The effectiveness of a teaching model designed on widely accepted principles of learning

Willie Cecelia Perrin Turner
Atlanta University

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THE EFFECTIVENESS OF A TEACHING MODEL DESIGNED
ON WIDELY ACCEPTED PRINCIPLES OF LEARNING

A THESIS

SUBMITTED TO THE FACULTY OF THE SCHOOL OF EDUCATION,
ATLANTA UNIVERSITY IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

BY
WILLIE CECELIA FERRIN TURNER

SCHOOL OF EDUCATION

ATLANTA, GEORGIA
AUGUST, 1967
DEDICATION

To my son, Carlton D. Turner, with the hope that this thesis will serve as an inspiration to him, and to Dr. Edward K. Weaver for inspiring me to undertake the study.

W.C.T.
ACKNOWLEDGMENTS

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CHAPTER I

INTRODUCTION

Rationale.—Many of the contemporary teaching methods or patterns of teacher behavior (using the terms interchangeably) cannot be considered to be, to any great extent, the product of scientific research. They could not have been so in the past because only in the last few years has scientific knowledge begun to reach a point which might permit the systematic design of a pattern of behavior for teachers which would maximize the achievement of the pupil with respect to specific objectives. If teaching methods were to be systematically designed, they would have to be founded on a theory of ethics which would determine the educational objectives that the method is to achieve. Second, they would have to be built in terms of a theory of behavior which would indicate the conditions under which particular learnings could be most effectively produced. In this case a theory is considered to subsume a series of interrelated laws which have been empirically established.

The fact is that most teaching methods do not have, and until recently they could not have, such a foundation. The advanced knowledge of both ethics and the psychology of learning has not existed which

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provide the solid foundation needed for the rational construction of teaching methods. Advances in the last decade in the psychology of learning, have reached the point where they can begin to provide a suitable basis for construction of a teaching method. Teaching methods of the past had to be designed on foundations other than those which will be used in the future. The sources of past teaching methods have not been, to any great extent, rational and scientific. Although in the past, knowledge available for the planning of teaching methods has been very meager, there are reasons for doubting that available knowledge has been used systematically. If teaching methods from the past are evaluated on their consistency with current knowledge of learning they appear even more inadequate.

With the advent of what is called modern mathematics or new mathematics which places less reliance on what has been regarded as self-evident truth, and greater emphasis on exploration of systems based upon postulates (assumptions), the need for more effective teaching methods is greater now than ever in the field of mathematics. The development of the new mathematics has raised serious questions as to the traditional mathematics program of the school. Many feel there is a possibility that perhaps students can learn more mathematics in less time. There is also the possibility that students who fail in traditional programs may do well in a modern program.

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1Ibid., p. 493.
2Ibid., p. 494.
4Ibid., p. 2.
Due, at least in part, to the shortage of mathematicians to meet the present needs, and the feeling that many students, who experience difficulty in mathematics would welcome a fresh approach, the climate at present is favorable toward innovations in the mathematics school programs.\footnote{Ibid., p. 8.}

The writer was of the opinion that while the climate is favorable toward improvement in mathematics education, experimentation toward better methods of teaching mathematics were not only timely, but imperative.

Evolution of the problem.—During the summer session of 1966, the writer took a course in educational research. Mouly, the author of the text used in the course, in his summary of the text, made the following statements:

Invariably, educational research is criticized for its inadequacies. An even greater gap exists between research results and their application in the classroom. Despite the hundreds of studies conducted in education and related fields every year, educational practice is frequently based as much on tradition, common sense, and consensus, as it is on research. The reasons for this gap are obviously multiple rather than single, but certainly among the more fundamental is the lack of appreciation of the crucial role of research to the advancement of educational practice. The lack of orientation toward research which characterizes educators as a group, is probably even more characteristic of the practitioner. This lack of orientation toward research thereby cuts the practitioner off from research as an ally in the solution of his problems and as a foundation of good teaching.\footnote{George J. Mouly, The Science of Educational Research (New York: American Book Company, 1963), pp. 397-98.}
teacher of eighth-grade mathematics, served as a challenge and inspiration to the writer. It brought to the writer's mind the desire and need to find the best method of presenting this newly vitalized subject matter. After much reading of materials on teaching methods, the writer came to accept the thesis that the only effective teaching methods are those based on how learning takes place. From all of this came the desire to design a teaching model (method) based on several accepted principles of learning, and to test such a model in the hope of finding a sound foundation for effective teaching.

Contribution to education.—The writer hoped that the findings of this study would show that an effective teaching design can be built or based on modern learning theory and can change notions of the effects of teacher behavior on the learner's behavior. It was also hoped that this study would present such strong implications for improvement in teaching methods that further research on designs using as many principles of learning as possible would be undertaken.

Finally, the writer hoped that this study would open the door a little wider on what takes place in the learning process.

Statement of the problem.—This was an experimental study to determine the effectiveness of following textbook procedures in teaching modern mathematics to eighth-grade pupils at Trinity High School, Decatur, Georgia, as opposed to the use of a teaching method designed to make use of six widely accepted principles of learning, namely: (1) behavior which represents achievement or partial achievement of an educational objective should be reinforced, (2) the introduction of cues which arouse motivation toward the achievement of an educational
objective will increase the effectiveness with which that objective
is achieved, (3) practice in applying a principle to the solution of
problems will increase the probability of transfer of training to new
problems which require the use of the same principle for their solution,
(4) since learners differ in their capacity to make the responses to
be acquired, learning will be more efficient if it is planned so that
each learner embarks on a program commensurate with his capacity to
acquire new responses, (5) if a pupil has had training in imitation,
then he is capable of learning by observing demonstrations of the skill
to be acquired, and (6) the learner will learn more efficiently if he
makes the responses to be learned than if he learns by observing
another make the response or makes some related response.1

Purposes of the study.—The major purpose of this study was to
conduct an experiment designed to test the effectiveness of a teaching
method based on selected principles of modern learning theory as
contrasted with a teaching method proposed by authors of a textbook for
teaching modern mathematics. The more specific purposes of this study
were to:

1. Define or specify the classes of variables (dependent,
   intervening, and independent) which have to be represented in
a learning model as the basis for design of a teaching method.
Ultimately, a teaching model was to be developed which
followed the general formula:

   \[ T = f(R_g, R_i) \]

2. Design a teaching method based on the principles of learning
   specified in the problem.

3. Conduct an experiment to ascertain whether learning mathematics was more efficient when it was taught to two eight-grade groups of children who had been equated as far as age, sex, and general intelligence was concerned, by using a teaching method designed on the above principles of learning.

4. Eliminate, as much as possible, the learning of mathematics by imitation (by means other than doing) by marked emphasis on the learner's own attempt to make the responses to be learned, and stress the importance of the learner's making the full and complete response.

5. Eliminate, as much as possible, the learner's making substitute responses, especially those of a verbal nature.


7. Report the findings, conclusions, implications and recommendations of this study.

Limitations of the study.—The limitations of the study were:

1. It concerned only Trinity High School in Decatur, Georgia.

2. It concerned only the eighth-grade pupils enrolled at Trinity High School.

3. It concerned itself only with progress in learning and the necessary conditions for learning.

Definitions of terms.—Significant terms used in this study are hereby defined:

1. "Response variables" (dependent) are the variables derived from publicly observable behavior, such as scores from test papers, which enable evaluation of the learning process.

2. "Independent variables" are the variables related to the learning process, that the teacher may be able to manipulate. They include:
   a. Situation characteristics, motivation and reinforcement.
   b. Readiness and mediating responses (how the learner perceives the situation).

