classrooms of eleven elementary schools, all of which were classified as Title I schools under ESEA definition. The programs which best met the criteria established for the selection process were Following Directions, representing Crowder's intrinsic programming technique, and Reading Longitude from Maps and How We Forecast the Weather which represented two possibly different levels of difficulty within the linear or Skinner programming technique.

Data collected for analysis included pre- and post-test scores, teacher predictions of pupil success, and the following learner characteristics: sex, age, grade average, and results from standardized tests indicating intelligence,
reading, language and arithmetic ability.

The chapter was concluded by listing the procedures followed in the analysis of the data. Interpretations of the results are presented in Chapter IV.
CHAPTER IV

PRESENTATION AND INTERPRETATION OF DATA

The stated purpose of this study was to examine the use of certain commercially published programmed materials by sixth-grade inner-city pupils. In Chapter III, the selection of the programs and their assignment to the student population were explained. The mechanics of the study and the collection of the data were outlined. In Chapter IV, the data, organized into two parts, will be presented and interpreted. In the first section, the data which describe the programmed material and the student interaction with it will be given. The results of two specific problems under investigation will be reported. The first problem was to determine whether the child could use programmed material independently or whether he required help while studying it. The null hypothesis proposed to test this problem was:

There is no significant difference in achievement as indicated by Post-test I means, final post-test means, percent of possible gain scores or percent of successful completion scores between the group studying programmed materials.
under the Limited Help study condition and those studying the program under the No Help condition.

A second problem was to determine whether groups of children would use all programs with equal success or whether they would be more successful in using one program than another. The null hypothesis proposed to test this problem was stated as follows:

There is no significant difference in achievement as measured by Post-test I means, final post-test means, percent of gain scores and percent of successful completion scores between the students using:

a. an intrinsic program and those using either of the two linear programs
b. one of two programs, both linear in design.

In addition to presenting the data used in the testing of the two null hypotheses, an explanation of the achievement measures used in these analyses will be given. Other pertinent information not bearing directly on the testing of the null hypotheses will also be incorporated at appropriate places in the development of the chapter. This information includes publishers' description of their programs and data obtained from readability studies of the three programmed texts.

In the second part of this chapter, the results of the attempt to identify the student who would be likely
to succeed when using programmed materials will be presented. The null hypothesis stated to test this problem is:

There is no significant difference between the accuracy of the teacher in correctly predicting that a child (1) will achieve at the 70% level or above or (2) will not achieve at that level and the accuracy demonstrated by the application of the prediction formula obtained from a multiple regression analysis in making the prediction.

Examination of Certain Characteristics of the Ss

The two conditions under which the Ss of the study were performing were characterized by the amount of help each was permitted to receive. Under the No Help (NH) condition, the Ss received no help but under the Limited Help (LH) condition the Ss were permitted to receive (1) help in the pronunciation of unknown words, (2) encouragement to continue work, (3) procedural help such as in manipulating the text.

Randomization was used throughout the selection and assignment phases of this study in an effort to obtain groups that did not differ significantly from one another. In addition to the precautions afforded by random assignment a test analysis was made of the significance of the
differences between certain characteristics of the Ss who had been grouped on the basis of the Limited Help or No Help study condition assignments. The data which was used to describe "learner characteristics" include the following:

A. Sex  
B. Age  
C. Prior Grade  
D. Standard scores from the California Test of Mental Maturities (CTMM)\(^1\) with subtests of:
   1. Language  
   2. Non-language  
   3. Total  
E. Standard scores from the California Comprehensive Tests of Basic Skills (CTBS)\(^2\) with subtests of:
   1. Reading
      a. Vocabulary  
      b. Comprehension  
   2. Language
      a. Mechanics  
      b. Expression  
      c. Spelling  
   3. Arithmetic
      a. Computation  
      b. Concepts  
      c. Application  

The abbreviations shown in the parentheses above will be used in this chapter.

\(^1\)Published by California Test Bureau, Monterey, California.  

\(^2\)Published by California Test Bureau, Monterey, California.
Explanation of learner characteristics

All the data describing each learner's characteristics were obtained from the cumulative record folder on file with the classroom teacher. Sex was recorded as male (1) or female (0) and age was recorded as the year attained at the last birthday. The prior grade entry was an estimation of the average of the pupil's yearly grades recorded to date. No attempt was made to assign different weights to the grades from the various content areas. The estimates were recorded for each pupil as A, B, C, D, or F and later, for purposes of analysis, the letter grades were converted into numerals 5, 4, 3, 2, or 1.

Prior to being recorded on the student's testing profile, the raw scores for the CTMM and the CTBS had been converted into standard scores with a midpoint of 50 and a standard deviation of 10. The standard scores were recorded on the pupil's testing profile as T-score bands with the midpoint of the band representing the standard score.\(^3\) The number at the mid-point of the band was the

\(^3\)This procedure was explained during a telephone conversation with William LeSage, Supervisor, Department of Child Study and Student Counseling, Columbus Public School System, Columbus, Ohio, July 2, 1969.
score used in this study.

In the section which follows, the means of the learner characteristics for each of the study groups will be presented for each of the three programs being studied. A null hypothesis proposed for the examination of the learner characteristics is as follows:

There is no significant difference in any of the means of the fourteen learner characteristics between the group studying under the Limited Help condition and the group studying under the No Help condition for the programs

a. **Following Directions**

b. **Reading Longitude from Maps**

c. **How We Forecast the Weather**

**Statistical tests**

Two tests, both proposed by Downie and Heath, were used in testing this hypothesis. One, used with the **Following Directions** program, was designed to test the difference between the means of uncorrelated data in a small sample \((N < 30)\). The other was used with the remaining programs and provided a test to be used with a large sample \((N > 30)\).

---


5Ibid., pp. 132-133.
Small sample technique for testing differences between means.—First, in order to satisfy one of the basic assumptions for this test, an F test was employed to test the difference between the variances of the two population groups using the following formula:

\[ f = \frac{s_1^2}{s_2^2} \]

When no difference was found the variances were pooled and the standard error of the difference was computed using this formula:

\[ S_{d\bar{x}} = \sqrt{S_{\bar{x}_1^2} + S_{\bar{x}_2^2}} \]

The t test was computed and the significance level determined by consulting a t table.

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{S_{d\bar{x}}} \]

Large sample technique for testing the difference between means of uncorrelated data.—The standard error of the difference between the means was computed by using the following formula: 6

---

6 Ibid.
\[ S_{D\bar{x}} = \sqrt{S_{x_1}^2 + S_{x_2}^2} \]

where

\[ S_{D\bar{x}} = \] the standard error of the difference between two means

and

\[ S_{x_1}, S_{x_2} = \] the standard errors of the two sample means

The deviation was changed into standard score units with the following formula:

\[ Z = \frac{D\bar{x}}{S_{D\bar{x}}} \]

where

\[ D\bar{x} = \] the difference between the two means

The level of significance for this study has been set at the 5 percent level.

Findings

Tables 1, 2 and 3 show the means of the learner characteristics of the Ss assigned to study Following Directions\(^7\) (Directions), Reading Longitude from Maps\(^8\)

\(^7\)Miles Midlock, Following Directions C-D (Monterey, California: California Test Bureau, 1965).

TABLE 1

FOLLOWING DIRECTIONS: MEANS AND STANDARD ERRORS OF LEARNER CHARACTERISTICS FOR TWO STUDY CONDITION GROUPS

<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Study Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Help</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Sex</td>
<td>.50</td>
</tr>
<tr>
<td>Age</td>
<td>12.25</td>
</tr>
<tr>
<td>Prior Grade</td>
<td>2.88</td>
</tr>
<tr>
<td><strong>CTMM</strong></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>40.77</td>
</tr>
<tr>
<td>Non-language</td>
<td>40.88</td>
</tr>
<tr>
<td>Total</td>
<td>41.00</td>
</tr>
<tr>
<td><strong>CTBS</strong></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>41.20</td>
</tr>
<tr>
<td>Comprehension</td>
<td>39.10</td>
</tr>
<tr>
<td>Language</td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>35.32</td>
</tr>
<tr>
<td>Expression</td>
<td>39.11</td>
</tr>
<tr>
<td>Spelling</td>
<td>41.37</td>
</tr>
<tr>
<td>Arithmetic</td>
<td></td>
</tr>
<tr>
<td>Computation</td>
<td>37.46</td>
</tr>
<tr>
<td>Concepts</td>
<td>38.64</td>
</tr>
<tr>
<td>Application</td>
<td>37.14</td>
</tr>
</tbody>
</table>
TABLE 2

READING LONGITUDE FROM MAPS: MEANS AND STANDARD ERRORS OF LEARNER CHARACTERISTICS FOR TWO STUDY CONDITION GROUPS

<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Study Conditions</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Help</td>
<td>Limited Help</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Error</td>
<td>Mean</td>
</tr>
<tr>
<td>Sex</td>
<td>0.54</td>
<td>0.08</td>
<td>0.45</td>
</tr>
<tr>
<td>Age</td>
<td>11.95</td>
<td>0.11</td>
<td>12.00</td>
</tr>
<tr>
<td>Prior Grade</td>
<td>3.15</td>
<td>0.12</td>
<td>3.31</td>
</tr>
<tr>
<td>CTMM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>42.91</td>
<td>1.52</td>
<td>45.87</td>
</tr>
<tr>
<td>Non-language</td>
<td>42.37</td>
<td>1.66</td>
<td>43.43</td>
</tr>
<tr>
<td>Total</td>
<td>42.43</td>
<td>1.54</td>
<td>43.97</td>
</tr>
<tr>
<td>CTBS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>40.27</td>
<td>1.42</td>
<td>42.50</td>
</tr>
<tr>
<td>Comprehension</td>
<td>40.98</td>
<td>1.54</td>
<td>43.64</td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
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<tr>
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<td>40.90</td>
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<td>40.29</td>
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<tr>
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<td></td>
<td></td>
</tr>
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<td>45.00</td>
</tr>
<tr>
<td>Application</td>
<td>41.66</td>
<td>1.50</td>
<td>43.38</td>
</tr>
</tbody>
</table>
# TABLE 3

HOW WE FORECAST THE WEATHER: MEANS AND STANDARD ERRORS OF LEARNER CHARACTERISTICS FOR TWO STUDY CONDITION GROUPS

<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Study Conditions</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Help</td>
<td>Limited Help</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Standard Error</td>
<td>Mean</td>
<td>Standard Error</td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td>.45</td>
<td>.80</td>
<td>.48</td>
<td>.08</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>12.00</td>
<td>.13</td>
<td>11.88</td>
<td>.14</td>
<td></td>
</tr>
<tr>
<td>Prior Grade</td>
<td>3.31</td>
<td>.13</td>
<td>3.28</td>
<td>.15</td>
<td></td>
</tr>
<tr>
<td>CTMM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>45.21</td>
<td>1.63</td>
<td>44.03</td>
<td>1.56</td>
<td></td>
</tr>
<tr>
<td>Non-language</td>
<td>43.38</td>
<td>1.76</td>
<td>44.33</td>
<td>1.66</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>44.12</td>
<td>1.59</td>
<td>43.69</td>
<td>1.58</td>
<td></td>
</tr>
<tr>
<td>CTBS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>42.97</td>
<td>1.57</td>
<td>44.21</td>
<td>1.27</td>
<td></td>
</tr>
<tr>
<td>Comprehension</td>
<td>42.38</td>
<td>1.72</td>
<td>45.34</td>
<td>1.37</td>
<td></td>
</tr>
<tr>
<td>Language</td>
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</tr>
<tr>
<td>Mechanics</td>
<td>41.89</td>
<td>1.62</td>
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<tr>
<td>Expression</td>
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<td>1.49</td>
<td>42.19</td>
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</tr>
<tr>
<td>Spelling</td>
<td>44.06</td>
<td>1.61</td>
<td>47.19</td>
<td>1.35</td>
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<tr>
<td>Arithmetic</td>
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<td></td>
</tr>
<tr>
<td>Computation</td>
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<td>1.33</td>
<td>45.77</td>
<td>1.27</td>
<td></td>
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<tr>
<td>Concepts</td>
<td>43.92</td>
<td>1.20</td>
<td>43.23</td>
<td>1.33</td>
<td></td>
</tr>
<tr>
<td>Application</td>
<td>45.08</td>
<td>1.35</td>
<td>45.54</td>
<td>1.50</td>
<td></td>
</tr>
</tbody>
</table>
In each table the statistics are presented in two groups formed on the basis of the study condition under which the Ss had worked.

After applying the appropriate statistical test, as described earlier, to each pair of means for the three tables, no significant differences were found and the null hypothesis was accepted.

Description of the Programmed Material Selected for Use in This Study

As explained in Chapter III, three commercially published programs were selected for use in this study. In the section which follows a description of these programs will be given by (1) reviewing the data supplied by the publisher about his program and (2) supplying those details of internal characteristics of the program that are of particular interest to this study. The program entitled Following Directions will be presented first followed by Reading Longitude from Maps and How We Forecast the Weather.

9Frances Unger Meade and Sheila Levinsky, programmers and Theodore W. Munch, consultant, How We Forecast the Weather (Chicago: Coronet Learning Programs, 1964).
Following Directions—an intrinsic program

Publisher's description.—Following Directions is one title in the series Lessons for Self-Instruction in Basic Skills (LSI). According to the publisher, LSI's were "designed primarily for intensive review," were "useful for enrichment as well as for strengthening the skills of weaker students," and should be used in conjunction with other sound instructional procedures but "not... as a steady scholastic diet." 

The process of program construction, as outlined in Research Procedures in the Development of Lessons for Self-Instruction, followed the recommendations of the Joint Committee on Programed Instruction and Teaching Machines (See Chapter II). In analyzing responses for the purpose of making revisions, the publisher accepted a question when 70-90% of the students responded correctly to it.

Concerning the efficiency of the program, as measured in terms of gains recorded by students, they reported the

11Ibid., p. 6.
12Ibid.
Repeated studies of performance on criterion tests have shown that for some students the gains will be outstanding. Other students benefit to some extent, and still others derive little profit because they have not been paying attention to the subject matter and the tasks of the program.¹⁴

A plan suggested for presenting the program included general explanations of programmed instruction, progress through the text, and completion of the answer sheet.¹⁵

Following Directions Series C-D was classified according to (1) subject matter as reading, (2) content difficulty level as Grade Five or Six, and (3) reading difficulty of the text as appropriate for Grades Four and below.¹⁶

According to the publisher, the statement of objectives for Directions was limited because the original list was lengthy and "were of limited interest to the curriculum director, teacher, or instructor."¹⁷

The text included the topics of Roman Numerals, affixes, compound words, and photography. Activities included tracing, working a directional game, applying


¹⁶Ibid., p. 9.

¹⁷Ibid., p. 8.
arithmetical operations to fulfill a non-arithmetic assignment. 18

Internal characteristics.—Although Following Directions was a "scrambled" text which followed the programming principles of the intrinsic programmer, Norman Crowder (see Chapter II), some constructed responses were included as "check frames" and served as performance tests. The program had a total of 116 frames which were placed on 84 pages. The content of the frames served one of three purposes: to instruct, to correct, or to confirm. The shortest route through the pre-test, program and post-test required 51 answers.