3. The formula $T = f(R_g, R_l)$ has the following meaning:
The behavior of the teacher $T$ is a function of the goals $R_g$ and $R_l$. 

R_\text{eq} \text{ and the present behavior of the pupil } R_i. ^1

Locale of study.—This study was conducted at Trinity High School, Decatur, Georgia.

Period of study.—This study was conducted during the months of January, February, March and April of the 1966-67 school term.

Subjects and materials.—The subjects of this study were the forty-four eighth-grade pupils enrolled at Trinity High School during the 1966-67 school year.

The following materials were used in this study:
1. Official school records.
2. Sequential Tests of Educational Progress.
4. Teaching model designed on selected principles of modern learning theory.

Method of research.—The experimental method was employed, utilizing specific techniques of statistical analyses and the rotation of groups.

Research procedures.—The following procedural steps were taken:
1. Permission to conduct the study was requested from the proper authorities of the Decatur City School System.
2. The forty-four eighth-grade pupils were divided into two equal sections designated as groups A and B on the basis of age, sex, and general intelligence as obtained from official school records.

3. A teaching model was designed based on several principles of modern learning theory employing as many of the techniques known to the writer as possible for an effective teaching method.

4. The Sequential Tests of Educational Progress - Mathematics (Form 3B) were administered to ascertain the present mathematical status of the pupils.

5. Group "A" was taught by the afore-mentioned teaching design and group B was taught by textbook procedures for a period of six weeks.

6. The Sequential Tests of Educational Progress - Mathematics (Form 3A) were administered to both groups to determine the progress made by the pupils.

7. Groups A and B were given two weeks of independent study and review as a "rest period".

8. The groups were then rotated so that group B was taught by use of the teaching design mentioned above and group A was taught by the textbook method.

9. The Sequential Tests of Educational Progress - Mathematics (Form 3B) were administered to determine the progress made by the pupils.

10. The Sequential Tests of Educational Progress - Mathematics were scored and the findings were interpreted and analyzed and conclusions, implications and recommendations were made in terms of the problem and purposes of the study and presented in the final thesis copy.

Survey of related literature.—Education is concerned with changing the behavior of students. Knowledge about behavior then should be useful to the educator in understanding and improving the teaching process. The educator must be willing to assume as the scientist does, that behavior can be controlled and that is his job. Then after this,

the educator must subject conventional explanations of educational processes and goals to the operational criteria of scientific discourse.

Teaching methods have, for the most part, not become established because they fitted a psychological model of the learning process. This probably accounts for the following conclusion found in the Encyclopaedia of Educational Research:

Because of variation in educational aims which produce variation in educational methodology, the safest generalization probably is that extant evidence is insufficient to establish the superiority of any single methodology. It follows that any effort to prescribe a single general methodology for use exclusively in a school system on the supposition that its relative merit over all methodologies has been established, is fraught with hazard.

Teaching methods must be based on a model stemming from psychological research. Only in this way can such methods be expected to show greater value than those they replace. The necessity for teaching procedures to be based on knowledge of learning makes it imperative to understand the nature of learning. The major concept of learning is that learning is the continuous change or modification of behavior brought about by physical or mental activity or both. This constant modification of behavior is necessary to enable the individual

1Ibid., pp. 37-38.


to adjust to changing life situations.

The term learning is customarily used to describe acquired habits, skills and knowledge resulting primarily from environmental conditions. In light of this definition it is necessary to look at some other aspects of learning. For example, there is a relationship between learning and maturation. It has been suggested that learning and maturation may be but two phases of the same process. The most advantageous time to introduce school activities, like reading and arithmetic, depend more on maturational processes than actual chronological age.

If intelligence is accepted as the appraisal of the individual's capacity to make adjustments to varying life situations, then learning represents the use of this capacity in actually adjusting to life situations by the acquisition and perfection of new skills and experiences.

Learning may be mechanical. That is, it may be conditioned. Mechanical learning is governed by the spinal cord and lower brain centers. Obviously the scope of simple mechanical conditioning is very limited and not much progress is made in real learning until perception, which begins when one is able to select certain impressions from one or more sensory avenues and to interpret them as meaningful experiences,


^Ibid., p. 307.

^Ibid., p. 308.
Abstraction, the recognizing and responding to certain properties in objects or situations and disregarding other properties therein, and generalization, the application of ideas to diverse objects regardless of other characteristics is the beginning of concept formation which is so important in problem solving. Although concept formation is probably the most important and characteristically human phase of learning, it is often the most neglected, especially among high school and college students.

Much, if not most, of the disagreement among workers in psychology is with respect to theory and interpretation rather than with respect to the facts of behavior. For example, the theory of association has been vigorously attacked by the Gestalt psychologists. They assembled new experimental evidence and interpreted old results which suggest that not mechanical coupling on the basis of the "laws" of learning, but dynamical interdependence is the essential factor involved in learning. This interdependence they thought, is due partly to the intrinsic organization which may obtain in the material itself and partly to the organization impressed upon it by the subject itself. According to this view the "laws" of learning state some conditions favorable to the occurrence of the required organization. Such organization sometimes occurs in a saltatory manner, giving rise to a sudden restructuring of the situation, that is, to insight.

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1Ibid., p. 310.

According to this view, learning and problem solving are not different processes. As for "trial and error" learning, they hold it to be a limiting case, occurring when the material is so difficult or extensive that insightful organization is impossible.

The contributions of Gestalt psychologists to problems of motivation in clarifying the conceptual difficulties involved have been important. Their criticism of the instinct theories, the investigations of incompleted tasks, success and failure, substitute behavior, level of aspiration and emotion have outstanding significance for education.

The Gestalt view of learning has played into the hands of those who have been critical of educational procedures bases upon association psychology in its various manifestations. The Gestalt view of the nature of development supports educational practices which proceed from the general to the particular, the whole to the part. It must be realized that the effect of Gestalt psychology has been largely limited to providing a rationale for procedures already adopted on the basis of practical experience and intuition. The full implication of Gestalt psychology for education awaits future developments.

Gestalt psychology, on the other hand, has been criticized for being mere theory and thereby of little importance for experimental science. This arises partly from ignorance of the great amount of


2Ibid., p. 548.
experimental work which their theories have inspired and partly from
the fact that Gestalt psychology acknowledges the prime necessity of
theory in psychology as in all sciences.¹

The objection that Gestalt psychology is opposed to analysis is
a misunderstanding. Objection is made only to the sort of analysis
which tears apart dynamically interdependent systems and neglects the
essential fact of interdependence in the explanation.²

Of the criticism that Gestalt psychologists have erected straw
men to demolish with gusto, that is, that organization and interde-
pendence have been dealt with by many schools of psychology, it may be
said, that the essential point of difference from traditional psychology,
lies not so much in their recognition of organization and interdependence
but rather it lies in their explanation of them, and in their place
in explanatory theory.³

Efforts to establish principles of learning have been seen in
many studies. One such study was undertaken by Neal E. Miller and
John Dollard to show that learning occurs as a result of imitation.
Their research with animal and human subjects showed that imitation is
a learned behavior tendency and without the learning of this tendency,
imitation does not occur.⁴ In their book, Social Learning and Imitation,

¹Ibid., p. 548.
²Ibid., p. 549.
³Ibid.
they state:

Everyone at sometime has tried to learn a skill and failed, without knowing why; or he has tried to teach and found others slow to understand. Such experiences drive home the fact that learning is not automatic. Where the principles are not understood so that the conditions can be correctly arranged, no learning takes place.1

The findings of Miller and Dollard suggest however, that there may be individual differences in the ability to imitate produced by differences in previous training in imitation. Insofar as this is the case, the teacher may either have to develop imitative skills in some children or plan for them a learning program which does not involve imitation. Certainly, the inability of children in kindergarten or first grade to learn from demonstrations suggests that substantial individual differences do exist in this area.2

This strengthens the knowledge that any teaching method built on a single principle of learning cannot be entirely effective.

In regard to a teaching method sometimes called the discovery method and based upon the principle of learning that the learner will learn more effectively if he makes the responses to be learned than if he learns by observing another make the response or some related response,3 has led many psychologists, notably Skinner, to emphasize the importance of the learner's making the full and complete response. A distinction

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3Ibid.
should be made between the learner's making the full response and
the learner's making certain substitute responses, often of a verbal
nature. For example, a child's expressing his attitude toward say,
religious or racial minorities in a classroom situation may differ
vastly from what emerges in a real problem situation.

Ausubel questions the long-standing doctrine that the only
knowledge one really possesses and understands is knowledge that one
discovers by himself. His opinion is that both expository and problem
solving techniques can be either rote or meaningful depending on the
conditions under which learning takes place. He further states:

Most of what one knows and meaningfully understands,
consists of insights discovered by others and which have
been communicated to him in meaningful fashion. If a
student is ever to discover, he must first learn.¹

Gertrude Hendrix's research on the inductive method of teaching
resulted in her leaving out the student's verbalization of the dis-
covered generalization until quite sometimes later. This she called
her method of unverbalized awareness method. She studied the problem,
"To what extent, if any, does the way in which one learns a generali-
ization affect the probability of his recognizing a chance to use it."²
From her study Hendrix concluded:

Important as symbolic formulation must be for veri-
fication and organization of knowledge, it is not the key
to transfer. The key is a sub-verbal internal process —
something which must happen to the organism before it has

¹David P. Ausubel, "Some Psychological and Educational Limitations
of Learning by Discovery," The Arithmetic Teacher, II (May, 1964), 291.

²Gertrude Hendrix, "A New Clue to Transfer of Training", Eleme-
tary School Journal, XLVIII (March, 1947), 197.
any new knowledge to verbalize. \(^1\)

Haslerud and Meyers confirmed Hendrix's findings when they tested the hypothesis "that principles derived by the learner will be more readily used in a new situation than those given him in the form of a statement of principle and an instance." \(^2\)

Two studies done by Lutchins and Lutchins point out some possible consequences of the tell-and-do method of teaching. Among the conclusions drawn from the study were the following:

They (the students) were accustomed to the use of isolated drill in arithmetic, wherein in order to "learn" a method or formula they practiced it in a series of similar problems. They were accustomed to being taught a method and then practicing it; to have to discover procedures were not only quite foreign to them in arithmetic but also in most school subjects. It seems that the methods of teaching to which they had been subjected tended to develop not adaptive responses, but fixations, so that a child might know methods and formulas and yet not know where to apply them or how to determine what method best suited a problem. Our schools may be concentrating so much on having the child master the habits that habits are mastering the child. \(^3\)

Ausubel still not in complete agreement with total use of the discovery method days of the students enrolled in the widely acclaimed University of Illinois Committee on School Mathematics Program:

The students learn more mathematics not because they are required to discover generalizations for themselves but because they have at their disposal a systematic body of organizing, explanatory, and integrative principles which

\(^1\text{Ibid.}, p. 200.\)

\(^2\text{G. M. Haslerud and Shirley Meyers, "The Transfer Value of Given and Individually Derived Principles", Journal of Educational Psychology, XLIX (February, 1958), 294.}\)

\(^3\text{A. S. Lutchins and Edith H. Lutchins, "New Experimental Attempts at Preventing Mechanization in Problem Solving", Journal of General Psychology, XLII (June, 1950), 286.}\)
are not part of the conventional secondary-school mathematics. These principles illuminate the subject for them and make it much more meaningful.1

Carolyn and Arthur Staats touch on the importance of the learning variables in the acquisition of mathematics. They contend that empirical support for the role of the variables in this area is sparse and that an analysis in such terms should prove worthwhile.

The findings of a study done by Joseph Draper, led to the implication that the use of "new methods" will not significantly (statistically) facilitate arithmetic achievement.

Likewise, the findings of a study done by Lelar C. Watts on the "inductive and deductive" methods of teaching revealed that both methods of teaching revealed that both methods were equally effective and that achievement or lack of it in arithmetic did not appear to be a function of teaching method.

Nicie B. Parks found in her study that teachers agreed on everything but methods of teaching which suggested "lip-service" acceptance of modern arithmetic education and research findings, while in practice, as evidenced in their rejection of modern methodology they continue to

1David P. Ausubel, op. cit., p. 300.
teach arithmetic in conventional or traditional ways. Similar findings were revealed in a study done by Geraldine Washington.2

Finally, a survey of the related literature revealed that teaching methods should be retained, at least in part, if they have utility in making predictions and discarded if they lack utility. The survey also revealed that different teaching methods emphasize different principles of learning. Finally, the survey revealed strong implications for an attempt to design a teaching method which makes as much use as possible of a wide range of learning principles.

Summary of related literature.—A survey of the related literature revealed that:

1. Education is concerned with changing the behavior of students, and that behavior can be controlled.

2. Teaching methods have not become established because they fitted a psychological model of the learning process.

3. The major concept of learning is that learning is the continuous change or modification of behavior brought about by physical or mental activity and is necessary to enable the individual to adjust to changing life situations.

4. Although concept formation is probably the most important and characteristically human phase of learning, it is often the most neglected, especially among high school and college students.


5. Much, if not most, of the disagreement among workers in psychology is with respect to theory and interpretation rather than with respect to the facts of behavior.

6. Where the principles of learning are not understood so that conditions can be correctly arranged, no learning takes place.

7. Some learning does occur as a result of imitation.

8. Many psychologists emphasize that the learner learns more efficiently if he makes the responses to be learned rather than if he learns by observing another make the response or some related response. The discovery method of teaching is based largely upon this principle of learning.

9. Students who learn more in certain school mathematics programs do so not because of the method of presentation but because they have at their disposal a systematic body of organizing explanatory and integrative principles which are not part of the conventional secondary-school mathematics. These principles illuminate the subject for them and make it more meaningful.

10. Teaching methods should be retained, at least in part, if they have utility in making predictions and discarded if they lack utility.

11. Different teaching methods emphasize different principles of learning.

12. There is a need for a teaching design which makes as much use as possible of a wide range of learning principles.
CHAPTER II

PRESENTATION, ANALYSIS, AND INTERPRETATION
OF THE DATA

Introductory Statement

The intent of this chapter is to present, analyze, and interpret the data obtained from the administration of the Sequential Tests of Educational Progress (Mathematics) to the forty-four eighth-grade pupils in Trinity High School, Decatur, Georgia, 1967, in an effort to determine the effectiveness of the use of a teaching model designed on six widely accepted principles of learning as opposed to the use of a teaching model proposed by the authors of a textbook for teaching modern mathematics to eighth grade pupils. The data revealed by the scores on the STEP Mathematics Tests, as earned by the subjects designated as Group "A" and Group "B", and the data from the official school records are presented in the appropriate tables and discussed throughout the chapter. The presentation, analysis and interpretation of the data have been organized under the following captions:

1. Description of the Study
2. Description of the Subjects
3. Procedures in the Equating of the Groups
4. Analysis of the Data on the Equated Groups
5. Analysis of the Data on the Pre-testing Program
6. Analysis of the Data on the Mid-testing Program
7. Analysis of the Data on the Final-testing Program

8. Interpretative Summaries

The quantitative data collected and treated are presented in the following series of tables:

1. There are 3 distribution tables which present the distribution of scores and percentile bands for the Group "A" and Group "B" subjects, together with the specific statistics of central tendency and variability.