A check of the readability level of Following Directions was made by the investigator, using the Dale-Chall formula. 19 Eighty-seven one-hundred-word passages were analyzed. The results showed that the reading matter was suitable for the youngster with a fifth- or sixth-grade reading ability. This was somewhat higher than that reported by the publisher (4th and below).

18 Ibid., p. 10.

Thirty-six lessons were listed in the Contents section of Following Directions. Readability scores for these pages were as follows:

20 were placed at grade 4 or below

11 were placed at grades 5 or 6

3 were placed at grades 7 or 8

1 was placed at grades 9 or 10.

According to information received from the Department of Testing and Evaluation, Columbus Public School System, the mean vocabulary and comprehension scores recorded by these Ss (see Table 1, 2, 3) placed them at the level of grade 5.5 or above in reading skills. It would seem that the readability level of the text as scored by the Dale-Chall formula would be appropriate for the average Ss in this population.

Reading Longitude from Maps

Reading Longitude from Maps was a linear program of vertical construction in which subsequent frames followed one another on the page.

---

Mimeographed page entitled ACHIEVEMENT TESTS-Conversion Table, Sixth Grade, Grade Placement Level to T-Score Bands, received July 2, 1969.
Publisher's description.—Information from the publisher about this program is included on pages iii-vi of the text. Details about the program construction include the recommended practices of classroom trials, error analysis of the work done there, and appropriate revisions of the content. The field test was completed with an average sixth-grade which had studied Reading Latitude From Maps during their fifth-grade. A table in which the final field trial results were given showed that all students scored at least 80% or above and that 95.2% scored 90% or above on Parts I and II of the program.

A total of nine teaching objectives were listed for the program. The prerequisite skills were stated and a readiness test included in the booklet for assignment by the teacher when necessary. The content of each part of the program was briefly outlined.

A provision was made to provide a shorter study sequence for knowledgeable students or to furnish review material for average students by placing one of two code marks before each question.

Teaching Notes were provided to the teachers using this program. The Notes outlined and explained the study procedures, presented details of administration,
gave suggestions for implementation of the program within the ongoing curriculum, proposed follow-up activities for all students and enrichment activities for the ones who finished early.

Acceptable performance for those studying the program was recommended to be 80%.

**Internal characteristics.**—This program was separated into chapters called "Parts." In each part the instructional material was followed by a test of ten questions. This test also served as a pre-test for that part. The answers required in the text called for the pupil to construct his answer. For some answers in the pre- and post-test the student was expected to construct his answer and in others he was asked to select one of the alternatives provided. Each Ss had a slide which he manipulated to cover the answers until after he had constructed his own response. Test answers were not provided the student.

Including the pre- and post-tests there were 75 questions in Part I, 112 in Part II, 93 in Part III, 94 in Part IV and 100 in Part V. Because of the time limitation imposed on this study, Parts IV and V were not
used by the students.

By necessity the program *Reading Longitude from Maps* was reproduced in ditto form for presentation to the youngsters. Between the time this program was requested for examination and the time the order was placed with the publisher (a period of three weeks) the book was both "out of stock" and "out of print." After a period of frantic communication, permission "to reproduce thirty copies of specific pages from *Reading Longitude from Maps* provided the proper copyright information is shown on each page, with full acknowledgment included in an appropriate place in the study" was gratefully received from Doris Stuckwish, Editorial Secretary, Copyrights—Permission of the Webster-Division of McGraw-Hill Book Company, Manchester, Missouri.  

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22 The investigator wishes to thank Mrs. Doris Stuckwish and the Webster Division of the McGraw-Hill Book Company of Manchester, Missouri for permission to reproduce thirty copies of specific pages from *Reading Longitude from Maps* written by Glenn Koehrer, Dorothy Peterson, and Richard Paul.
The copyright form supplied by the editorial secretary was:

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A Thermofax process of creating a ditto master was used so that a faithful reproduction of the program was possible.

The Dale-Chall formula for determining the readability of reading material was applied to the programmed booklet Reading Longitude from Maps with the following results:

Part I Average corrected grade-level 7th or 8th
Part II Average corrected grade-level 8th or 9th

Readability scores for the nine passages examined for Part I were as follows:

1 was placed at grades 5 or 6
5 were placed at grades 7 or 8
3 were placed at grades 9 or 10

For Part II nineteen passages were scored with the following results:

1 was placed at grades 4 and below
1 was placed at grades 5 and 6
9 were placed at grades 7 and 8
6 were placed at grades 9 and 10
2 were placed at grades 11 and 12

The skill needed to read the text with understanding appeared to be beyond that of the average Ss in the sixth-grade classrooms utilized in this study. When applying this finding to other areas in this study, the following factor was found to be among those needing consideration. Some of the words identified as "unfamiliar" by the Dale-Chall formula appeared repeatedly in the text of the program. Words such as "prime" "meridian" "degree" appeared many times and may have served to inflate the grade equivalent score thus making the material appear to be more difficult for the sixth-grade pupil than it actually was.

How We Forecast the Weather

How We Forecast the Weather, a linear program of vertical construction was selected as one of the two linear programs for this study.

Publisher's description.—Information about the construction of the Coronet Learning Programs included explanations of informal and formal testing of the first
draft of the program with individual pupils or with small groups followed by an analysis of the errors made. On the basis of the analysis, revision to the program was made after which additional testing was completed. Six revisions were made during the process of program development. An extensive field test was completed with large groups of students representing "a wide range of social backgrounds and ability levels."

Effectiveness of the program was measured in terms of pre-test and post-test scores, percent of gain scores computed by dividing the mean gain by the mean pre-test score, and the percent of possible gain which was computed by dividing the difference between the pre-test score and a perfect score by the gain actually made.  

The details concerning the production of How We Forecast the Weather were included in the programmed booklet on pages ii and iii. The field test was completed with fourth, fifth and sixth-grade students having an IQ

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23 How Coronet Learning Programs Are Prepared and Tested (Chicago: Coronet Learning Program from Coronet Instructional Films, no date).

24 How Coronet Learning Programs are Field Tested (Chicago, Coronet Learning Program from Coronet Instructional Films, no date).
range of 102-127. The five objectives for the program were stated in behavioral terms.

The teacher's attention was directed to the page of instructions for classroom experiments which were included in the booklet. A suggestion was offered that several of the Coronet films (listed by name) could be used to supplement or enrich the content of the program.

**Internal characteristics.**—This program was divided into sections called "Sets." Each set contained the learning material and the post-test over that section. The post-test also served as a pre-test for that section. Constructed answers and answers chosen from alternatives were required in both the text and the tests. A slider panel was used by the student to hide the correct answer until after he had constructed his own. This panel formed an integral part of the booklet.

Including pre- and post-tests, there were 35 questions in Set 1, 45 in Set 2, 36 in Set 3, 40 in Set 4, 37 in Set 5, 31 in Set 6, 34 in Set 7, 37 in Set 8, 42 in Set 9, and 29 review questions in Set 10. Because of the time limitation, Sets 6 through 10 were not used in this study.
The Dale-Chall formula for predicting readability of the text *How We Forecast the Weather* was used by the investigator with the following results:

1. Six 100 word passages of Set 1 contained reading material suitable for grades 4 or below and the two remaining suitable for grades 5 or 6.

2. In Set 2, six of the eight passages were rated suitable for grades 4 and below; the remaining two suitable for grades 5 or 6. The overall grade-level average for the set was 4 or below.

3. For Set 3, the overall average of the corrected grade-level of the text was 7 or 8. Readability scores for the twelve passages examined show grade placement as follows:

   - 6 were placed at grades 5 or 6
   - 2 were placed at grades 7 or 8
   - 4 were placed at grades 9 or 10

The readability scores for Sets 1 and 2 indicate that the text of this program was well within the level suitable for the average Ss at this grade level. The difficulty of reading the text appeared to increase rapidly at the Set 3 level.
Achievement of Students with Programmed Materials

Introduction

One of the objectives of this study was to conduct an examination of the effectiveness of commercially published programmed materials when used by inner-city sixth-grade pupils. Effectiveness as used here indicates how well the Ss achieved on the measurement device supplied with the program studied. This device was a post-test which also served as a pre-test. From the means of these two scores other achievement measures were computed so that a more complete description of effectiveness could be made. The additional achievement measures include a ratio of gain/possible gain computed from the crude gain scores and a ratio of successful completions/completions computed from the post-test scores.

It was also important to this study to investigate the question of whether the student required help in order to use programmed materials successfully or whether he could be equally successful in its use when he received no help. The students in the study were randomly assigned to the No Help study condition or to the Limited Help section in which word pronunciation and procedural help was
available. The data pertaining to effectiveness will be reported for each study condition group.

Accordingly, a null hypothesis was proposed in which the effect of the study condition on achievement by the inner-city population of this study will be examined. After the null hypothesis is tested and the findings presented, a discussion of the effectiveness of the programs will be given.

A second null hypothesis was proposed in which the effect on achievement of the one intrinsic and the two linear programs used in this study will be compared. The same measures of achievement will be used in this examination as were proposed for the preceding null hypothesis. A discussion of the effectiveness of the programs for the total group will be given.

After a brief explanation of the achievement measures to be used and the statistical procedures to be followed in analyzing the data collected, the findings regarding the effectiveness of the program under the study conditions imposed will be presented. The level of
significance set for this study is the .05 level.\textsuperscript{25}

\textbf{Post-test means.}---For this study, a mean on the post-test measure of 70\% was set arbitrarily, but not without a supporting rationale, as the minimum level of satisfactory achievement. The 70\% figure is generally recognized in educational circles, including the Columbus Public School System, as being the lowest of the "passing" or satisfactory grades.

The early programmers used a 90-95\% figure as the minimum achievement level for a program they considered acceptable. This appears to be too stringent for the purpose of this study. Programmers are engaged in the process of developing a program and they typically use a small population to which they tailor the program. In contrast, the programs were not tailored for the population in this study. It is not anticipated that their performance will, or desirably should, reach that high level.

\textsuperscript{25}A helpful discussion of these measures of achievement can be found in Henry C. Ellis, "Judging the Teaching Effectiveness of Programs," \textit{Trends in Programmed Instruction} ed. Gabriel D. Ofiesh and Wesley C. Meierhenry (Washington: Department of AudioVisual Instruction of the National Education Association and the National Society of Programmed Instruction, 1964), pp. 207-209.
It may be remembered that in Chapter II a reference was made to the Markle observation that the program she developed with her target population was used with less success by a group of urban pupils.\textsuperscript{26}

Bassler set a 70\% level as that of a successful performance and was disappointed that the Ss in his study did not reach that level.\textsuperscript{27}

\textbf{Pre-test means}.—The use of the means of the pre-test can give an indication of the level of those skills and abilities required by the test, and presumably by the program, that the Ss has before he begins his study. The inclusion of the pre-test means in the category of achievement is necessary since these data are used in the computation of the gain scores.

\textbf{Gain Scores}.—When the pre-test mean is used with the post-test mean, two kinds of information can be obtained. First, a gain score can be computed by finding the difference between means. This computation offers limited information but, in cases such as in this study where it was highly unlikely that additional instruction

\textsuperscript{26}See Markle, Chapter II.
\textsuperscript{27}See Bassler, Chapter II.
was offered during the period between the pre- and post-
testing, it is reasonable to assume that the gain reflects
the instructional qualities of the program for the student
using it.

Secondly, the difference between the pre- and
post-test means can be tested statistically to determine
its significance. If the difference between them is
greater than one which could be attributed to chance
fluctuations, the assumption is strengthened that the
change in behavior of the Ss was due to the program.

The tests used to test the significance of the
difference between the means of correlated data (pre-post-
test) were described by Downie and Heath as follows: 28

a. for a large sample \((N = \text{more than 30})\)

\[ S_{D\bar{X}} = \sqrt{S_{\bar{X}_1}^2 + S_{\bar{X}_2}^2 - 2(\bar{X})(S_{\bar{X}_1})(S_{\bar{X}_2})} \]

Then

\[ Z = \frac{\bar{X}_1 - \bar{X}_2}{S_{D\bar{X}}} \]

b. for a small sample \((N = 30 \text{ or less})\) a \(t\) test

is substituted for the \(Z\) test and an appropriate \(t\) table is consulted to interpret the
results using the number of pairs minus 1 as
the degrees of freedom.

\[ ^{28}\text{Downie and Heath, pp. 133-140.} \]
c. Since the post-test means are expected to be higher than those of the pre-test, this is a one-directional test. The directional null hypothesis states that the mean of the post-test will be equal to or less than that recorded for the pre-test.

The levels of significance are $z$ is 1.64 for the 5% point and $z$ is 2.33 for the 1% point.

Gain/possible gain.—While gain scores are useful in describing the program's effectiveness by revealing the difference between the pre- and post-test means, they do not provide information as to the level of the entering behavior of the Ss as is indicated in the pre-test mean. This kind of information is especially necessary in the case where little gain is possible from a high pre-test to a perfect post-test. Access to this kind of information can be made by presenting a ratio of the gain (pre- to post-test) to the possible gain (100 minus pre-test). The value of the gain/possible gain in judging the effectiveness of programmed material has been investigated by
McGuigan and Peters. As a result of their study, they concluded that when the percentage of possible gain exceeded 50%, the program was effective in teaching. This figure will be used in this analysis.

The test selected for use in determining the significance of the difference between proportions when the N is less than 100 is described by Downie and Heath. The following formulas are used:

\[
\frac{(p_1)(N_1) + (p_2)(N_2)}{N_1 + N_2}
\]

Then

\[
S_{DP} = \sqrt{pq} \left( \frac{1}{N_1} + \frac{1}{N_2} \right)
\]

Then

\[
t = \frac{p_1 - p_2}{S_{DP}}
\]

**Number of successful completions.**--As the name implies, this statistic identifies the number of Ss who scored 70% or above on the post-test measure. It provides more specific information in this regard than the post-test

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30 Downie and Heath, pp. 148-149.
Percent of successful completions.— The percent of successful completions was computed by dividing the number of successful completions by the number of completions. It was computed for the purpose of statistical testing. The formula used in testing for the significance of the difference between proportions when the N is less than 100 is:

\[
\frac{(p_1)(N_1) + (p_2)(N_2)}{N_1 + N_2}
\]

Then

\[
S_{Dp} = \sqrt{p_1 \cdot q_1 \left( \frac{1}{N_1} + \frac{1}{N_2} \right)}
\]

Then

\[
t = \frac{p_1 - p_2}{S_{Dp}}
\]

The Effect of Study Condition on Student Achievement and Program Effectiveness

In the following section the data are organized to test the null hypothesis:

There is no significant difference in achievement between the group studying programmed materials under the Limited Help study condition and those studying the program under No Help conditions when the achievement is measured by

\[31 \text{Ibid.}\]
(a) Post-test I means
(b) Final post-test means
(c) Percent of possible gain from Post-test I means
(d) Percent of possible gain from Final post-test means
(e) Percent of successful completions from Post-test I means
(f) Percent of successful completions from the final post-test mean

Data for Following Directions, Reading Longitude from Maps and How We Forecast the Weather will be presented in the order given.