2. There are 3 comparison tables to the distribution tables which present the indices of significant difference on the performance of the Group "A" and Group "B" pupils.

The criterion of reliability for the data was established as Fisher's "t" of 2.58 at the one (.01) per cent level of confidence for 42 degrees of freedom.

Description of the Study

This was an experimental study designed to determine the effectiveness of following textbook procedures in teaching modern mathematics to eight grade pupils at Trinity High School, Decatur, Georgia, as opposed to the use of a teaching model designed to make use of six widely accepted principles of learning, namely; (1) behavior which represents achievement or partial achievement of an educational objective should be reinforced, (2) the introduction of cues which arouse motivation toward the achievement of an educational objective will increase the effectiveness with which that objective is achieved, (3) practice in applying a principle to the solution of problems will increase the probability of transfer of training to new problems which require the use of the same principle for their solution, (4) since learners differ in their capacity to make responses to be acquired, learning will be more efficient if it is planned so that each learner embarks on a program commensurate with
his capacity to acquire new responses, (5) if a pupil has had training in imitation, then he is capable of learning by observing demonstrations of the skill to be acquired, and (6) the learner will learn more efficiently if he makes the responses to be learned than if he learns by observing another make the response, or makes some related response.

The teaching model designed on the above six widely accepted principles of learning and the teaching procedures proposed by the authors of the textbook used in the study are presented in the appendixes.

Description of the subjects.—The subjects used in this study were the forty-four eighth-grade pupils enrolled in Trinity High School, Decatur, Georgia, during the 1966-1967 school term.

Procedure in the equating of the groups.—The forty-four eighth-grade pupils were divided into two equal groups, designated throughout this study as Group "A" and Group "B". The groups were equated on the basis of age, sex and general intelligence as obtained from the official school records.

Analysis of the data on the equated groups.—The data on the indices of chronological age, sex and Intelligence Quotients of the forty-four eighth-grade pupils in Groups "A" and "B", respectively, are presented in Tables 1 and 2.

The chronological ages of the twenty-two pupils in Group "A" ranged from a low of 13 to a high of 16, with a mean age of 13 years, 6 months. The chronological ages of the pupils in Group "B" ranged from a low of 13 to a high of 16, with a mean age of 13 years, 6 months.
TABLE 1


<table>
<thead>
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<th>Subject</th>
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<td>F</td>
</tr>
<tr>
<td>22</td>
<td>13</td>
<td>F</td>
</tr>
</tbody>
</table>

Mean Age - 13 yrs., 6 mos.
Mean I. Q. - 83
Total Boys - 11
Total Girls - 11
Total Number of Students - 44

Mean age - 13 yrs., 6 mos.
Mean I. Q. - 83
Total Boys - 12
Total Girls - 10
TABLE 2


<table>
<thead>
<tr>
<th>I. Q. Ranges</th>
<th>Group &quot;A&quot;</th>
<th>Group &quot;B&quot;</th>
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</thead>
<tbody>
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<td>Frequency</td>
<td>Frequency</td>
</tr>
<tr>
<td>130+ - Very High</td>
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</tr>
<tr>
<td>116 - 129 - High</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>93 - 115 - Average</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>85 - 92 - Low Average</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>71 - 84 - Low</td>
<td>11</td>
<td>8</td>
</tr>
<tr>
<td>70 - Very Low</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Total 22 22

Mean I. Q. Score - 83
Mean I. Q. Rating - Low
The Intelligence Quotients of the pupils in Group "A" ranged from a low of 70 to a high of 112, with a mean I. Q. score of 83. The Intelligence Quotients of the pupils in Group "B" ranged from a low of 69 to a high of 111, with a mean I. Q. score of 83. Further, as shown in Table 2, Group "A" and Group "B", respectively, had a mean I. Q. score rating of "low".

The division by sex of the twenty-two eighth-grade pupils in Group "A" resulted in 11 boys and 11 girls. The division by sex of the twenty-two eighth-grade pupils in Group "B" resulted in 12 boys and 10 girls.

Analysis of the Data on the Pre-testing Program

Introductory statement.—This section of the research report deals with the pre-testing period of equated groups "A" and "B", which were to be subjected to two different teaching methods, namely; (1) a teaching method designed on six widely accepted principles of learning and (2) a teaching method proposed by the authors of the textbook used in the study. The purpose of the pre-test was to determine the mathematical knowledge and performance of the subjects. The STEP Mathematics Test, Form 3B, was administered the second week of the month of February, 1967, with all the necessary routine of controls being observed. The results are reported in Tables 3 and 4, with the accompanying analyses.

Sequential Tests of Educational Progress, Mathematics (Form 3B).—The data on the performance on the STEP Mathematics Test, Form 3B, as revealed by the raw scores obtained by the twenty-two pupils in Group "A" and the twenty-two pupils in Group "B" of Trinity High School,
Decatur, Georgia, 1966-1967, are presented in Tables 3 and 4, and are analyzed in the paragraphs below.

**Group "A"**—For the twenty-two eighth-grade pupils in Group "A", the scores ranged from a low of 7 to a high of 23, with a mean of 15, a median of 15, a standard deviation of 4, and a standard error of the mean of 1. Nine or 41 per cent scored above the mean, 10 or 45 per cent scored below the mean and 3 or 14 per cent scored within the mean class-interval. The mean score of 15 indicated a percentile band of 8 - 34, which was substantially below the norm of expectancy in the area of mathematics.

**Group "B"**—For the twenty-two eighth-grade pupils in Group "B", the scores ranged from a low of 9 to a high of 30, with a mean of 14, a median of 13, a standard error of the mean of 1. Seven or 32 per cent scored above the mean, 12 or 54 per cent scored below the mean and 3 or 14 per cent scored within the mean class-interval. The mean score of 14 indicated a percentile band of 3 - 30, which was markedly below the norm of expectancy in the area of mathematics.

**The "t" ratio or Comparative Data.**—In addition, Table 4, shows that the comparative measures for the two groups were as follows: the mean was 15 and 14 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "A"; the median was 15 and 13 for Group "A" and Group "B", respectively, with a difference of 2 in favor of Group "A"; the standard deviation was 4 and 5 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "A"; and the standard error of the mean was 1 for Group "A" and Group "B", respectively,
### TABLE 3