Following Directions

In Table 4, background information about the work of Ss with the program Following Directions is shown. It was necessary for the Ss to complete the entire program rather than a segment of it since there was only one post-test. Information supplied by the publisher indicated that it was possible to complete the program in the time allocated to this study.32

The table shows that the performance of the No Help (NH) and Limited Help (LH) study condition groups was

### TABLE 4

**FOLLOWING DIRECTIONS: ASSIGNMENTS AND COMPLETIONS FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS**

<table>
<thead>
<tr>
<th>Study Condition</th>
<th>NH</th>
<th>LH</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-test I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Ss assigned to program</td>
<td>42</td>
<td>42</td>
<td>84</td>
</tr>
<tr>
<td>Number to complete Post-test I</td>
<td>24</td>
<td>25</td>
<td>49</td>
</tr>
<tr>
<td>Percent to complete Post-test I</td>
<td>55.81%</td>
<td>60.98%</td>
<td>58.33%</td>
</tr>
<tr>
<td>Number scoring 70% or above</td>
<td>2</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>8.33%</td>
<td>4.00%</td>
<td>6.12%</td>
</tr>
</tbody>
</table>

found between the two groups on the percent of Ss to complete the program or in the percent of those completing the program with scores of 70% or above on the post-test measure.  

In Table 5, the post-test scores of the NH and the LH groups studying Directions are given. The results of an analysis of variance which included the post-test means

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33 In examining the records of the three Ss who completed the program successfully, it was found that their pre-test scores had also been above 70%. Two of them answered one additional question correctly on the post-test while the other received an identical pre-and post-test grade.
TABLE 5

FOLLOWING DIRECTIONS: PRE- AND POST-TEST MEANS AND GAIN SCORES FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS

<table>
<thead>
<tr>
<th>Achievement Measure</th>
<th>Study</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Help</td>
<td>Limited Help</td>
</tr>
<tr>
<td>Post-test I Mean</td>
<td>40.42 3.83</td>
<td>37.80 3.90</td>
</tr>
<tr>
<td>Pre-test I Mean</td>
<td>29.83 4.37</td>
<td>34.72 3.98</td>
</tr>
<tr>
<td>Gain</td>
<td>10.59</td>
<td>3.08</td>
</tr>
<tr>
<td>% of gain Possible</td>
<td>.15.09</td>
<td>4.72</td>
</tr>
</tbody>
</table>

of the Directions groups showed no significant differences between them. (See Table 6).

The pre-test score (Table 5) shows that both groups prior to instruction knew about one-third of the material asked for in the test. In this category the mean for the LH group was higher but did not represent one significantly different from that shown for the NH group.

For the LH group the movement from pre-test to post-test mean score was 3.08 percentage points which was not found to be significant. For the NH group, however,
TABLE 6

ANALYSIS OF VARIANCE: PROGRAMS AND STUDY CONDITIONS
POST-TEST I SCORES

<table>
<thead>
<tr>
<th>Source of Variance</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>Mean Squares</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programs (3)</td>
<td>2</td>
<td>98316.00</td>
<td>49158.00</td>
<td>121.31*</td>
</tr>
<tr>
<td>Study Conditions (2)</td>
<td>1</td>
<td>756.24</td>
<td>756.24</td>
<td>1.87</td>
</tr>
<tr>
<td>Interaction</td>
<td>2</td>
<td>745.61</td>
<td>372.81</td>
<td>.92</td>
</tr>
<tr>
<td>Within Replicates</td>
<td>206</td>
<td>83473.81</td>
<td>405.21</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>211</td>
<td>183291.66</td>
<td>50692.26</td>
<td></td>
</tr>
</tbody>
</table>

*Significant at the .001 level

the difference between the pre- and post-test means was significant at the .01 level.

When the percent of possible gain scores were examined no significant differences were found between the two groups.

Summary of findings relative to the effect of study conditions on achievement of Ss using Directions. — The acceptance is made of the null hypothesis: There is no significant difference between the groups studying
Directions under the NH and the LH study conditions when achievement was defined as

(a) post-test I measure  
(b) percent of successful completions  
(c) percent of possible gain scores.

Summary of findings relative to judging the effectiveness of the program Following Directions.—The measures on which effectiveness of a program were judged and the performance of the Ss using the Direction program are as follows:

(a) The post-test means of 40.42 (NH) and 37.80 (LH) did not reach the criterion of 70 which had been established as the minimum level of satisfactory achievement.

(b) The gain/possible gain of 15.09 (NH) and 4.72 (LH) did not reach the minimum of 50% which had been accepted as the minimum level of satisfactory achievement.

(c) The difference between the pre- to post-test means registered for the LH group did not reach the .05 level of significance required in this study. The gains shown by the NH group did reach the .01 level of significance.
Conclusions.—The intrinsic program Following Directions was not effective under any of the measurement criteria for teaching the LH study condition group.

Following Directions was found to be effective in teaching under one of the three measures of effectiveness for the NH group where a difference between pre-test and post-test means was found to be significant at the .01 level.

The null hypothesis of no significant differences between the NH and the LH study condition groups in achievement as measured by post-test I means, percent of possible gain scores and percent of successful completions is accepted for the program Following Directions.

Reading Longitude From Maps

The completion rate shown in Table 7 for Longitude Part I (75 questions) was very high for both groups with only one Ss in the NH group failing to complete the post-test. For Part II (112 questions) the completion rate dropped but remained fairly high with over half of those assigned to this program completing it within the time limitations of the study. The data for Part III was excluded from analysis because of an insufficient number
TABLE 7

READING LONGITUDE FROM MAPS: ASSIGNMENTS AND COMPLETIONS
FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS

<table>
<thead>
<tr>
<th>Study Condition</th>
<th>NH</th>
<th>LH</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-test I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Ss assigned to program</td>
<td>42</td>
<td>42</td>
<td>84</td>
</tr>
<tr>
<td>Number to complete Post-test I</td>
<td>41</td>
<td>42</td>
<td>83</td>
</tr>
<tr>
<td>Percent to complete Post-test I</td>
<td>97.62%</td>
<td>100%</td>
<td>98.81%</td>
</tr>
<tr>
<td>Number scoring 70% or above</td>
<td>14</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>34.15%</td>
<td>52.38%</td>
<td>43.37%</td>
</tr>
<tr>
<td><strong>Post-test II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number to complete Post-test II</td>
<td>29</td>
<td>30</td>
<td>59</td>
</tr>
<tr>
<td>Percent to complete Post-test II</td>
<td>69.05%</td>
<td>71.43%</td>
<td>71.95%</td>
</tr>
<tr>
<td>Number scoring 70% or above (successful completions)</td>
<td>9</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>31.03%</td>
<td>30.00%</td>
<td>30.51%</td>
</tr>
</tbody>
</table>

of completions.

A statistical test was applied using the data recorded for the percent of successful completions for Post-test I where a large difference appeared between the percent recorded for the NH group and the one recorded for the LH group. It resulted in a finding of no significant
difference between the percentages of the study groups.

No significant differences were found in the percent of successful completions between the study condition groups for the final post-test measure (Post-test II).

As seen in Table 8 the performance on the post-test measures did not reach the 70% level which was used as one indication that a program had been instructionally effective. The post-test mean for the NH group in Part I was lower than that of the LH group. The difference was not significant when an analysis of variance using the Post-test I means was performed. (See Table 6)

The pre-test mean for the NH group was also lower and when the gains for the two groups were computed a small gain of 1.53 percentage points appeared.

Statistical tests used to compare achievement as indicated in the percent of possible gain scores resulted in a finding of no significant difference between the scores of the two groups.

Significant differences at the .001 point were found when the movement from pre- to post-test means were analyzed for Parts I and II for both groups. This finding coupled with the positive direction from pre- to
TABLE 8

READING LONGITUDE FROM MAPS: PRE- AND POST-TEST MEANS AND GAIN SCORES FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS

<table>
<thead>
<tr>
<th>Achievement Measure</th>
<th>Study Condition</th>
<th>Study Condition</th>
<th>Study Condition</th>
<th>Study Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No Help</td>
<td>Limited Help</td>
<td>No Help</td>
<td>Limited Help</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>Error</td>
<td>r</td>
<td>Mean</td>
</tr>
<tr>
<td>Post-test I Mean</td>
<td>53.42</td>
<td>3.59</td>
<td>-.05</td>
<td>57.62</td>
</tr>
<tr>
<td>Pre-test I Mean</td>
<td>19.27</td>
<td>2.60</td>
<td>.39</td>
<td>25.00</td>
</tr>
<tr>
<td>Gain</td>
<td>34.15</td>
<td></td>
<td>32.62</td>
<td></td>
</tr>
<tr>
<td>% of Gain Possible</td>
<td>42.30%</td>
<td></td>
<td>48.41%</td>
<td></td>
</tr>
<tr>
<td>Post-test II Mean</td>
<td>52.14</td>
<td>4.16</td>
<td>.31</td>
<td>51.00</td>
</tr>
<tr>
<td>Pre-test II Mean</td>
<td>27.41</td>
<td>2.59</td>
<td>.35</td>
<td>24.19</td>
</tr>
<tr>
<td>Gain</td>
<td>24.73</td>
<td></td>
<td>26.81</td>
<td></td>
</tr>
<tr>
<td>% of Gain Possible</td>
<td>32.86%</td>
<td></td>
<td>33.63%</td>
<td></td>
</tr>
</tbody>
</table>

The post-test was interpreted to mean that the program had been successful in teaching.

The relatively low pre-test means of 19.27 (NH) and 25.00 (LH) were interpreted to mean that the Ss had initially few of the skills needed for this program.

In examining the records of the Ss who completed the section with a satisfactory score, it was found that all had increased their scores from a point below 70% to one above 70%.
Summary of findings relative to the effect of study conditions on achievement of Ss using Longitude.--There were no significant differences between the groups studying Reading Longitude from Maps under the NH and the LH study conditions when achievement was defined as

(a) Post-test I measures
(b) final post-test measures (Post-test II)
(c) percent of successful completions (Post-test I)
(d) percent of successful completions final post-test (test II)
(e) percent of possible gain scores. (Post-test I)
(f) percent of possible gain scores final post-test (Post-test II)

Summary of findings relative to the effectiveness of the program Reading Longitude from Maps.--The measures on which effectiveness of a program were judged and the performance of the Ss using the program Reading Longitude from Maps are as follows:

(a) The Post-test I means of 53.42 (NH) and 57.62 (LH) did not reach the criterion of 70 which had been established as the minimum level of satisfactory achievement.

(b) The means recorded for the final post-test measure (Post-test II) of 52.14 (NH) and 51.00 (LH) did not reach the criterion which had been established as the minimum level of satisfactory achievement.
(c) The gain/possible gain of 42.30% (NH) and 48.41% (LH) recorded for Part I and the 32.86% (NH) and 33.63% (LH) for Part II did not reach the minimum of 50% which had been accepted as the minimum level of satisfactory achievement.

(d) The difference between the pre- to post-test means registered for Parts I and II for both groups did reach the level of significance required in this study.

Conclusions.—The linear program Reading Longitude from Maps was found to be ineffective in teaching these children on two measures but effective when judged on the basis of the significance of the difference between pre- and post-test for Parts I and II and for both study condition groups.

The null hypothesis of no significant differences between the NH and the LH study condition groups in achievement as measured by Post-test I means, final post-test means, the percent of possible gain scores for Test I and Test II and the percent of successful completions for Test I and Test II is accepted for the program Reading Longitude from Maps.
How We Forecast the Weather

As shown in Table 9, there was a high completion rate for the Ss under each study condition for Sets 1 (35 questions) and Set 2 (45 questions) but for Set 3 (36 questions) the rate of completion dropped sharply with slightly over one-half the Ss of each study condition group finishing that section. There were no significant differences found in the percent of completion between the study groups for Sets 1, 2 or 3.

As can be seen in Table 9, the percent of successful completion in Set 1 for the NH group was in excess of 92% while that of the LH group was 75%. This difference was found to be significant at the .05 level. At Set 3, the final post-test section, the position of the groups has reversed with the LH group having a rate of successful completion of 82.61% and the NH group a rate of 63.64%. This difference at Set 3 did not reach the .05 level of significance.

The post-test means shown in Table 10 are all well above the 70% minimum set for describing a program as effective in terms of achievement on Post-test I measures and final post-test (Set 3) measures.
### TABLE 9

**HOW WE FORECAST THE WEATHER: ASSIGNMENTS AND COMPLETIONS FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS**

<table>
<thead>
<tr>
<th>Study Conditions</th>
<th>NH</th>
<th>LH</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Post-test I</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Ss assigned to program</td>
<td>42</td>
<td>42</td>
<td>84</td>
</tr>
<tr>
<td>Number to complete Post-test I</td>
<td>40</td>
<td>40</td>
<td>80</td>
</tr>
<tr>
<td>Percent to complete Post-test I</td>
<td>95.24%</td>
<td>95.24%</td>
<td>95.24%</td>
</tr>
<tr>
<td>Number scoring 70% or above</td>
<td>37</td>
<td>30</td>
<td>67</td>
</tr>
<tr>
<td>(Successful completions)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>92.50%</td>
<td>75.00%</td>
<td>83.75%</td>
</tr>
<tr>
<td><strong>Post-test II</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number to complete Post-test II</td>
<td>34</td>
<td>34</td>
<td>68</td>
</tr>
<tr>
<td>Percent to complete Post-test II</td>
<td>80.95%</td>
<td>80.95%</td>
<td>80.95%</td>
</tr>
<tr>
<td>Number scoring 70% or above</td>
<td>28</td>
<td>31</td>
<td>59</td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>82.35%</td>
<td>91.18%</td>
<td>86.76%</td>
</tr>
<tr>
<td><strong>Post-test III</strong> (final post-test)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number to complete Post-test III</td>
<td>22</td>
<td>23</td>
<td>45</td>
</tr>
<tr>
<td>Percent to complete Post-test III</td>
<td>52.38%</td>
<td>54.76%</td>
<td>56.25%</td>
</tr>
<tr>
<td>Number scoring 70% or above</td>
<td>14</td>
<td>19</td>
<td>33</td>
</tr>
<tr>
<td>Percent of successful completions</td>
<td>63.64%</td>
<td>82.61%</td>
<td>73.33%</td>
</tr>
</tbody>
</table>
### TABLE 10

**HOW WE FORECAST THE WEATHER: PRE- AND POST-TEST MEANS AND GAIN SCORES FOR GROUPS UNDER NO HELP AND LIMITED HELP STUDY CONDITIONS**

<table>
<thead>
<tr>
<th>Achievement Measure</th>
<th>Study Condition</th>
<th>No Help</th>
<th>Limited Help</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Error</td>
<td>r</td>
</tr>
<tr>
<td>Post-test I Mean</td>
<td>88.28</td>
<td>2.59</td>
<td>-0.14</td>
</tr>
<tr>
<td>Pre-test I Mean</td>
<td>65.15</td>
<td>3.76</td>
<td>-0.14</td>
</tr>
<tr>
<td>Gain</td>
<td>23.13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of Gain Possible</td>
<td>66.37%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test II Mean</td>
<td>83.24</td>
<td>3.48</td>
<td>-0.37</td>
</tr>
<tr>
<td>Pre-test II Mean</td>
<td>53.28</td>
<td>3.00</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>29.96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of Gain Possible</td>
<td>64.13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test III Mean</td>
<td>81.27</td>
<td>4.29</td>
<td>-0.23</td>
</tr>
<tr>
<td>Pre-test III Mean</td>
<td>53.09</td>
<td>5.70</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>28.18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of Gain Possible</td>
<td>60.07%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
An analysis of variance performed on the Post-test I means yielded a finding of no significant difference between them due to study conditions. (See Table 6). Also, no significant differences were found between the Post-test III means.