**INITIAL TESTING**

<table>
<thead>
<tr>
<th>Raw Score</th>
<th>Converted Score</th>
<th>Percentile Band</th>
<th>Group &quot;A&quot;</th>
<th>Group &quot;B&quot;</th>
</tr>
</thead>
<tbody>
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<td></td>
<td></td>
<td></td>
<td>Frequency %</td>
<td>Frequency %</td>
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<tr>
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<td>68 - 88</td>
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<td>68 - 88</td>
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<td>28</td>
<td>269</td>
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<tr>
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<td>56 - 80</td>
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<tr>
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<td>13.65</td>
</tr>
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<td>14</td>
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<td>2</td>
<td>9.10</td>
</tr>
<tr>
<td>13</td>
<td>239</td>
<td>0 - 23</td>
<td>3</td>
<td>13.65</td>
</tr>
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<td>12</td>
<td>234</td>
<td>0 - 19</td>
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<td>0.00</td>
</tr>
<tr>
<td>11</td>
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<td>0 - 14</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td>10</td>
<td>230</td>
<td>0 - 14</td>
<td>2</td>
<td>9.10</td>
</tr>
<tr>
<td>9</td>
<td>230</td>
<td>0 - 14</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>8</td>
<td>230</td>
<td>0 - 14</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td>7</td>
<td>230</td>
<td>0 - 14</td>
<td>1</td>
<td>4.55</td>
</tr>
</tbody>
</table>

| Total     | 22              | 22              |

| Mean      | 15              | 14              |
| Sigma     | 4               | 5               |
| SE_m      | 1               | 1               |
| Mean Percentile Band | 8 - 34 | 3 - 30 |

27
### TABLE 4

**SIGNIFICANT DIFFERENCES ON THE STEP (MATHEMATICS, FORM 3 B) BETWEEN GROUP "A" AND GROUP "B" EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL, DECATUR, GEORGIA, 1966-1967**

**INITIAL-TESTING**

<table>
<thead>
<tr>
<th>Groups</th>
<th>No.</th>
<th>Median</th>
<th>Mean</th>
<th>Sigma</th>
<th>S. E. Mean</th>
<th>$M_1 - M_2$</th>
<th>S. E. $M_1 - M_2$</th>
<th>&quot;t&quot;</th>
</tr>
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<tr>
<td>Group A</td>
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<td>4</td>
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<td>1</td>
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<td>.714</td>
</tr>
<tr>
<td>And</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>22</td>
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<td>14</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1.414</td>
<td>.714</td>
</tr>
</tbody>
</table>
with no difference in favor of either group. The standard error of the difference between the two means was 1.414.

The "t" for these data was .714 which was not significant for it was less than 2.58 at the one (.01) per cent level of confidence at 42 degrees of freedom. Therefore, the difference on the Mathematics Test, Form 3 B, of the Sequential Tests of Educational Progress was not statistically significant for these two groups of pupils on the pre-testing program.

Analysis of the Data on the Mid-Testing Program

Introductory statement.—This section of the research report deals with the mid-testing period of groups "A" and "B", respectively. The purpose of the mid-testing was to determine the progress, if any, that had been made by the two groups. The mid-test was administered the first week in the month of April, 1967. The results are reported in Tables 5 and 6, with the accompanying analyses.

It is to be noted here that groups "A" and "B" were rotated for the second period of instruction, with Group "A" being taught by textbook procedures, thereby, becoming Group "B", and Group "B" was taught by the teaching model designed on six widely accepted principles of learning, becoming Group "A" with the exchange of teaching methods.

Sequential Tests of Educational Progress, Mathematics (Form 3A).—The data on the performance on the STEP Mathematics Test, Form 3A, as derived from the raw scores obtained by the twenty-two eight-grade pupils in Group "A" and the twenty-two eighth-grade pupils in Group "B"
of Trinity High School, Decatur, Georgia are presented in Tables 5 and 6; and are analyzed in the paragraphs below.

**Group A.**—For the twenty-two eighth-grade pupils in Group "A", the scores ranged from a low of 10 to a high of 21, with a mean of 16, a median of 16, a standard deviation of 3, and a standard error of the mean of 1. Ten or 45 per cent scored above the mean and 11 or 50 per cent scored below the mean, and 1 or 5 per cent scored within the mean class-interval. The mean score of 16 indicated a percentile band of 12 - 43, which was substantially below the norm of expectancy in the area of mathematics.

**Group B.**—For the twenty-two eighth-grade pupils in Group "B", the scores ranged from a low of 7 to a high of 22, with a mean of 15, a median of 15, a standard deviation of 4, and a standard error of the mean of 1. Ten or 45 per cent scored above the mean and 10 or 45 per cent scored below the mean, and 2 or 10 per cent scored within the mean class-interval. The mean score of 15 indicated a percentile band of 9 - 38, which was substantially below the norm of expectancy in the area of mathematics.

**The "t" ratio or comparative data.**—Table 6 shows the comparative measures for the two groups were as follows: the mean was 16 and 15 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "A"; the median was 16 and 15 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "A"; the standard deviation was 3 and 4 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "A"; and the standard error of the mean
TABLE 5

DISTRIBUTION OF THE RAW SCORES ON THE STEP MATHEMATICS TEST, FORM 3 A,
FOR THE FORTY-FOUR EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL
DECATUR, GEORGIA, 1966-1967

MID-TESTING

<table>
<thead>
<tr>
<th>Raw Score</th>
<th>Converted Score</th>
<th>Percentile Band</th>
<th>Group &quot;A&quot;</th>
<th>Group &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
</tr>
<tr>
<td>22</td>
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<td><strong>Total</strong></td>
<td><strong>22</strong></td>
<td></td>
<td><strong>16</strong></td>
<td><strong>22</strong></td>
</tr>
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</table>

Mean 16 15
Sigma 3 4
SE 1 1
Mean %tile Band 12 - 43 9 - 38

31
TABLE 6

SIGNIFICANT DIFFERENCES ON THE STEP (MATHEMATICS, FORM 3 A) BETWEEN GROUP "A" AND GROUP "B" EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL, DECATUR, GEORGIA, 1966-1967

MID-TESTING

<table>
<thead>
<tr>
<th>Groups</th>
<th>No.</th>
<th>Median</th>
<th>Mean</th>
<th>Sigma</th>
<th>S. E. Mean</th>
<th>S. E. Mₐ - Mᵦ</th>
<th>S. E. M₂ - Mₚ</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>22</td>
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<td>16</td>
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<td>1</td>
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<td></td>
<td>1</td>
</tr>
<tr>
<td>Group B</td>
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<td>15</td>
<td>4</td>
<td>1</td>
<td></td>
<td></td>
<td>1.414</td>
</tr>
</tbody>
</table>

32
was 1 for Group "A" and Group "B", respectively, with no difference in favor of either group. The standard error of the difference between the two means was 1.414.

The "t" for these data was .714, which was not significant for it was less than 2.58 at the one (.01) per cent level of confidence at 42 degrees of freedom. Therefore, the difference on the Mathematics Test, Form 3A, of the Sequential Tests of Educational Progress was not statistically significant for these two groups of pupils on the mid-testing program.

Analysis of the Data on the Final - Testing Program

Introductory statement.—This section of the research report deals with the final - testing period. The purpose of the final - test was to determine to what extent the method of experimentation had been effective in the mathematical achievement of either the control or experimental group or both. The STEP Mathematics Test, Form 3B, was administered the third week in the month of May, 1967. Quantitative data are presented in Tables 7 and 8, with the accompanying analyses.

Further, a comparison of the test performance at the time of the initial - testing and the final - testing is presented in Table 9, with the accompanying interpretation.

Sequential Tests of Educational Progress, Mathematics (Form 3B).—The data on the STEP Mathematics Test, Form 3B as revealed by the raw scores obtained by the twenty-two eighth-grade pupils in Group "A" and the twenty-two pupils in Group "B" of Trinity High School, Decatur,
Georgia, 1966-67, are presented in Tables 7 and 8, and are analyzed in the separate paragraphs below.

**Group "A".**—For the twenty-two eighth-grade pupils in Group "A", the scores ranged from a low of 7 to a high of 25, with a mean of 15, a median of 16, a standard deviation of 4, and a standard error of the mean of 1. Thirteen or 59 per cent scored above the mean, and 9 or 41 per cent scored below the mean and none or no per cent scored within the mean class-interval. The mean score of 15 indicated a percentile band of 8 - 34, which was substantially below the norm of expectancy in the area of mathematics.