The pre-test means indicated that the average Ss was relatively well-prepared for the test and presumably the content of the program. No significant differences were found between the means recorded for the NH and the LH groups.

When statistical tests were performed to analyze the movement from pre- to post-test means for both study condition groups, a significant difference at the .001 level was found at the Post-test I level and at the final post-test level. The change in behavior which occurred between the pre- and post-testing was considered to be an effect of the program and the conclusion was made that learning by both groups had taken place.

35 Using the formula $S_{D^2} = \sqrt{S_{k1}^2 + S_{k2}^2}$ followed by a conversion to a z score, a significant difference at the .05 level was found between the post-test I means of the two study condition groups. (Downie and Heath, p. 132.)
In comparing the pre- and the post-test means of the two study conditions groups, it was interesting to note that in every case the NH group scored a higher pre-test and a lower post-test than did its LH counterpart. The result of this was reflected in the comparison of the percent of possible gain scores at the Post-test I level where they were found to differ significantly at the .05 level favoring the LH group. However, the ratios at the final post-test level did not reach the .05 level of significance. All the percent of possible gain scores for both study condition groups were found to be well above the 50% level which was used in this study as an indication that the program was effective in teaching this population.

Summary of findings relative to the effect of study condition on achievement of Ss using How We Forecast the Weather.—There were no significant differences between the groups studying How We Forecast the Weather under the NH and the LH study conditions when achievement was defined as:

(a) Post-test I measure as determined by an analysis of variance
(b) final post-test measure (Post-test III)
(c) percent of gain scores at final post-test level
(d) percent of successful completion scores at the
final post-test level

Significant differences were found between the groups under the NH and the LH study conditions when achievement was defined as:

(a) percent of possible gain scores at the Post-test I level favoring the LH group

(b) percent of successful completion scores at the Post-test I level favoring the NH group

Summary of findings relative to the effectiveness of the program How We Forecast the Weather.---The performance of the Ss on the measures used to determine the program's effectiveness is as follows:

(a) The post-test I means of 88.28 (NH) and 95.53 (LH) did reach the criterion of 70 which had been established as the minimum level of satisfactory achievement.

(b) The final post-test measure (Post-test III) of 81.27 (NH) and 89.22 (LH) did reach the criterion of 70 which had been established as the minimum level of satisfactory achievement.

(c) The percent of gain score of 66.37% (NH) and 89.66% (LH) recorded for Set 1 and the 60.07% (NH) and 78.44% (LH) for Set 3 did reach the minimum of 50% which had been accepted as the minimum level of satisfactory achievement.
(d) The difference between the pre-test and post-test means registered for Set 1 and for Set 3 for both the NH and the LH groups did exceed the .05 level of significance required in this study to indicate that learning had taken place.

**Conclusions.**—The linear program, *How We Forecast the Weather*, was found to be effective when used by the population of this study.

The null hypothesis of no significant difference between the NH and the LH study condition groups in achievement when achievement was measured by Post-test I and final post-test means, percent of gain at the final post-test level and percent of successful completions at the final post-test level is accepted.

When achievement was measured by the percent of gain at the Post-test I level and the percent of successful completions at the Post-test I level the null hypothesis is rejected.

**Conclusions relative to the effectiveness of the three programs**

Effectiveness in this study was measured by (1) achievement on Post-test I and final post-test measures of
at least 70% (2) a percent of possible gain score of at least 50% and (3) a difference between the pre- and post-test means that was significant at at least the .05 point.

*How We Forecast the Weather* was the only program of the three utilized in this research which was found to be instructionally effective when judged on the basis of all three criteria.

The relatively high pre-test scores indicated that the Ss were better prepared for the study of the *Weather* program than they were for the other two.

According to the publishers' descriptions of the three programs, *Weather* could be judged as the least difficult. Since it was field tested with the fourth, fifth and sixth-grades, whereas *Directions* was recommended for use by the fifth and sixth grades and *Longitude* was field tested using a sixth-grade population.

*How We Forecast the Weather* could also be judged the least difficult for these sixth-graders on the basis of the difficulty of the reading passages. The program having the highest readability score as revealed by the Dale-Chall formula was *Longitude* which averaged a corrected grade level score of 7-8 for Part I and 8-9 for Part II. The average score for *Directions* was 5-6. For the *Weather*
program the scores for the first two sets indicated that the material was suitable for 4th grade level and below. The score at Set 3 indicated that the difficulty of the reading material increased to that which would be recommended for the 7th or 8th grade student. It should be noted here in passing that when the reading difficulty went up the percent of successful completions went down. Whether a cause-and-effect relationship existed or whether this could be accounted for by the same kind of attrition that can be seen in the data for the Longitude program or for some other reason is not known.

Considering the findings for Following Directions and Reading Longitude from Maps, a conclusion must be reached that neither were effective in teaching the children in this study. Both were found to be ineffective on all achievement measures and percent of possible gain scores. The only indications of effectiveness were found in the significant movement from pre- to post-test for both the LH and the NH groups using the Longitude program and the No Help group using the Directions program.
Conclusions relative to the effect of study condition on student achievement

There were no significant differences found in the analysis of the effects of study condition on achievement for programs Direction or Longitude.

The study condition appeared to affect achievement on only two measures of the Weather scores. Significant differences at the .05 level and favoring the NH group were found when the percent of successful completions were studied. A second finding of significance was revealed favoring the LH group when the percent of possible gain was analyzed. There were no findings of significance in the final post-test measures.

Because of the inconsistency of these findings favoring one study condition group or another and because of the findings of no significant difference between the achievement measures for the Direction and Longitude groups, a conclusion was reached that the study condition under which these students performed had little effect on the achievement via programmed material of the sixth-grade inner-city child.

A noticeable trend of progressively lower post-test means beginning at the Post-test I mean and moving
through the Post-test II and III means was seen in the data supplied for the *Longitude* and *Weather* programs. This same trend was also noticed in the Pre-test means for the *Weather* groups and for the LH but not the NH groups studying the *Longitude* program.

Several possible explanations for this trend may be offered:

1. The program was becoming more difficult and affecting achievement.

2. There may have been inadequate learning of that portion of Part I that was prerequisite for instruction at Part II level.

3. The novelty of the experience of programmed instruction might have been replaced by boredom.

There is no apparent explanation for the reversal of this trend as seen in the Pre-test II means of the NH *Longitude* group.

**The Effect on Student Achievement of a Programming Technique**

In the following section the data are organized to test the null hypothesis:

There is no significant difference in achievement as measured by Post-test I means, final post-test means, percent of possible gain scores, percent of successful completion scores between the groups using
a. an intrinsic program and those using either of the two linear programs and 
b. one of two programs, both linear in design.

The data divided in the previous section for the purpose of studying the effect of study conditions on achievement with programmed materials will be recombined in this section so that the overall effect of the program on achievement of the Ss can be investigated. The data for the total N of the groups studying Directions, Longitude and Weather can be seen in Table 11.

Post-test I means

The achievement levels for the three program groups as revealed by the Post-test I means show a wide range of performance among them. An analysis of variance performed on the three means found their differences to be significant at the .001 level.

Final Post-test means

The Post-test I mean for the Direction group, the Post-test II measure for the Longitude group and the Post-test II measure for the Weather group were used in this analysis. Using the formula \( S_{p} = \sqrt{S_{x_{1}}^{2} + S_{x_{2}}^{2}} \) 36 and a

36 Downie and Heath, pp. 132-133.
<table>
<thead>
<tr>
<th></th>
<th>Program 1</th>
<th>Program 2</th>
<th>Program 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Completions</td>
<td>49</td>
<td>83</td>
<td>80</td>
</tr>
<tr>
<td>Successful Completions</td>
<td>3</td>
<td>36</td>
<td>67</td>
</tr>
<tr>
<td>Successful/Completions</td>
<td>6.12%</td>
<td>43.37%</td>
<td>83.75%</td>
</tr>
<tr>
<td>Post-test I Mean</td>
<td>39.08</td>
<td>55.54</td>
<td>91.90</td>
</tr>
<tr>
<td>Standard Error</td>
<td>2.71</td>
<td>2.78</td>
<td>1.55</td>
</tr>
<tr>
<td>r (pre-post-test)</td>
<td>.65</td>
<td>.25</td>
<td>.05</td>
</tr>
<tr>
<td>Pre-test I Mean</td>
<td>32.33</td>
<td>22.17</td>
<td>60.95</td>
</tr>
<tr>
<td>Standard Error</td>
<td>2.94</td>
<td>1.94</td>
<td>2.70</td>
</tr>
<tr>
<td>z score</td>
<td>2.84(.001)</td>
<td>11.21(.001)</td>
<td>13.17(.001)</td>
</tr>
<tr>
<td>Gain (Pre-post-test)</td>
<td>6.75</td>
<td>33.37</td>
<td>30.95</td>
</tr>
<tr>
<td>Gain/Possible Gain</td>
<td>9.83%</td>
<td>42.31%</td>
<td>79.26%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Program 1</th>
<th>Program 2</th>
<th>Program 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Completions</td>
<td>59</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Successful Completions</td>
<td>18</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Successful/Completions</td>
<td>30.51%</td>
<td>86.76%</td>
<td></td>
</tr>
<tr>
<td>Post-test II Mean</td>
<td>51.55</td>
<td>86.54</td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td>3.42</td>
<td>2.11</td>
<td></td>
</tr>
<tr>
<td>r (pre-post-test)</td>
<td>.33</td>
<td>.33</td>
<td></td>
</tr>
<tr>
<td>Pre-test II Mean</td>
<td>25.69</td>
<td>52.80</td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td>1.81</td>
<td>1.83</td>
<td></td>
</tr>
<tr>
<td>z score</td>
<td>7.84(.001)</td>
<td>14.73(.001)</td>
<td></td>
</tr>
<tr>
<td>Gain (Pre-post-test)</td>
<td>25.86</td>
<td>33.74</td>
<td></td>
</tr>
<tr>
<td>Gain/Possible Gain</td>
<td>34.80%</td>
<td>71.48%</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Program 1</th>
<th>Program 2</th>
<th>Program 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Completions</td>
<td>45</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Successful Completions</td>
<td></td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Successful/Completions</td>
<td></td>
<td>73.33%</td>
<td></td>
</tr>
<tr>
<td>Post-test III Mean</td>
<td></td>
<td>85.33</td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td></td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td>r (pre-post-test)</td>
<td></td>
<td>.009</td>
<td></td>
</tr>
<tr>
<td>Pre-test III Mean</td>
<td></td>
<td>51.51</td>
<td></td>
</tr>
<tr>
<td>Standard Error</td>
<td></td>
<td>4.10</td>
<td></td>
</tr>
<tr>
<td>z score</td>
<td></td>
<td>6.60(.001)</td>
<td></td>
</tr>
<tr>
<td>Gain (Pre-post-test)</td>
<td></td>
<td>33.82</td>
<td></td>
</tr>
<tr>
<td>Gain/Possible Gain</td>
<td></td>
<td>69.75%</td>
<td></td>
</tr>
</tbody>
</table>
z test, all means were found to differ from each other significantly (.001).

**Percent of gain/possible gain scores**

A relatively small gain of 6.75 for Pre-test I to Post-test I was recorded for the Direction group. The Longitude and Weather groups scored similar gains of 31 and 33 points respectively. When the percents for gain/possible gain were computed and subjected to statistical analysis, the scores recorded for each program were found to differ significantly (.001) from those recorded for any other program.

Using the percent of gain/possible gain computed from the final post-test measures, significant differences at the .001 level were found for all programs. These findings are shown in Table 12.

**Summary of the findings relative to the effect on achievement of the intrinsic program (Directions) and the two linear programs (Longitude and Weather)**

When achievement was measured by post-test I means, the final post-test measure, the percent of possible gain scores or the percent of successful completions, significant differences at the .001 level were found to exist
### TABLE 12

**DIFFERENCES BETWEEN PERCENT OF GAIN SCORES AT THE POST-TEST I LEVEL AND AT THE FINAL POST-TEST LEVEL FOR ALL PROGRAMS**

<table>
<thead>
<tr>
<th>Program and Achievement Measure used in calculating percent of gain</th>
<th>t</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directions and Longitude</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test I Level</td>
<td>-6.55</td>
<td>.001</td>
</tr>
<tr>
<td>Final Post-test Level</td>
<td>-3.05</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Directions and Weather</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test I Level</td>
<td>-7.308</td>
<td>.001</td>
</tr>
<tr>
<td>Final Post-test Level</td>
<td>-6.968</td>
<td>.001</td>
</tr>
<tr>
<td><strong>Longitude and Weather</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-test I Level</td>
<td>-4.56</td>
<td>.001</td>
</tr>
<tr>
<td>Final Post-test Level</td>
<td>-3.53</td>
<td>.001</td>
</tr>
</tbody>
</table>

between the intrinsic program (**Directions** and each of the linear programs. Similar differences were found between the achievement measures when both the programs were of the linear format.

No decision relative to the null hypothesis was taken. The reasons for this decision are given in the **Conclusion** section which follows.
Conclusions

Clearly, the achievement of the inner-city sixth-grade student was significantly affected by the program that he studied. The highest achievement was shown by those Ss who studied the linear program, *How We Forecast the Weather* which, according to the criteria used in this study, was an instructionally effective program. The lowest achievement was reported for those Ss who studied the intrinsic program, *Following Directions*. All programs were found to differ significantly (.001) from all other programs on all achievement measures.

It is not the intent of the investigator to generalize on the basis of this study that one programming technique is superior to another in promoting achievement. In the present investigation, only one of two linear programs proved to be instructionally effective; the second did not. The intrinsic program proved to be ineffective in terms of most of the criteria for judging effectiveness that were adopted in this study. Had there been a second intrinsically constructed program examined, would the results have duplicated those found in the case of the linear programs? No unequivocal answer can be offered on the basis of the data collected.
No evidence has been presented that the programs were of equal difficulty. The evidence, presented in the form of achievement measures, publisher's descriptions and readability scores, collectively imply, rather strongly, that the programs were not of equal difficulty. If true, this basic difference could account for the fact that one program was more effective in promoting the learning of the population of the study than were the others.

The testing of the null hypothesis was done without making provisions for controlling the difficulty variable; hence, no acceptance or rejection of it is possible.

Stated concisely, the conclusion that apparently can be drawn from the findings of this section is: For the inner-city sixth-grade students of this study, achievement via programmed materials was significantly affected by the program chosen for study.

The Prediction of Student Success with Programmed Instructional Material

In this section of the study an attempt was made to compare the achievement scores resulting from the Ss's use of programmed materials with certain of their characteristics. The purpose of this analysis was to identify, if possible, a configuration of those learner character-
istics which correlated highly with achievement via pro-
grammed instruction. It was hypothesized that, with the
knowledge of such correlations, a teacher would be better
equipped to make appropriate assignments of materials which
were programmed to those pupils most likely to be successful
in its use.

The learner characteristics under investigation
were sex, age, prior grades, and scores resulting from the
administration of standardized intelligence, reading,
language, and arithmetic tests. The achievement scores and
the learner characteristics were compared first by using
the Pearson formula for obtaining correlation coefficients.
Later the number of learner characteristics was reduced
by dropping those correlations with which achievement was
minimal. The scores for those characteristics which re-
mained were included with achievement scores of Post-test I
in a multiple regression analysis. The equation provided
by the multiple regression data was used on a small sample
of students to investigate the accuracy of this prediction
technique.

A second, perhaps less complicated, procedure for
identifying the Ss who would be likely to achieve success-
fully with programmed materials was investigated. During
the In-school project the teachers of the participating students were asked to predict which of their students would score at least 70% on the Post-test I measure of the program to which each was assigned. The percentage of correct responses was tabulated and then compared with those obtained from the multiple regression formulas.

The results of the Pearson Correlation Coefficients analysis, the multiple regression analysis and the teacher predictions of student success follow.

Results of the Pearson Correlation Coefficient Analysis

The Pearson Correlation Coefficient was computed using the data compiled for the total N for each of the three programs, Directions, Longitude and Weather. The results of the analysis follow.

Following Directions

The data presented in Table 13 shows that the correlations of achievement with learner characteristics all reached the .05 level of significance except those which included the variables of sex, Language: spelling and Arithmetic: computations. The coefficients of correlation
<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Number</th>
<th>r</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>49</td>
<td>.0955</td>
<td>.257</td>
</tr>
<tr>
<td>Age</td>
<td>49</td>
<td>-.3662</td>
<td>.005*</td>
</tr>
<tr>
<td>Prior Grade</td>
<td>49</td>
<td>.4706</td>
<td>.001*</td>
</tr>
<tr>
<td><strong>California Test of Mental Maturities</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>39</td>
<td>.5701</td>
<td>.001*</td>
</tr>
<tr>
<td>Non-language</td>
<td>39</td>
<td>.5086</td>
<td>.001*</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>.6259</td>
<td>.001*</td>
</tr>
<tr>
<td><strong>Comprehensive Tests of Basic Skills</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Reading</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>43</td>
<td>.3780</td>
<td>.006*</td>
</tr>
<tr>
<td>Comprehension</td>
<td>43</td>
<td>.4422</td>
<td>.001*</td>
</tr>
<tr>
<td><strong>Language</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>41</td>
<td>.2886</td>
<td>.034*</td>
</tr>
<tr>
<td>Expression</td>
<td>41</td>
<td>.4137</td>
<td>.004*</td>
</tr>
<tr>
<td>Spelling</td>
<td>41</td>
<td>.1976</td>
<td>.108</td>
</tr>
<tr>
<td><strong>Arithmetic</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computation</td>
<td>41</td>
<td>.2048</td>
<td>.091</td>
</tr>
<tr>
<td>Concepts</td>
<td>41</td>
<td>.4505</td>
<td>.001*</td>
</tr>
<tr>
<td>Application</td>
<td>41</td>
<td>.4335</td>
<td>.002*</td>
</tr>
</tbody>
</table>

* significantly beyond the .05 level
yielded an \( r \) of substantial or marked relationship\(^{37}\) between achievement and the California Test of Mental Maturities (CTMM): Total (.63) and \( r \)'s of moderate relationship with CTMM: Language (.57), CTMM: Non-language (.51), prior grade (.47), Arithmetic: Concepts (.45), Reading: Comprehension (.44), Arithmetic: Application (.43) and Language: Expression (.41).

**Reading Longitude from Maps**

The correlations between achievement and learner characteristics for those Ss studying the program *Longitude* are shown in Table 14. All correlations except sex and age reached at least the .05 level of significance for Part I. The highest correlations were recorded for Reading: Comprehension and Vocabulary. These were in the moderate range.

**How We Forecast the Weather**

Table 15 contains the correlations obtained for the scores of the *Weather* program. Significant correlations

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\(^{37}\)John W. Best, *Research in Education*, Second Edition (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1970), p. 257 provided the following information: Magnitude of the Correlation Coefficients negligible if .00 to .20; low or slight if .20 to .40; moderate if .40 to .60; substantial or marked if .60 to .80; high to very high if .80 to 1.00.
TABLE 14

READING LONGITUDE FROM MAPS: PEARSON CORRELATION COEFFICIENTS OF LEARNER CHARACTERISTICS AND ACHIEVEMENT

<table>
<thead>
<tr>
<th>Learner Characteristics</th>
<th>Part I</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
</tr>
<tr>
<td>Sex</td>
<td>83</td>
</tr>
<tr>
<td>Age</td>
<td>83</td>
</tr>
<tr>
<td>Prior Grade</td>
<td>82</td>
</tr>
<tr>
<td>California Test of Mental Maturities</td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>72</td>
</tr>
<tr>
<td>Non-language</td>
<td>72</td>
</tr>
<tr>
<td>Total</td>
<td>72</td>
</tr>
<tr>
<td>California Tests of Basic Skills</td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>83</td>
</tr>
<tr>
<td>Comprehension</td>
<td>83</td>
</tr>
<tr>
<td>Language</td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>79</td>
</tr>
<tr>
<td>Expression</td>
<td>79</td>
</tr>
<tr>
<td>Spelling</td>
<td>79</td>
</tr>
<tr>
<td>Arithmetic</td>
<td></td>
</tr>
<tr>
<td>Computation</td>
<td>83</td>
</tr>
<tr>
<td>Concepts</td>
<td>83</td>
</tr>
<tr>
<td>Application</td>
<td>83</td>
</tr>
</tbody>
</table>

**Significant beyond the .05 level
## HOW WE FORECAST THE WEATHER: PEARSON CORRELATION COEFFICIENT OF LEARNER CHARACTERISTICS AND ACHIEVEMENT

<table>
<thead>
<tr>
<th>Learner Characteristic</th>
<th>Post-test I</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>r</td>
</tr>
<tr>
<td>Sex</td>
<td>80</td>
<td>.0085</td>
</tr>
<tr>
<td>Age</td>
<td>80</td>
<td>-.1423</td>
</tr>
<tr>
<td>Prior Grade</td>
<td>79</td>
<td>.2444</td>
</tr>
<tr>
<td><strong>California Test of Mental Maturities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Language</td>
<td>73</td>
<td>.1179</td>
</tr>
<tr>
<td>Non-language</td>
<td>73</td>
<td>.4218</td>
</tr>
<tr>
<td>Total</td>
<td>73</td>
<td>.2608</td>
</tr>
<tr>
<td><strong>Comprehensive Tests of Basic Skills</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reading</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vocabulary</td>
<td>75</td>
<td>.2059</td>
</tr>
<tr>
<td>Comprehension</td>
<td>75</td>
<td>.1335</td>
</tr>
<tr>
<td>Language</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanics</td>
<td>73</td>
<td>.0343</td>
</tr>
<tr>
<td>Expression</td>
<td>73</td>
<td>.3159</td>
</tr>
<tr>
<td>Spelling</td>
<td>73</td>
<td>.1379</td>
</tr>
<tr>
<td>Arithmetic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computation</td>
<td>77</td>
<td>.2699</td>
</tr>
<tr>
<td>Concepts</td>
<td>77</td>
<td>.1895</td>
</tr>
<tr>
<td>Application</td>
<td>77</td>
<td>.1189</td>
</tr>
</tbody>
</table>

* significance beyond the .05 level
were found to exist between achievement in Test I and prior grade, CTMM: Non-Language and Total, Reading: Vocabulary, Language: Expression, and Arithmetic: Computation and Concepts. Only two of these were found to reach the level which indicated a correlation in the moderate range—Arithmetic: Computation (.53) and CTMM: Non-language (.42).

**Summary of the results of the Pearson Correlation Coefficient analysis**

For all three programs there were no significant correlations between achievement with the variables of sex and only one correlation with age. Correlations significant at the .05 level, appeared for all three programs between achievement and the variables of CTMM: Non-language and Total, Reading: Vocabulary, Language: Expression, Arithmetic: Concepts, and Prior Grade. Other variables appeared to be more important in the correlations for one of the programs than for others.

On the basis of these results, it was decided to drop the variables of sex and age from further study and to subject the remaining variables to a multiple regression analysis.
Results of the Multiple Regression Analysis and Prediction Technique

The purposes of the multiple regression analysis were to identify, if possible, a cluster of learner characteristics which correlated to a high degree with the Ss achievement scores and to obtain a formula which could be used in the process of predicting Ss achievement scores. A new prediction equation was formed with the addition of each new variable during the regression process. The equation chosen for prediction purposes was different for each program and was the final one in the regression which contained variables whose F values remained significant at the .05 level.

In the section which follows, the equation resulting from the multiple regression analysis for each of the programs Direction, Longitude and Weather is presented and then used to compute the predicted scores for a small sample of students who had studied each of the programs. The sample for each program was chosen by taking the scores for every fifth student from a list which includes all Ss who had completed the Post-test I measure. In cases where the particular scores needed in the prediction equation were missing, that student's scores were dropped
and the next student on the list with all the needed scores was used as a replacement.

Multiple Regression Analysis

In Tables 16, 17, and 18, it can be seen by the "Multiple r" column that the correlations reached the substantial or marked level for the program Directions and lower or moderate levels for the programs Weather and Longitude. Two observations can be made at this point:

(1) There appears to be an inverse relationship which exists between the successful achievement of the Ss with programmed material and the magnitude of the correlations which are shown in Tables 16-18. In a previous section, the data presented showed that the achievement level reached by students was found to be lowest for those using the program Directions and highest for the Ss using the program Weather.

The combination of the two sets of data supports the interpretation that if Ss are highly successful with programmed materials, the magnitude of the correlation between achievement and learner characteristics will be smaller than will be the magnitude of those in which the achievement scores reflect a less successful performance.
### TABLE 16

**FOLLOWING DIRECTIONS: MULTIPLE REGRESSION ANALYSIS**  
**DEPENDENT VARIABLE: POST TEST I**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>F</th>
<th>Multiple (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTMM Total</td>
<td>1.297</td>
<td>17.509</td>
<td>.62591</td>
</tr>
<tr>
<td>Arithmetic Concepts</td>
<td>.937</td>
<td>5.731</td>
<td>.65928</td>
</tr>
<tr>
<td>Arithmetic Computation</td>
<td>-.606</td>
<td>3.334</td>
<td>.69751</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-29.677</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F table entered at 3 and 33 df gave of F at the .05 level as 2.89

### TABLE 17

**READING LONGITUDE FROM MAPS: MULTIPLE REGRESSION ANALYSIS**  
**DEPENDENT VARIABLE: POST-TEST I**

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>F</th>
<th>Multiple (r)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Comprehension</td>
<td>1.055</td>
<td>9.865</td>
<td>.57363</td>
</tr>
<tr>
<td>Reading Vocabulary</td>
<td>.755</td>
<td>4.602</td>
<td>.60958</td>
</tr>
<tr>
<td>(Constant)</td>
<td>-20.38085</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

F table entered at 2 and 68 df gave value of F at the .05 level as 3.14
TABLE 18
HOW WE FORECAST THE WEATHER: MULTIPLE REGRESSION ANALYSIS
DEPENDENT VARIABLE: POST-TEST I

<table>
<thead>
<tr>
<th>Variable</th>
<th>B</th>
<th>F</th>
<th>Multiple r</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTMM Non-Language</td>
<td>1.16</td>
<td>14.284</td>
<td>0.42177</td>
</tr>
<tr>
<td>CTMM Total</td>
<td>-0.71</td>
<td>4.703</td>
<td>0.48147</td>
</tr>
<tr>
<td>(Constant)</td>
<td></td>
<td>72.364</td>
<td>94</td>
</tr>
</tbody>
</table>

F table entered at 2 and 67 df gave value of F at the .05 level as 3.14.

(2) By comparing the variables which constitute the prediction formulas for the three programs, it can be seen that each appears to be demanding different qualities of the learners. In the Longitude equation the reading variables show the highest correlations. Achievement in the Weather post-test correlates most highly with two of the three subtests of the CTMM. Achievement in the program Directions correlates most highly with CTMM: Total scores and with two of the Arithmetic subtests.
Prediction scores.—Tables 19, 20, and 21 contain (1) the data needed to solve the prediction equations that were expressed in Tables 13, 14, and 15\textsuperscript{38} (2) the predicted score, and (3) the score the Ss actually made.

The data for twelve students are shown for the Direction population, twenty-one for the Longitude Ss and twenty for those studying Weather. This represents about one-fourth of the total population who completed the Post-test I measure for each program.

Accuracy of the predicted scores.—Tables 19, 20, and 21 which show the results of the application of the prediction equation to student scores was entered in the "Predicted Score" column. All the predicted scores which were at least 70 were checked. If the score actually made by these students was at least 70% the prediction was considered to be correct.

\textsuperscript{38}Equations for the Weather program and for the Longitude program originally contained four variables whose F values were significant at the .05 level. However, it was found that the equation in which only two variables were used predicted the scores at least as accurately as the one which required the longer computations. In the interest of economy of time and effort, the equation of only two variables is presented.
### TABLE 19

**FOLLOWING DIRECTIONS: APPLICATION OF PREDICTION EQUATION TO STUDENT SCORES**

<table>
<thead>
<tr>
<th>Student Number</th>
<th>Variable 16</th>
<th>Variable 23</th>
<th>Variable 22</th>
<th>Predicted Score (Rounded)**</th>
<th>Actual Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>355</td>
<td>50 x 1.297</td>
<td>58 x 0.937*</td>
<td>59 x -.606*</td>
<td>54 (16)</td>
<td>38</td>
</tr>
<tr>
<td>416</td>
<td>61</td>
<td>52</td>
<td>53</td>
<td>66 (3)</td>
<td>63</td>
</tr>
<tr>
<td>527</td>
<td>47</td>
<td>51</td>
<td>45</td>
<td>52 (11)</td>
<td>63</td>
</tr>
<tr>
<td>612</td>
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<td>46</td>
<td>49</td>
<td>49 (1)</td>
<td>50</td>
</tr>
<tr>
<td>632</td>
<td>49</td>
<td>56</td>
<td>53</td>
<td>65 (23)</td>
<td>88</td>
</tr>
<tr>
<td>327</td>
<td>49</td>
<td>41</td>
<td>50</td>
<td>42 (4)</td>
<td>38</td>
</tr>
<tr>
<td>451</td>
<td>44</td>
<td>37</td>
<td>31</td>
<td>43 (5)</td>
<td>38</td>
</tr>
<tr>
<td>544</td>
<td>42</td>
<td>34</td>
<td>31</td>
<td>38 -</td>
<td>38</td>
</tr>
<tr>
<td>647</td>
<td>42</td>
<td>36</td>
<td>38</td>
<td>36 (2)</td>
<td>38</td>
</tr>
<tr>
<td>266</td>
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<td>39</td>
<td>30</td>
<td>46 (8)</td>
<td>38</td>
</tr>
<tr>
<td>413</td>
<td>45</td>
<td>27</td>
<td>42</td>
<td>29 (4)</td>
<td>25</td>
</tr>
<tr>
<td>531</td>
<td>43</td>
<td>46</td>
<td>45</td>
<td>42 (17)</td>
<td>25</td>
</tr>
</tbody>
</table>

Variable 16: CTMM: total  
Variable 23: Arithmetic: concepts  
Variable 22: Arithmetic: computation  