**Group "B".**—For the twenty-two eighth-grade pupils in Group "B", the scores ranged from a low of 8 to a high of 32, with a mean of 15, a median of 14, a standard deviation of 2, a standard error of the mean of 0. Ten or 45 per cent scored above the mean, and 11 or 50 per cent scored below the mean, and 1 or 5 per cent scored within the mean class-interval. The mean score of 15 indicated a percentile band of 8 - 34, which was substantially below the norm of expectancy in the area of mathematics.

**The "t" ratio or comparative data.**—Table 8 shows the comparative measures for the two groups were as follows: the mean was 15 for Group "A" and Group "B", respectively, with no difference in favor of either group; the median was 16 and 14 for Group "A" and Group "B", respectively, with a difference of 2 in favor of Group "A"; the standard deviation was 4 and 2 for Group "A" and Group "B", respectively, with a difference of
TABLE 7

DISTRIBUTION OF THE RAW SCORES ON THE STEP MATHEMATICS TEST, FORM 3 A,
FOR THE FORTY-FOUR EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL
DECATUR, GEORGIA, 1966-1967

<table>
<thead>
<tr>
<th>Raw Score</th>
<th>Converted Score</th>
<th>Percentile Band</th>
<th>Group &quot;A&quot;</th>
<th>Group &quot;B&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
</tr>
<tr>
<td>32</td>
<td>273</td>
<td>80 - 90</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>31</td>
<td>272</td>
<td>80 - 90</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>30</td>
<td>271</td>
<td>68 - 88</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>29</td>
<td>270</td>
<td>68 - 88</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>28</td>
<td>269</td>
<td>62 - 85</td>
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<td>267</td>
<td>56 - 80</td>
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<td>26</td>
<td>266</td>
<td>57 - 80</td>
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<td>25</td>
<td>265</td>
<td>50 - 74</td>
<td>2</td>
<td>9.10</td>
</tr>
<tr>
<td>24</td>
<td>264</td>
<td>50 - 74</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>23</td>
<td>263</td>
<td>43 - 68</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>22</td>
<td>261</td>
<td>38 - 62</td>
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</tr>
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<td>38 - 62</td>
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<td>257</td>
<td>24 - 55</td>
<td>1</td>
<td>4.55</td>
</tr>
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<td>18</td>
<td>255</td>
<td>18 - 50</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>17</td>
<td>253</td>
<td>12 - 43</td>
<td>4</td>
<td>18.20</td>
</tr>
<tr>
<td>16</td>
<td>251</td>
<td>9 - 38</td>
<td>5</td>
<td>22.75</td>
</tr>
<tr>
<td>15</td>
<td>248</td>
<td>8 - 34</td>
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<tr>
<td>14</td>
<td>245</td>
<td>3 - 30</td>
<td>2</td>
<td>9.10</td>
</tr>
<tr>
<td>13</td>
<td>239</td>
<td>0 - 23</td>
<td>2</td>
<td>9.10</td>
</tr>
<tr>
<td>12</td>
<td>234</td>
<td>0 - 19</td>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>11</td>
<td>231</td>
<td>0 - 14</td>
<td>3</td>
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</tr>
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<td>0</td>
<td>0.00</td>
</tr>
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<td>9</td>
<td>230</td>
<td>0 - 14</td>
<td>1</td>
<td>4.55</td>
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<td>8</td>
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<td>0 - 14</td>
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<td>7</td>
<td>230</td>
<td>0 - 14</td>
<td>1</td>
<td>4.55</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

Mean: 15
Sigma: 4
SE: 1
8 th - 14 th Band: 8 - 34

35
TABLE 8

SIGNIFICANT DIFFERENCES ON THE STEP (MATHEMATICS, FORM 3 B) BETWEEN GROUP "A" AND GROUP "B" EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL, DECATUR, GEORGIA, 1966-1967

FINAL-TESTING

<table>
<thead>
<tr>
<th>Groups</th>
<th>No.</th>
<th>Median</th>
<th>Mean</th>
<th>Sigma</th>
<th>S. E. Mean</th>
<th>M₁ - M₂</th>
<th>S. E. M₁ - M₂</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>22</td>
<td>16</td>
<td>15</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1.00</td>
<td>0.00</td>
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<tr>
<td>And</td>
<td></td>
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<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group B</td>
<td>22</td>
<td>14</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
2 in favor of Group "B"; and the standard error of the mean was 1 and 0 for Group "A" and Group "B", respectively, with a difference of 1 in favor of Group "B". The standard error of the two means was 1.00.

The "t" for these data was 0.00 which was not significant for it was less than 2.58 at the one per cent level of confidence at 42 degrees of freedom. Therefore, the difference on the Mathematics Test, Form 3B, of the Sequential Tests of Educational Progress was not statistically significant for these two groups of pupils on the final-testing program.

**Comparison of initial and final-test periods (Group "A").**--The data on the comparison of the mathematical performance on the initial and final-test of the STEP Mathematics Test for Groups "A" and "B", respectively, are presented in Table 9. The mean for Group "A" on the initial period was 15 and the mean on the final-test period was 15; the standard error of the mean was 1 on the initial and final-test periods, respectively; the difference between the mean on the initial and final-test periods was 0; the standard error of the difference between the mean of the initial and final-test periods was 1.414, with a "t" of .714 which was not significant.

**Comparison of initial and final test periods (Group "B").**--The mean for Group "B" was 14 on the initial test period, whereas, it was 15 on the final-test period; the standard error of the mean was 1 on the initial test period, whereas, it was 0 on the final-test period; the difference between the mean on the initial test-period and the final-test period was 1; the standard error of the difference between the mean of the initial and final-test periods 1, with a "t" of 1.00 which was not significant.
TABLE 9

SIGNIFICANT DIFFERENCES ON THE STEP MATHEMATICS TEST BETWEEN PRE-
TESTING AND FINAL-TESTING OF GROUP "A" AND GROUP "B"
EIGHTH-GRADE PUPILS IN TRINITY HIGH SCHOOL, DECATUR,
GEORGIA, 1966-1967

<table>
<thead>
<tr>
<th>Groups</th>
<th>Tests No.</th>
<th>Median</th>
<th>Mean</th>
<th>Sigma</th>
<th>S. E. Mean</th>
<th>M₁-M₂</th>
<th>S. E. M₁-M₂</th>
<th>&quot;t&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group &quot;A&quot;</td>
<td>Pre-test 22</td>
<td>15</td>
<td>15</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>1.414</td>
<td>.714</td>
</tr>
<tr>
<td></td>
<td>Final-Test 22</td>
<td>16</td>
<td>15</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td>Group &quot;B&quot;</td>
<td>Pre-test 22</td>
<td>13</td>
<td>14</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1.00</td>
</tr>
<tr>
<td></td>
<td>Final-Test 22</td>
<td>14</td>
<td>15</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
Interpretative Summaries

Introductory statement.—This section of the research report deals with the interpretation and summarization of the findings of this study and are reported under the following captions:

1. Interpretative Summary on the Indices of Age, Sex and I.Q. of the Subjects

2. Interpretative Summary on the Sequential Tests of Educational Progress, Mathematics (Form 3B) - Pre-Test

3. Interpretative Summary on the Sequential Tests of Educational Progress, Mathematics (Form 3A) - Mid-Test

4. Interpretative Summary on the Sequential Tests of Educational Progress, Mathematics (Form 3B) - Final-Test

5. Interpretative Summary on the Comparison of the Initial and Final Test Periods

Interpretative summary on the indices of age, sex and I.Q. of the subjects.—The data on the age, sex and I.Q. of the subjects as shown in Tables 1 and 2 may be summarized and interpreted as follows:

1. The mean age of 13 years, 6 months for Group "A" and Group "B", respectively, indicated that the pupils in each group had been closely equated on the basis of age and had proper chronological grade placement.