* Beta value  
** Numbers in parentheses are the differences between the predicted and actual scores.
TABLE 20
READING LONGITUDE FROM MAPS: APPLICATION OF PREDICTION EQUATION TO STUDENT SCORES

<table>
<thead>
<tr>
<th>Student Number</th>
<th>Variable 17 x 0.755*</th>
<th>Variable 18 x 1.055*</th>
<th>Predicted Score</th>
<th>Actual Score</th>
<th>Difference in Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>154</td>
<td>27</td>
<td>35</td>
<td>37</td>
<td>70</td>
<td>33</td>
</tr>
<tr>
<td>245</td>
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<td>11</td>
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<td>345</td>
<td>42</td>
<td>24</td>
<td>37</td>
<td>30</td>
<td>7</td>
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<tr>
<td>365</td>
<td>51</td>
<td>51</td>
<td>72</td>
<td>80</td>
<td>8</td>
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<td>426</td>
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<td>23</td>
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<td>3</td>
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<td>513</td>
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<td>49</td>
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<td>80</td>
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<td>367</td>
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<td>48</td>
<td>40</td>
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<tr>
<td>432</td>
<td>53</td>
<td>57</td>
<td>80</td>
<td>100</td>
<td>20</td>
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</tbody>
</table>

Variable 17  Reading: Vocabulary  
Variable 18  Reading: Comprehension  
(constant)  -20.38  

*Beta value
## Table 21

**How We Forecast the Weather: Application of Prediction Equation to Student Scores**

<table>
<thead>
<tr>
<th>Student Number</th>
<th>Variable 15</th>
<th>Variable 16</th>
<th>Predicted Score</th>
<th>Actual Score</th>
<th>Difference in Scores</th>
</tr>
</thead>
<tbody>
<tr>
<td>453</td>
<td>33</td>
<td>35</td>
<td>86</td>
<td>100</td>
<td>14</td>
</tr>
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<td>466</td>
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<td>62</td>
<td>101</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>663</td>
<td>48</td>
<td>43</td>
<td>98</td>
<td>84</td>
<td>14</td>
</tr>
<tr>
<td>132</td>
<td>33</td>
<td>33</td>
<td>87</td>
<td>100</td>
<td>13</td>
</tr>
<tr>
<td>223</td>
<td>43</td>
<td>41</td>
<td>91</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>233</td>
<td>36</td>
<td>37</td>
<td>88</td>
<td>90</td>
<td>9</td>
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<tr>
<td>322</td>
<td>36</td>
<td>34</td>
<td>90</td>
<td>100</td>
<td>10</td>
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<tr>
<td>111</td>
<td>58</td>
<td>62</td>
<td>96</td>
<td>100</td>
<td>4</td>
</tr>
<tr>
<td>417</td>
<td>50</td>
<td>55</td>
<td>91</td>
<td>100</td>
<td>9</td>
</tr>
<tr>
<td>437</td>
<td>49</td>
<td>42</td>
<td>99</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>524</td>
<td>49</td>
<td>45</td>
<td>97</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>624</td>
<td>35</td>
<td>23</td>
<td>97</td>
<td>100</td>
<td>3</td>
</tr>
<tr>
<td>631</td>
<td>42</td>
<td>48</td>
<td>87</td>
<td>84</td>
<td>3</td>
</tr>
<tr>
<td>155</td>
<td>50</td>
<td>45</td>
<td>98</td>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>261</td>
<td>48</td>
<td>47</td>
<td>95</td>
<td>84</td>
<td>11</td>
</tr>
<tr>
<td>262</td>
<td>34</td>
<td>31</td>
<td>90</td>
<td>100</td>
<td>10</td>
</tr>
<tr>
<td>343</td>
<td>44</td>
<td>48</td>
<td>89</td>
<td>100</td>
<td>11</td>
</tr>
<tr>
<td>363</td>
<td>48</td>
<td>46</td>
<td>95</td>
<td>100</td>
<td>5</td>
</tr>
</tbody>
</table>

Variable 15: CTMM: Non language  
Variable 16: CTMM: Total  

*Beta value*
Because the predicted scores could also be used to identify students who will not score at least 70% on the Post-test I measure, the "Predicted Score" column was reentered and those scores which did not reach the 70% level were identified. If the actual score was found to be below 70% the prediction was considered to be correct.

The success of the use of the prediction formula to identify those students who (1) would score at least 70% on the Post-test I measure and (2) would not reach the 70% level can be seen in Table 22.

When using the prediction formula to forecast student success at the 70% level, accurate predictions were made for over 90% of the cases sampled for the Weather and for the Directions programs. For the Longitude program, two-thirds of the predictions were made accurately.

Results of Teacher Predictions

The work involved in the construction of a prediction equation includes compiling the data, constructing the equation and completing the computations necessary to arrive at the predicted score. To expect that the classroom teacher will become involved in this process is somewhat unrealistic.
### TABLE 22

THE ACCURACY OF THE PREDICTION FORMULA IN IDENTIFYING SUCCESSFUL AND UNSUCCESSFUL USERS OF PROGRAMMED MATERIALS

<table>
<thead>
<tr>
<th>Program</th>
<th>The formula predicted that</th>
<th>Number of correct predictions</th>
<th>Percentage of correct predictions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Directions</strong> (12 scores)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>would achieve 0 at least 70%</td>
<td>0</td>
<td>91.6%</td>
</tr>
<tr>
<td>12</td>
<td>would not</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td><strong>Longitude</strong> (21 scores)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>would achieve 6 at least 70%</td>
<td>6</td>
<td>66.7%</td>
</tr>
<tr>
<td>14</td>
<td>would not</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td><strong>Weather</strong> (20 scores)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>would achieve 19 at least 70%</td>
<td>19</td>
<td>95.0%</td>
</tr>
<tr>
<td>0</td>
<td>would not</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
A less complicated method of predicting student success with programmed materials was investigated during the course of this study. The classroom teacher was asked to identify those of her students who would score at least 70% on the Post-test I measure of the particular program to which he was assigned.

The student assistant supplied the classroom teacher with the name of the student and the title of the program to which he had been assigned. Few of the teachers took the opportunity extended to them to inspect the programs on which they were making their predictions. Most of the predictions, therefore, could not have been founded on a knowledge of the content or difficulty of the programmed material. One of several assumptions relative to the generation of the prediction can be made: (1) the prediction was based primarily on a general knowledge of the child's ability to cope with instructional materials in the classroom, (2) the prediction was based primarily on a confidence of the instructional abilities of programmed materials or (3) the prediction was based on a suspicion that the question was asked in order to get some measure of teacher expectations of student success since the
implications drawn from Pygmalion In the Classroom\textsuperscript{39} were getting much attention at that time.

As seen in Table 23, teachers appeared to be more accurate in predicting the success of those Ss who were assigned to the Weather program where 83.75\% scored at least 70\% on the Post-test I measure. They were least accurate in their predictions for the Direction program where only 6.12\% of the Ss scored at least 70\% on that measure. Perhaps the fact that almost three-fourths of the predictions were "Yes" had some effect on these observations.

Comparisons of the Accuracy of Two Methods of Predicting the 70\% Level of Student Achievement

When the predictions made by the teachers relative to the degree of success of the students using programmed material were compared statistically to those made by the use of the multiple regression equation the differences favoring the latter technique were significant at the .01 level for Program Directions and at the .05 level for Weather. For the Longitude program the two predictions

### TABLE 23

**THE ACCURACY OF TEACHER PREDICTIONS IN IDENTIFYING SUCCESSFUL AND UNSUCCESSFUL USERS OF PROGRAMMED MATERIALS**

<table>
<thead>
<tr>
<th>Correct responses given for programs</th>
<th>Directions</th>
<th>Longitude</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, the student will score at least 70% on the Post-test I measure.</td>
<td>3</td>
<td>26</td>
<td>49</td>
</tr>
<tr>
<td>No, the student will not score at least 70% on the Post-test I measure.</td>
<td>15</td>
<td>17</td>
<td>4</td>
</tr>
<tr>
<td>Number of correct predictions (Total responding)</td>
<td>18 (48)</td>
<td>43 (77)</td>
<td>53 (76)</td>
</tr>
<tr>
<td>% of correct predictions</td>
<td>37.5%</td>
<td>55.84%</td>
<td>69.74%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Incorrect responses given for programs</th>
<th>Directions</th>
<th>Longitude</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes, the student will score at least 70% on the Post-test I measure</td>
<td>30</td>
<td>25</td>
<td>8</td>
</tr>
<tr>
<td>No, the student will not score at least 70% on the Post-test I measure.</td>
<td>0</td>
<td>9</td>
<td>15</td>
</tr>
<tr>
<td>Number of incorrect responses (Total responding)</td>
<td>30 (48)</td>
<td>34 (77)</td>
<td>23 (76)</td>
</tr>
</tbody>
</table>
did not differ one from the other.

In assigning programmed materials to sixth-grade inner city children, it would seem on the basis of these findings, to be more efficient, in terms of accuracy, to base that decision on an application of a prediction equation obtained from a multiple regression analysis, rather than on the predictions made by the teachers. Whether the construction of a prediction formula using the multiple regression analysis is feasible would depend on the strength or extent of the commitment the school system to the use of instructional materials that were programmed.

Summary of Chapter IV

In this chapter, programmed material was examined on the basis of its use by sixth-grade inner-city children. Measures of achievement were analyzed and conclusion as to the effectiveness of the programs to instruct were made.

Correlations between the means of certain of the learners' characteristics and the Post-test I means of each program were computed by the Pearson Product Moment process and by a multiple regression analysis. From the multiple
regression analysis a prediction equation was extracted. Its predictive accuracy was compared to the accuracy of the teacher in predicting a 70% achievement performance of the Ss.
CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

This study was an examination of the use of commercially available programmed material by inner-city sixth-grade children. It was an attempt to investigate the feasibility of including such material among the instructional resources regularly made available to such pupils in the classroom. The purpose of the first portion of the study was to examine the effect on achievement measures of (a) the conditions of study which were identified by the amount of teacher help available to the child during study and (b) the programming technique, linear or intrinsic, by which the program was constructed.

It was anticipated that some children would be able to achieve satisfactorily via programmed instruction and that others would not. If programmed material were to serve as an instructional resource in an inner-city classroom, its use would be made more efficient if the identity of those most likely to achieve satisfactorily could be
predicted in advance. The purpose of the second portion of the study, then, was to investigate two methods of identifying such children by: (1) identifying a characteristic or a cluster of characteristics of the learner that correlated highly with achievement or (2) using the predictions of the teachers relative to pupil achievement.

The samples of pupils used as subjects in the study were seven-pupil groups who had been randomly selected from thirty-six sixth-grade classrooms located in eleven Priority I inner-city schools of Columbus, Ohio. Three commercially available programs were located which were recommended for use by sixth-grade students. Random assignment of the three programs was made in such a way that copies of each program were studied by at least two children in each group. The study assistants, who were employed to supervise during the experiment, met with six groups of children per day—three in the A.M. and three in the P.M. Random assignment of study condition was made so that either the A.M. groups or the P.M. groups completed their work under the (a) NH study condition in which no help was made available to students or under the (b) LH study condition in which limited help short of teaching or providing an answer was available. The length of the study
for each group, including the orientation session, was six days.

The efforts of the children were graded and achievement measures—post-test and pre-test scores—were analyzed to determine whether the study conditions or programming techniques affected achievement significantly.

Correlational studies of achievement and characteristics of the learner were made using the Pearson correlational coefficient and a multiple regression analysis technique. The prediction equations extracted from the multiple regression analysis were applied to a small sample of student scores for the purpose of predicting those children who would achieve at the 70% (Post-test I) level. The accuracy of this prediction was then compared with that of the teacher who had made similar predictions earlier.

**Findings**

The findings of this study are as follows:

1. The null hypothesis of no significant difference (.05) between the NH and the LH study condition groups in achievement as measured by Post-test I means, final post-test means, percent of possible gain scores (Post-test I and final post-test level) and percent of successful com-
pletions (Post-test I and final post-test level) was accepted for the programs

(a) **Following Directions**

(b) **Reading Longitude from Maps**

For the program *How We Forecast the Weather*, the null hypothesis was accepted for achievement as measured by Post-test I means, final post-test means, percent of possible gain scores (final post-test level) and percent of successful completions (final post-test level).

The null hypothesis was rejected when achievement was identified as (a) a percent of possible gain (Post-test I level) when a difference significant at the .05 level was found favoring the LH group and (b) a percent of successful completion (Post-test I level) when a difference significant at the .05 level was found favoring the NH group.

2. The null hypothesis of no significant difference in achievement as measured by the Post-test I means, the final post-test means, the percent of successful completions (Post-test I and final post-test levels) and the percent of possible gain scores (Post-test I and final post-test levels) between the groups using (a) an intrinsic program and those using either of the two linear programs
and (b) one of two programs, both linear in design, was accepted when differences between each combination of programs were found at the .001 level. The acceptance of the null hypothesis was based on the differences in achievement of the groups using each program and not primarily on the basis of the programming technique used to construct the program.

3. The application of the Dale-Chall readability formula to the passages of the programs used in this study resulted in the following average corrected grade level placements: (For Post-test I level)

(a) **Directions** fifth-to-sixth-grade (5.5)
(b) **Longitude** seventh-and-eighth (7.5)
(c) **Weather** fourth and below (4.0)

4. The results of the Pearson correlation coefficient showed: (a) no significant correlations (.05) between achievement measures on any program and the independent variable of sex and (b) one significant correlation between the achievement measure for the program **Directions** and the independent variable of age.
The results of the Pearson correlation coefficient identified the following variables for inclusion in the multiple regression analysis: (a) prior grade, (b) the standard scores for the language, non-language and total subtests of the California Test of Mental Maturities and (c) the standard scores obtained from the Comprehensive Tests of Basic Skills which consisted of the subtest vocabulary and comprehension of Reading; mechanics, spelling and expression of Language; and computation, concepts and application of Arithmetic.

5. The results of the prediction equation constructed from the multiple regression analysis were as follows:
(a) for the program Directions, the variables of CTMM: total, Arithmetic: concepts and a negative value for Arithmetic: computations were found to account for 69.75% of the variance in the Ss scores. This equation was correct 91.6% of the time in predicting those who scored at least 70% on the Post-Test I. measure and those who did not.
(b) For the program Longitude, the variables of Reading: comprehension, and Reading: vocabulary accounted for 60.96% of the variance in the Ss scores.
The equation was correct 66.7% of the time in correctly identifying those who had scored at least 70% on the Post-test I measure and those who had not.

(c) For the program *Weather*, the variables of CTMM: non-language and CTMM:total were found to account for 48.14% of the variance in the Ss scores.

The equation was correct 95% of the time in correctly identifying those who had scored at least 70% on the Post-test I measure and those who had not.

7. When effectiveness in teaching was defined in terms of at least 70% scores on post-test measures, a minimum of 50% in percent of possible gain scores and a significant (.05) movement from pre-to-post-test means, only the *Weather* program was found to be effective in teaching.

The only indications of effectiveness were found in the significant movement from pre-to-post-test for the two groups of the *Longitude* program and for the NH group of the *Directions* program.

8. The accuracy of the teachers in predicting those pupils who would score at least 70% on the Post-test I
measure and those who would not was found to be

(a) 37.5% for program Directions
(b) 55.87% for program Longitude
(c) 69.74% for program Weather

9. When comparing the accuracy of the equation obtained from the multiple regression analysis for predicting a Post-test I score at at least the 70% level with that of the classroom teacher, the following comparisons were found:

(a) for the program Directions, a significant difference at the .01 level and favoring the equation formula
(b) for the program Longitude, no significant differences
(c) for the program Weather, a significant difference at the .05 level and favoring the equation formula.

Conclusions

1. The No-Help and the Limited-Help study conditions did not appear to have any significant influence on achievement via programmed instruction for the Ss of this study. There were significant differences found on two of
the eight measures of achievement tallied for the Weather program. The importance of these findings may perhaps be discounted for the following reasons:

(a) They occurred only at the Post-test I level and not at the final post-test level.

(b) They did not indicate an advantage to one group over the other since the significant differences were found in one case for the LH group, and in the other for the NH group.

(c) Even though a significant difference was found between the means of the study condition groups, both means, even the lower one, were above the minimum level required for satisfactory achievement.

Based on these considerations, the conclusion is made that the child in this study achieved substantially as well when working in an independent study situation as he did when help was available.

2. Because achievement means for the three programs differed significantly from one another, the conclusion is reached that for this population, the programs appeared to be of three levels of difficulty. Supportive evidence of this conclusion is provided by the results of
readability studies of the three texts and by the recommen-
dations of the publishers as to the range of the grade-
level for whom the program was thought to be appropriate.

3. Of the three programs used by the population of this study, only How We Forecast the Weather was found to be effective in teaching.

4. Because different variables were found to contribute significant amounts to the three equation formulas which were obtained during the multiple regression analysis, the conclusion is made that the programs appear to demand different skills or abilities of the learners.

5. The equations obtained from the multiple regression analysis were significantly more accurate than were the teachers' predictions in identifying the children who would or would not achieve at least 70% on the Post-
test I measure for the program Following Directions (.01) and the program How We Forecast the Weather (.05). It was not significantly more accurate than were teachers' predictions when predicting the child's success with the pro-
gram Reading Longitude from Maps.
Discussion and Suggested Research

This investigation was unique in that it provided the opportunity to investigate the use by one population of three different programs. The findings indicate some areas in which additional investigation may be warranted. The first is suggested by the highly satisfactory performance of the study participants with the program *How We Forecast the Weather*. On the basis of post-test measures for which a minimum acceptable level was set in this study at 70%, the Post-test I, II, and III scores for the pupils using the program were 92%, 87%, and 85%, respectively. On the basis of the percent of possible gain scores set at 50%, the Post-test I, II, and III scores were 90%, 79% and 78%, respectively. Thus, the findings of this study clearly indicate that inner-city sixth-grade pupils were able to achieve at a level far in excess of the minimums required for a satisfactory performance in this study. It would seem worthwhile, therefore, to undertake an in-depth examination of *How We Forecast the Weather* in order to identify, if possible, the significant elements in its construction which combined to make this highly satisfactory performance possible.
A second area that offers an opportunity for additional inquiry was suggested by the results of the correlational studies. The findings encourage speculation about the differences seen in the magnitude of the correlations which appeared between achievement via the three programs and identical independent variables.

Of particular interest in this investigation were the correlations between achievement and reading. It had been anticipated that reading scores would correlate to a marked degree with achievement since reading was the primary, if not the only, method of gaining the information conveyed by the program. Such correlations were not found consistently.

The highest reading-achievement correlation, as determined by use of the Pearson formula was found when examining Reading Longitude from Maps. The only instance in which reading skills were found to be a factor in the prediction formulas generated by the multiple regression analysis was for Reading Longitude from Maps where comprehension and vocabulary accounted for approximately 61% of the variance in Post-test I scores.
It was interesting to note that the reading ability required for the text (7.5) had been judged to be approximately two grade levels above the average ability of the population of this study (5.5). The lowest correlations were found to be with achievement from the program *How We Forecast the Weather*. In the latter case, the reading ability required for the text (below fourth grade) was judged to be about two grade levels below the average reading ability of this group (5.5).

Based on this observation, three hypotheses can be presented which may help to explain the magnitude of the correlations found between reading ability and achievement scores.

1. In instances, where the program demands for reading skills are easily met by the capabilities of most learners only slight correlations can be expected.

2. In instances where the program demands for reading skills are at such a level that they are met by some but are too difficult for others, correlations at least at the moderate level can be expected.

3. In instances where the program demands exceed the abilities of most students, the correlations will be small.

There is some support for these hypotheses in pertinent studies reviewed earlier in Chapter II. In one
instance, where the students' reading ability was at least two years above their grade-level placement, the investigator found no correlation of achievement with reading ability.\(^1\) In the second instance, a moderate correlation of .55 was found when the demands of the program were equal to or perhaps exceeded the capabilities of the learners.\(^2\)

If these hypotheses were supported by the findings of further research, it might help (1) to explain why, in some cases, reading ability tended to correlate highly with achievement via programmed material and, in others, only slightly and (2) in identifying the level of reading capabilities which are needed by the learner to be successful with a particular text of programmed material.

If support were found for these hypotheses in the case of reading, similar ones might be proposed and tested with respect to other academic areas.

A second observation made of the correlational data which generates speculation is the prime importance of the IQ correlations in the prediction equations for **Weather** and for **Directions**. In both cases it was a subtest of the IQ

\(^1\)See Markle, p. 108.

\(^2\)See Herr and Tobias, p. 98.
test rather than one in an academic area that accounted for the greatest amount of the variance in the Post-test I scores. If, in the case of the Weather program, this information were combined with (1) the knowledge of the child's success when studying it, and (2) the hypotheses proposed in the preceding section, an additional hypothesis could be presented to explain the prime importance of IQ in the prediction equation.

When the student capabilities in academic areas are equal to or greater than those required by the program, major components of the prediction equations are intelligence scores.

Further research is needed to test the hypothesis dealing with the interpretation of the correlational data and, if support is found, to find practical application in the area of efficient assignment of program to pupil.

The Feasibility of Using Programmed Material As an Instructional Resource

The major purpose of this investigation was to examine the feasibility of including commercially available programmed materials among the resources regularly used for instruction of sixth-grade pupils by the inner-city classroom teacher. Throughout this investigation, the
data collected has led to several observations relative to this purpose.

Support for several of the possible advantages of programmed instruction, as listed in Chapter II, was found during the course of this investigation.

1. Progress through the text occurred at an individual rate.

2. In most cases, the program held the students' attention. There were rare occasions noted by the study assistants in which this was not the case but, for the most part, the children appeared to be interested in their study.

3. The attitude of the students engaged in the short term study appeared to be positive. Whether their attitude was entirely due to programmed instruction is doubtful. The fact that these children represented a "special" group because they were excused from the classroom daily and the fact that they were received courteously each day by the study assistant may have contributed to the positive reaction of the students. They may have been generalizing their reaction to the total situation rather than reacting specifically to the program or to programmed
instruction.

4. A fourth advantage of programmed instruction which was not listed in Chapter II but was found during the course of the investigation, was noted when groups of children studying programmed materials independently were found to achieve substantially as well as those studying in a situation in which teacher help was available. If, in a classroom, there were time to develop the philosophy of programmed instruction, students could become even more independent by taking and scoring their own tests as they progressed through the text.

The advantages seen in the use of programmed instructional material would certainly recommend the inclusion of such material among the resources for instruction in an inner-city classroom if it were not for the fact that they are offset by some serious problems.

The disadvantages identified during the investigation are consistent with and extend those listed in Chapter II.

1. Many needed programs have not yet been developed. The number of programs from which the selection of programs for this study was made was limited. One of the programs selected was found to be "out of stock" and "out
of print" before the "In-school" phase of the investigation started. In order for programmed instructional material to account for a meaningful amount in any instructional resource bank, many titles of programmed material would be needed in order to compliment the teacher's objectives for the curriculum throughout the year.

2. Of the programs selected for use, some were ineffective in terms of teaching the population of this study. During the selection process in which two programs were finally identified for use, several others were eliminated because they failed, for one reason or another, to meet the criteria. After the investigation, the results showed that only one of the two programs which had met the criteria was found to be effective in teaching this population.

A third program was not required to meet all the criteria since it represented the only set of materials in which intrinsic programming had been used. It was found to be ineffective in teaching.

3. Some children did not achieve measurably significant learning when using programmed materials. This statement is more a fact of life than a specific disadvantage of programmed materials. Children learn in different
ways so some could be expected to respond positively to programmed material and others not. The problem for the educator is to be able to identify with a high degree of accuracy, and before assignment, those children who are most likely to use it satisfactorily. In this investigation, teacher predictions of pupil success, which would be the most available, least expensive and the least difficult method of identifying likely achievers, was found not to be highly accurate. The method found to be more accurate, that of using the prediction equation, required a great deal of preliminary work before it could be constructed.

4. A fourth disadvantage not listed in Chapter II but found during the course of the study was that of determining the level of difficulty of a program. The difficulty level is not always accurately identified by the program description supplied by the publisher. To ascertain the difficulty level of the reading passages by completing a readability study requires time and energy that may not be readily available. Other factors such as content load, writing style, and perhaps concepts of programming such as step size, reinforcement schedules and the like enter into determining the difficulty level of a program.
5. A fifth problem was seen in the fact that the child was required to complete the entire program rather than using only that part of it that he needed at the time of first use. None of the programs that were used in this investigation or examined in the earlier portion for selection purposes had made any provision for the student to begin his study at any point other than at the beginning. Efficient use should allow for entry and exit from a program when the needed instruction had been given.

**Summary**

After becoming aware of the potential advantages in the use of programmed material and after becoming fully cognizant of the problems that appear in conjunction with its use, the educator must decide whether the cost in terms of time, monies, and energy necessary to search out, buy, and test the programs will be outweighed by the convenience of its use, the type of individualization of instruction it offers, and the freeing of the teacher for more instructionally productive tasks.

In light of the information gathered in the course of this investigation it would seem unrealistic to depend on commercially available programmed texts as a major
component of the instructional resources that should be made available to the inner-city sixth-grade classroom teacher. However, if further research can identify the elements of the program, *How We Forecast the Weather* which contributed to the consistently high level of performance of the study participants who used it, a major breakthrough in the instructional dilemma which faces educators of the inner-city child may be seen. At that time, a far different conclusion relative to the importance of programmed materials in the educational program of the inner-city setting may be reached.
APPENDIX A

LETTER FORMS USED TO REQUEST
PROGRAMMED MATERIALS

FORMS 1 and 2
(Inside Address)

Dear Sirs:

I am attempting to locate programmed materials suitable for use in a study I plan to complete as the dissertation requirement for a Ph.D. degree from The Ohio State University. I have selected the topic THE USE OF PROGRAMMED MATERIAL WITH THE CULTURALLY DIFFERENT CHILD UNDER TWO INSTRUCTIONAL SITUATIONS AT THE SIXTH GRADE LEVEL. The purposes are (1) to determine whether the disadvantaged child with a variety of attendant learning problems can use programmed materials independently as a means of individualized instruction and (2) to determine whether measurements such as IQ or Reading Age can be used by the teacher to predict the disadvantaged child's probable success when using programmed materials independently.

My proposal calls for administering one program to 60 sixth-grade students in the inner-city schools of Columbus, Ohio hopefully in late February or early March, 1969.

CRITERIA It is planned that the program meet a number of "highly desirable" criteria as well as the following list of "imperative" specifications:

Content: suitable for use by sixth-grade students
Reading level: at or below sixth-grade level
Program scope: possible to limit to a single concept (perimeters) or to a single group of closely related concepts (letters and sounds)
Tests: 1. include materials for pre-tests and post-tests
2. require a minimum amount of reading
Length: possible for student to complete in 100 minutes, that is five 20 minute periods

Difficulty: possible for student to complete program independently, that is without any required instruction or guidance from other persons

Cost*: maximum of $3.00 per program

In addition to the "imperative" category listed above, it is also highly desirable that the program
1. include a description of the audience on whom testing was completed, and the average time required for completion
2. utilize a form of response designed to minimize the incidence of cheating, allow for error analysis
3. include stated objectives

Carl H. Hendershot's Programmed Learning: A Bibliography of Programs and Presentation Devices (1967) has listed the following of your publications that appear from the information given to meet the specifications set forth above.

(List specific titles here)

Would it be possible to send an examination copy of each of the programs listed above and any other more recent additions that appear to meet the stated criteria?

*Since this study is personally financed, certain more expensive programs and those requiring the use of mechanical devices will, of necessity, be eliminated from possible selection unless some mutually equitable arrangement can be made.
Also, would you send a price list for these programs including details of any discounts that may be available for an order for 30 or 60 programs for use in this study?

Yours truly,

(My signature)

Virginia Mellott
(Mrs. Forrest L. Mellott)
Dear Sirs:

I am attempting to locate programmed materials suitable for use in a study I plan to complete as the dissertation requirement for a Ph.D. degree from The Ohio State University. I have selected the topic THE USE OF PROGRAMMED MATERIAL WITH THE CULTURALLY DIFFERENT CHILD UNDER TWO INSTRUCTIONAL SITUATIONS AT THE SIXTH GRADE LEVEL. The purposes are (1) to determine whether the disadvantaged child with a variety of attendant learning problems can use programmed materials independently as a means of individualized instruction and (2) to determine whether measurements such as IQ or Reading Age can be used by the teacher to predict the disadvantaged child's probable success when using programmed materials independently.

My proposal calls for administering one program to 60 sixth-grade students in the inner-city schools of Columbus, Ohio hopefully in late February or early March, 1969.

CRITERIA It is planned that the program meet a number of "highly desirable" criteria as well as the following list of "imperative" specifications:

<table>
<thead>
<tr>
<th>Category</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Content:</td>
<td>suitable for use by sixth-grade students</td>
</tr>
<tr>
<td>Reading level:</td>
<td>at or below sixth-grade level</td>
</tr>
<tr>
<td>Program scope:</td>
<td>possible to limit to a single concept</td>
</tr>
<tr>
<td></td>
<td>(perimeters) or to a single group of closely related concepts</td>
</tr>
<tr>
<td></td>
<td>(letters and sounds)</td>
</tr>
<tr>
<td>Tests:</td>
<td>1. include materials for pre-tests and post-tests</td>
</tr>
<tr>
<td></td>
<td>2. require a minimum amount of reading</td>
</tr>
</tbody>
</table>
Length: possible for student to complete in 100 minutes, that is five 20 minute periods

Difficulty: possible for student to complete program independently, that is without any required instruction or guidance from other persons

Cost*: maximum of $3.00 per program

In addition to the "imperative" category listed above, it is also highly desirable that the program
1. include a description of the audience on whom testing was completed, and the average time required for completion
2. utilize a form of response designed to minimize the incidence of cheating, allow for error analysis
3. include stated objectives

Your company has been listed in the Second Quarter 1968 publication of Product Information for Schools as producers of programmed materials.

If you have a program which will meet the criteria listed above, would you send a copy for my consideration.

Also, would you send a price list for the program(s) including details of any discount that may be available for an order for 30, 60 or 90 programs (if they are expendable) for use in this study?