2. The mean I.Q. score of 83 for Group "A" and Group "B", respectively, indicated that both groups had equal potential for benefiting from formal and informal school experiences. Therefore, any differences in achievement to be later observed because of the experimental situation may be attributable to the absence or presence of the type of teaching method.

Interpretative summary on STEP Mathematics Test (Form 3B) - Pre-Test.—The data on the STEP Mathematics Test, Form 3B, as presented in Tables 4 and 5, pages 28 and 31, respectively, may be summarized and interpreted as follows:
1. There was no significant difference between Group "A" and Group "B" in the initial-test results of the STEP Mathematics Test, Form 3B. The "t" of .714 for these two groups was not significant for it was less than 2.58 at the one (.01) per cent level of confidence and at 42 degrees of freedom. Therefore, there was no significant difference in mathematical performance for the two groups.

2. The mean of 15 and 14 for Group "A" and "B", respectively, and a percentile band of 8 - 34, and 3 - 30, respectively, indicated that the two groups were below the norm of expectancy on the STEP Mathematics Test, Form 3B.

3. The lack of significant difference in mathematical performance between Group "A" and Group "B", respectively, indicated that the two groups had the same levels of aspiration, had had mathematics teachers who were equally effective, and had studied the same content. Further, since the groups had been equated on the basis of age, sex and intelligence, these variables probably had no effect on the level of achievement.

Interpretative summary on STEP Mathematics Test (Form 3A) – Mid-Test. — The data on the STEP Mathematics Test, Form 3A, as shown in Tables 5 and 6, pages 31 and 32, respectively, may be summarized and interpreted as follows:

1. There was no significant difference in mid-test results of the STEP Mathematics Test, Form 3A. The "t" of .714 for these two groups was not significant for it was less than 2.58 at the one (.01) per cent level of confidence and at 42 degrees of freedom. Therefore, there was no significant difference in mathematical performance for the two groups.

2. The mean of 16 and 15 for Groups "A" and "B", respectively, and a percentile band of 12 - 43, and 9 - 38, respectively, indicated that the two groups were below the norm of expectancy on the STEP Mathematics Test, Form 3A.

3. The lack of significant difference in mathematical performance between Group "A" and Group "B", respectively, indicated that neither of the two teaching methods was more effective than the other, or that the two methods of instruction were equally effective.

Interpretative summary on STEP Mathematics Test (Form 3B) – Final-
Test.—The data on the STEP Mathematics Test, Form 3B, as shown in Tables 7 and 8, pages 35 and 36, respectively, may be summarized and interpreted as follows:

1. There was no significant difference between Group "A" and Group "B" in the final-test results of the STEP Mathematics Test, Form 3B. The "t" of .00 for these two groups was not significant as it was less than 2.58 at the one (.01) per cent level of confidence and at 42 degrees of freedom. Therefore, there was no significant difference in mathematical performance for the two groups.

2. The mean of 15 for Group "A" and Group "B", respectively, and a percentile band of 8 - 34 for Group "A" and Group "B", respectively, indicated that the two groups were below the norm of expectancy on the STEP Mathematics Test, Form 3B.

3. The lack of significant difference in mathematical performance between Group "A" and Group "B", respectively, indicated that neither of the two teaching methods was more effective than the other or that the two methods of instruction were equally effective.

Interpretative summary on the comparison of the initial and final-test periods.—The data on the comparison of the initial and final-test periods as shown in Table 9, page 38, may be summarized and interpreted as follows:

1. There was no significant difference between the performance of Group "A" on the initial and final-test results of the STEP Mathematics Test, Form 3B. The "t" of .714 for these data was not significant for it was less than 2.58 at the one (.01) per cent level of confidence and at 42 degrees of freedom.

2. The lack of significant difference in the mathematical performance of Group "A" between the initial and final-test results, indicated that neither of the two teaching methods was more effective than the other, or that both methods of instruction were equally effective for Group "A".

3. There was no significant difference between the performance of Group "B" on the initial and final-test results of the STEP Mathematics Test, Form 3B. The "t" of 1.00 for these data was not significant for it was less than 2.58 at the
one (.01) per cent level of confidence and at 42 degrees of freedom.

4. The lack of significant difference in the mathematical performance of Group "B" between the initial and final-test results, indicated that neither of the two teaching methods was more effective than the other, or that both methods were equally effective for Group "B".
CHAPTER III

SUMMARY AND CONCLUSIONS

Introductory Statement

The purpose of this chapter is to present the findings, conclusions, implications, and recommendations derived from the administration of the Sequential Tests of Educational Progress (Mathematics) to the forty-four eighth-grade pupils in Trinity High School, Decatur, Georgia, 1967, in an effort to determine the effectiveness of the use of a teaching model designed on six widely accepted principles of learning as opposed to the use of a teaching model proposed by the authors of a textbook for teaching modern mathematics to eighth-grade pupils.

Statement of the problem.—This was an experimental study to determine the effectiveness of following textbook procedures in teaching modern mathematics to eighth-grade pupils at Trinity High School, Decatur, Georgia, as opposed to the use of a teaching method designed to make use of six widely accepted principles of learning, namely: (1) behavior which represents achievement, or partial achievement of an educational objective should be reinforced, (2) the introduction of cues which arouse motivation toward the achievement of an educational objective will increase the effectiveness with which that objective is achieved, (3) practice in applying a principle to the solution of problems will increase the probability of transfer of training to new problems which
require the use of the same principle for their solution, (4) since learners differ in their capacity to make the responses to be acquired, learning will be more efficient if it is planned so that each learner embarks on a program commensurate with his capacity to acquire new responses, (5) if a pupil has had training in imitation, then he is capable of learning by observing demonstrations of the skill to be acquired, and (6) the learner will learn more efficiently if he makes the responses to be learned than if he learns by observing another make the response or some related response.

Purpose of the study.—The major purpose of this study was to conduct an experiment designed to test the effectiveness of a teaching method based on selected principles of modern learning theory as contrasted with a method proposed by authors of a textbook for teaching modern mathematics. The more specific purposes of this study were to:

1. Define or specify the classes of variables (dependent, intervening, and independent) which have to be represented in a learning model as the basis for design of a teaching method. Ultimately, a teaching model was to be developed which followed the general formula:

\[ T = f(R_g, R_i) \]

2. Design a teaching method based on the principles of learning specified in the problem.

3. Conduct an experiment to ascertain whether learning mathematics was more efficient when it was taught to two eighth-grade groups of children who had been equated as far as age, sex

and general intelligence was concerned, by using a teaching method designed on the above principles of learning.

4. Eliminate, as much as possible, the learning of mathematics by imitation (by means other than doing) by marked emphasis on the learner's own attempt to make the responses to be learned, and stress the importance of the learner's making the full and complete response.

5. Eliminate, as much as possible, the learner's making substitute responses, especially those of a verbal nature.


7. Report the findings, conclusions, implications and recommendations.

Locale and research design of the study.—The significant aspects of the locale and research design of this study are indicated below:

1. Locale and Period of Study: This study was conducted at Trinity High School, Decatur, Georgia, during the months of February, March, April and May, 1967.