Yours truly
(My signature)

Virginia T. Mellott
(Mrs. Forrest L. Mellott)

*Since this study is personally financed, certain more expensive programs and those requiring the use of mechanical devices will, of necessity, be eliminated from possible selection unless some mutual equitable arrangement can be made.
APPENDIX B

PROGRAMMED MATERIAL EXAMINED

FOR USE IN THIS STUDY
I. Allied Education Council
Distribution Center, P.O. Box 78
Galien, Michigan 49113

A. Materials Received
   (a) Spatial Organization Series
       Shape Matching Book 101
   (b) Language and Number Series
       Alphabet and Common Nouns Book 201
       Narrative Problems and Division Book 206
   (a) Semi-Programed Series
       Book 2
       Book 3
       Book 7
   (b) Comprehension Series
       Sound and Structure Book 160
       Read-Understand-Remember Book 301
   (c) Word Bank Series 300

B. Disposition

These books were either semi-programmed requiring instructional assistance of the teacher or the contents were not appropriate for use in this study.

II. Allyn and Bacon, Incorporated
150 Tremont Street
Boston, Massachusetts 02116

A. Materials Received
2. Teacher's Manual for Decimals and Percents
II. Allyn and Bacon, Incorporated (cont.)

B. Disposition

The teacher's manual described the target audience as "a highly motivated sixth" and, thus, was of a difficulty level not appropriate for this study.

III. California Test Bureau
Division of McGraw-Hill Book Company
Del Monte Research Park
Monterey, California 93940

A. Materials Received

1. Reading
   (a) Following Directions A-B written by Miles Midlock, 1965.
   (b) Following Directions C-D written by Miles Midlock, 1965.
   (c) Reading Interpretations I written by Grace Bostwick, 1965.

   (a) Addition A-B
   (b) Subtraction A-B
   (c) Multiplication A-B
   (d) Division A-B

3. Manual for Teachers

B. Disposition

The arithmetic materials were presented by the author as "A Programmed Review." Initial instruction is preferred in this study over review of content that was taught at some previous time.

Following Directions C-D was chosen for use in this study. It represents the branching format of program construction and was the level recommended by the publisher for the sixth grade student.
IV. Cenco Educational Aids - A Division of Cenco Instruments Corporation
Centrack Scientific Company
1700 Irving Park Road
Chicago, Illinois 60601

A. Materials Received

B. Disposition
Frames 438 to 500 of Arithmetic II dealing with Roman Numerals was considered because of its length. However, during the selection process, the Lexington Avenue group was found to be familiar with the content and therefore this program could not be used.

The content of Earth Movements was not considered appropriate for pupils in this study.

V. Coronet Learning Programs
Coronet Instructional Films
65 East South Water Street
Chicago, Illinois 60601

A. Materials Received
1. Your Heart and Circulation, Marta Zaborska, programmer and Robert A. Patterson, educational consultant, 1965.
V. Coronet Learning Programs (con't.)

B. Disposition

All these programs met most of the criteria proposed for the selection process.

One program, How We Forecast the Weather, was selected.

VI. Division of Trade and Industrial Education
University of Alabama
P.O. Box 2847
University, Alabama 35486

A. Materials Received

1. How To Read a Rule developed for Manpower Development and Training.

2. Fraction Package (12 lessons) developed for Manpower Development and Training.

3. Fractions Laboratory To The Instructor

B. Disposition

How To Read A Rule was only 16 pages in length and provisions were included for pre-and post-testing. In the selection process with the Lexington Avenue pupils, some help from the instructor was needed and student reaction was neutral.

The Fraction Package required help from the instructor.

VII. Follett Publishing Company
1010 West Washington Boulevard
Chicago, Illinois 60607

A. Materials Received

All were written by Richard H. Turner and copyrighted in 1962.

1. The Person You Are

2. The Money You Spend

3. The Family You Belong To

4. The Jobs You Get

5. The Friends You Make

6. The Town You Live In
VII. Follett Publishing Company (con't.)

B. Disposition

In applying the criteria to these titles, each was found to be inappropriate because (a) progress through the program required that the teacher correct each lesson and (b) the content was constructed for the Junior or Senior High School level.

VIII. Ginn and Company
Statler Building
Boston, Massachusetts 02117

A. Materials Received
1. The Big City
2. Basic Word-Study Skills for Middle Grades
   (a) Part I The Letters and Sounds in Words
   (b) Part II Words and Their Parts

B. Disposition
Not considered because no information concerning program construction was included.

IX. TMI-Grolier
575 Lexington Avenue
New York, New York 22

A. Materials Received
Squaring Two-Digit Numbers Ending in 5: A Demonstration Course, James L. Evans, programmer, 1960

B. Disposition
Not found to be suitable for this grade level.

X. Harcourt, Brace, and World, Incorporated
7555 Caldwell Avenue
Chicago, Illinois 61648

A. Materials Received
X. Harcourt, Brace, and World, Incorporated (con't.)


B. Disposition

Exploring Sets, Geometry, and Numeration, series. Although the teacher's manual stated that the series could provide supplemental activity for any arithmetic program, it did not appear to support the content of the arithmetic program of the Columbus Schools.

The Mathematics Skill Builders was received after the program selection had been made. The cost in excess of $3.00 would have disqualified it.

XI. D. C. Heath and Company
Division of Raytheon
2700 North Richardt Avenue
Indianapolis, Indiana 46219

A. Materials Received

   (a) Introduction to Sets, S-1
   (b) Set Relations, S-2
   (c) Set Operations, S-3

2. Logic written by J. W. Blyth. Instructor's guide included.

B. Disposition

Materials were received after the selection process had been completed.

XII. Learning Incorporated
P.O. Box 1721
Scottsdale, Arizona 85252

A. Materials Received

All titles were copyrighted in 1963. No author or programmer information was included.

1. Using the Comma
XII. Learning Incorporated (con't.)

2. Division by Zero - Impossible
3. Synonyms, Antonyms, and Homonyms
4. The Biggest Reptile: Alligators and Crocodiles

B. Disposition

No construction data was included so the materials were not considered.

XIII. The Macmillan Company
866 Third Avenue
New York, N.Y. 10022

A. Materials Received

3. Test Booklets for Books I, II, and III.
4. Teacher's Manuals for Books I, II, and III.

B. Disposition

Book I of Programmed Geography was not received. The use of Books II and III assumed knowledge equivalent to that of a student having finished Book I.

Learning How to Use the Dictionary was designed to be used with the Webster dictionary. This dictionary is not in general use in Columbus Schools.
A. Materials Received


B. Disposition

Word Problems was prepared for use at the third grade level and it required the presence of a teacher.

Fractions had no information regarding preparation and testing of the program.

Reading Longitude met much of the criteria proposed for the selection process. The program, after being field tested with the Lexington Avenue group, was selected as one of the two linear programs for use in this study.

A. Materials Received


B. Disposition

Using the Library was a short program and because of its length was tried out in preliminary session with the Lexington Avenue group. In use, it was found to be less interesting and more difficult than the other programs tested.
XV. Programmed Instructional Press (con't.)

Programmed Drawing provided no construction information or provisions for testing.

XVI. Scholastic Book Service
904 Sylvan Avenue
Englewood Cliffs, N. J. 07632

A. Materials Received
Sample parts of Self-Teaching Arithmetic by John W. Studebaker.

B. Disposition
Not considered because of cost.

XVII. World Book Company
(Formerly Field Enterprises Educational Corporation
Merchandise Mart Plaza
Chicago, Illinois 60654)

A. Materials Reviewed
Cyclo Teacher

B. Disposition
Not considered because of cost.
APPENDIX C

LETTER REQUESTING PERMISSION TO CARRY OUT STUDY IN COLUMBUS SCHOOLS
February 25, 1969

Dear Miss Dyer:

This is a resume of a proposal for a Ph.D. dissertation study which, hopefully, will be made during the period from March 12 - 28, 1969.

The details of the study are explained briefly on pages 1, 2, and 3.

A summary on page 4 indicates my request for access to classrooms and to certain information contained in the cumulative record files.

Mrs. Forrest L. Mellott
335 East Granville Road
Worthington, Ohio 43085
888-0603
THE USE OF PROGRAMMED MATERIAL WITH THE CULTURALLY DIFFERENT CHILD UNDER TWO INSTRUCTIONAL SITUATIONS AT THE SIXTH GRADE LEVEL

THE PROBLEM
The problem is to find a basis on which the classroom teacher can predict with a degree of certainty the disadvantaged child for whom the use of programmed material as a method in individualization of instruction is appropriate.

THE PURPOSE
The purposes of this study are (1) to examine certain commercially published programmed materials relative to their potential use as an instructional resource for independent study by sixth-grade inner-city pupils, and (2) to examine the degree of relationship between certain characteristics of the study participants and the achievement scores resulting from their use of these programmed materials.

THE RESULTS
As a result of this study, one hopes to find which of a limited number of characteristics of a particular child may be useful to the teacher in determining when it is likely that individualization of instruction through the use of commercially available programmed materials
1. can be accomplished with no help from the teacher
2. can be accomplished with only limited help from the teacher.
Programmed materials selected for use in this study are *Reading Longitude from Maps* by Koehrer, Peterson, and Paul; *Following Directions* by Midloch; and *How We Forecast the Weather* by Meade and Levinsky.

Programmed materials will be administered to 252 sixth-grade students from the inner-city schools of Columbus. Seven students will be randomly selected from each of the thirty-six classrooms participating in the study. Only one booklet of programmed material will be assigned to one child; however, all three booklets will be studied within the seven member classroom group. Study sessions of 30 minutes will be regularly scheduled and will continue each day for six consecutive school days.

Each of the classroom groups will be assigned to study under one of two conditions—Limited help or No help.

A **Limited help** condition is one in which the study assistant who is overseeing the group is permitted to pronounce words, give encouragement, or to help the child—short of giving the answer—to proceed through the program.

A **No help** condition is one in which the study assistant is present but is not free to offer any help after the preliminary explanations have been made and after the child has indicated understanding.
The study assistant will administer the programs to three sixth-grade classes in the morning and to three in the afternoon. In one day she will work with 42 pupils.

There will be six examiners who will be selected, instructed, assigned, and reimbursed by the study director. The study director will conduct—in the presence of each examiner—the first orientation-type session with each of his groups. These orientation sessions will continue from March 12th through March 20th. Following each day of orientation, the examiner assigned to these groups will assume charge and meet with the students for the following five consecutive school days and at regularly scheduled times.

The study assistants will need permission to record the following data from the cumulative folder for each student taking part in the study: (1) age, (2) sex, (3) IQ, (4) Arithmetic test data—reasoning, computation, and total, (5) Reading test data—1969—vocabulary, comprehension, total, (6) Language test data—mechanics, expression and spelling, and (7) the average of teacher awarded grades in prior years.

The classroom teacher will be present when the seven students are randomly selected from the class. After it is decided whether her group will function under the Limited
help or No help condition and after the program has been assigned to the pupil, the teacher will be asked to predict whether the student will be successful in his use of the programmed material—success being determined by a percentage of 70 or above on the test included in the program.

The details of the study will be given to the principal and to the classroom teacher and permission obtained from them for the use of the portion of the student's time required for this study. The student will also be allowed the option to participate in this study.

SUMMARY

For this study, then, it will be necessary to have access to a sufficient number of inner-city (Title I) sixth-grade classrooms to assure clusters of 3 classrooms in each of 12 schools—a total of 36 classrooms.

It will also be necessary that there be some space within the school made available for the study assistant and the students to hold their sessions.

It will also be necessary that access to the cumulative folders be given the study assistants for the purposes stated earlier.

The program is intended to last no longer than the
period from March 12 through March 28. (It is scheduled at this time in order to avoid the possibility of conflict with student teacher assignments.) Any one classroom will not be disrupted for a period of more than six days.
APPENDIX D

STUDY ASSISTANT ASSIGNMENT SCHEDULE LISTING SCHOOLS
PRINCIPALS, TEACHERS, STUDY CONDITIONS
AND DATES IN SCHOOLS
### STUDY ASSISTANT I
March 12 through March 19, 1969

<table>
<thead>
<tr>
<th>A.M. Session</th>
<th>Main Street Elementary School</th>
<th>Principal: Thomas McCormick</th>
</tr>
</thead>
<tbody>
<tr>
<td>(No Help)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers: Mrs. Porter</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Batram</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Bearden</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P.M. Session</th>
<th>Lincoln Park Elementary School</th>
<th>Principal: Anita Maxine Smith</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Limited Help)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers: Mrs. Boston</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Broomall</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mrs. Edmonson</td>
<td></td>
</tr>
</tbody>
</table>

### STUDY ASSISTANT II
March 13 through March 20, 1969

<table>
<thead>
<tr>
<th>A.M. Session</th>
<th>Douglas Elementary School</th>
<th>Principal: Paul Kindinger</th>
</tr>
</thead>
<tbody>
<tr>
<td>(No Help)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers: Mr. Baker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Sahr</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Schmidt</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>P.M. Session</th>
<th>Windsor Elementary School</th>
<th>Principal: Merrill Stevens</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Limited Help)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teachers: Mrs. Foster</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mrs. Tumey</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mr. Jackson</td>
<td></td>
</tr>
</tbody>
</table>
STUDY ASSISTANT III
March 14 through March 21, 1969

A.M. Session Livingston Avenue Elementary School
(No Help) Principal: Sam Simon
Assistant Principal: Harold Rickman

Teachers: Mr. Daniels
         Mr. Mahaffey
         Mrs. Goldberg
         Mr. Eblin

P.M. Session Felton Elementary School
(Limited Help) Principal: Howard Green

Teachers: Mrs. Banks
          Mr. Johnson

STUDY ASSISTANT IV
March 17 through March 24, 1969

A.M. Session Milo Elementary School
(Limited Help) Principal: Richard Murray

Teachers: Mrs. Breece
          Mrs. Cox
          Mr. Durfey

P.M. Session Garfield Elementary School
(No Help) Principal: Mabel Henderson

Teachers: Mrs. Coleman
          Mrs. Holland
          Mr. Wiseman

STUDY ASSISTANT V
March 19 through March 26, 1969

A.M. Session Weinland Park Elementary School
(Limited Help) Principal: Robert Pritts

Teachers: Mr. Ehrhart
          Mrs. McCue
          Mr. Riggs
P.M. Session
(No Help)

Eleventh Avenue Elementary School
Principal: Elmer Winner

Teachers: Mrs. Martin
Mr. Davis
Mr. Fields

STUDY ASSISTANT VI
March 20 through March 27, 1969

A.M. and P.M. Sessions
(Limited Help)

Hamilton Avenue Elementary
Principal: Kenneth Paul

Teachers: Mrs. Vince
Miss Plummer
Mrs. Titus
Mr. Rodeheffer
Miss Ritchey
Mr. Overmyer
SELECTED BIBLIOGRAPHY
SELECTED BIBLIOGRAPHY

Books


Midlock, Miles. Following Directions C-D. Monterey, California: California Test Bureau, 1965.


**Periodicals**


Yearbook Articles


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"A Comparative Study of Spelling Test Scores Involving Teaching Machine and Textbook Methods of Teaching Spelling to Sixty Columbus, Ohio, Sixth Grade Students." Columbus Public School System, Columbus, Ohio. (Xeroxed)


**Other Materials**