2. Research Method: The Experimental Method of Research (Rotation-Group Design), employing tests, statistical analysis and official school records, was used to collect the data required for this study.

3. Subjects: The subjects were the forty-four eighth-grade pupils enrolled in Trinity High School, Decatur, Georgia, 1966-67.

4. Materials: The basic data-gathering instruments were:
   1) Sequential Tests of Educational Progress, Mathematics (Forms 3A and 3B), and the official school records.

5. Criterion of Reliability: The criterion of reliability for the statistics of comparison was Fisher's "t" of 2.58 at the one per cent (.01) level of confidence at 42 degrees of freedom.

Procedural steps.—The data necessary to the development of this study were gathered, analyzed, interpreted, and presented through the following steps:

1. Permission to conduct this study was secured from the proper
The related literature pertinent to this study was reviewed and summarized for the thesis copy.

A teaching model was designed on the six principles of learning specified in the problem.

The forty-four eighth-grade pupils were divided into two equal groups on the basis of age, sex and general intelligence as obtained from the official school records.

The Sequential Tests of Educational Progress, Mathematics (Form 3B) was administered to the two equated groups of eighth-grade pupils, designated throughout the study as Group "A" and Group "B".

Group "A" was taught by the teaching method designed on six widely accepted principles of learning and Group "B" was taught by the model proposed by the author of the textbook used in the study for a period of six weeks.

At the end of the first instructional period, the Sequential Tests of Educational Progress, Mathematics (Form 3A) was administered to Group "A" and Group "B" pupils.

Group "A" and Group "B" were rotated so that Group "A" was taught by the model proposed by the authors of the text used in the study, and Group "B" was taught by the model designed on six widely accepted principles of learning.

At the end of the second instructional period, the Sequential Tests of Educational Progress, Mathematics (Form 3B) was administered to Group "A" and Group "B" pupils.

The data were interpreted, analyzed, and assembled into appropriate tables in keeping with the nature and purpose of the study.

The findings, conclusions, implications and recommendations were formulated and incorporated in the thesis copy.

Summary of related literature: The summarization and interpretation of the related literature pertinent to this research revealed that:

1. Education is concerned with changing the behavior of students, and that behavior can be controlled.

2. Teaching methods have not become established because they fitted a psychological model of the learning process.
3. The major concept of learning is that learning is the continuous change or modification of behavior brought about by physical or mental activity and is necessary to enable the individual to adjust to changing life situations.

4. Although concept formation is probably the most important and characteristically human phase of learning, it is often the most neglected, especially among high school and college students.

5. Much, if not most, of the disagreement among workers in psychology is with respect to theory and interpretation rather than with respect to the facts of behavior.

6. Where the principles of learning are not understood so that conditions can be correctly arranged, no learning takes place.

7. Some learning does occur as a result of imitation.

8. Many psychologists emphasize that the learner learns more efficiently if he makes the responses to be learned rather than if he learns by observing another make the response or some related response. The discovery method of teaching is based largely upon this principle of learning.

9. Students who learn more in certain school mathematics programs do so not because of the method of presentation but because they have at their disposal a systematic body of organizing explanatory and integrative principles which are not part of the conventional secondary-school mathematics. These principles illuminate the subject for them and make it more meaningful.

10. Teaching methods should be retained, at least in part, if they have utility in making predictions and discarded if they lack utility.

11. Different teaching methods emphasize different principles of learning.

12. There is a need for a teaching design which makes as much use as possible of a wide range of learning principles.

Summary of Basic Findings

The summary of the basic findings of this research dealing with the
significant differences, if any, for measures of achievement in mathematics, and the indices of age, sex and I. Q. of the forty-four eighth-grade pupils enrolled in Trinity High School, Decatur, Georgia, 1966-1967 are presented below under the appropriate data-captions.

**Characteristics of Equated Groups "A" and "B"**

**Tables 1 and 2**

With reference to the indices of age, sex, and I. Q. of the pupils used in this study, Group "A" had 12 boys and 10 girls, a mean age of 13 years, 6 months, and a mean I. Q. score of 83. Group "B" had 11 boys and 11 girls, a mean age of 13 years, 6 months and a mean I. Q. score of 83. The two groups showed no difference in mean age, mean I. Q. score, and number of pupils in each group. The two groups had an I. Q. score rating of "low".

**Results on the Sequential Tests of Educational Progress, Mathematics (Form 3B) - Pre-test**

**Tables 3 and 4**

With reference to the performance, in mathematics, of the pupils used in the study, on STEP Mathematics Test, 3B, the mean score for Group "A" was 15, the sigma score was 4, the standard error of the mean was 1, and the percentile band was 8 - 34. For Group "B", the mean score was 14, the sigma score was 5, the standard error of the mean was 1, and the percentile band was 3 - 30. The two groups showed a difference in the mean of 1, with a standard error of difference between the two means of 1.414, and a difference in percentile band of 5 - 4. The "t" of .714 was not significant.
Results on the Sequential Tests of Educational Progress.

Mathematics (Form 3A)—Mid-Test

Tables 5 and 6

With reference to the performance, in Mathematics, of the pupils used in study, on STEP Mathematics Test, 3A, the mean score for Group "A" was 16, the sigma score was 3, the standard error of the mean was 1, and the percentile band was 12 - 43. For Group "B", the mean score was 15, the sigma score was 4, the standard error of the mean was 1, and the percentile band was 9 - 38. The two groups showed a difference in the mean of 1, with a standard error of the difference between the two means of 1.414, and a difference in percentile band of 3 - 5. The "t" of .714 was not significant.

Results on the Sequential Tests of Educational Progress.

Mathematics (Form 3B)—Final-Test

Tables 7 and 8

With reference to the performance, in Mathematics, of the pupils used in this study, on STEP Mathematics Test, 3B, the mean score for Group "A" was 15, the sigma score was 4, the standard error of the mean was 1, and the percentile band was 8 - 34. For Group "B", the mean score was 15, the sigma score was 2, the standard error of the mean was 0, and the percentile band was 8 - 34. The two groups showed a difference in the mean of 0, with a standard error of the difference between the two means of 1.00, and no difference in percentile band. The "t" of .00 was not significant.
Significant Differences on Test Variables Between Initial and Final - Testing Periods

Table 9

With reference to the performance of Group "A" on the pre-test and final-test, on STEP Mathematics Tests, 3B and 3A, the mean was 15 for the pre-test and final-test, respectively; the difference between the two means was 0, the standard error of the difference between the two means was 1.414. The "t" of .714 was not significant.

For Group "B", the mean was 14 and 15 for the pre-test and final-test, respectively; the difference between the two means was 1, the standard error of the difference between the two means was 1. The "t" of 1.00 was not significant.

Conclusions.—The analysis and interpretation of the findings would appear to warrant these conclusions:

1. There was no significant difference in the mathematical performance of Group "A" and Group "B" at the pre-testing period. Both groups were experiencing the same level of achievement, as well as the same level of mental growth and development.

2. There was no significant difference in the mathematical performance of Group "A" and Group "B" at the mid-testing period. The teaching model designed on six widely accepted principles of learning, and the model proposed by the authors of the text used in the study, were equally effective.

3. There was no significant difference in mathematical performance of Group "A" and Group "B" at the final-testing period. The teaching model designed on six widely accepted principles of learning, and the model proposed by the authors of the text used in the study, were equally effective.

Implications.—The implications derived from the findings and conclusions of this research are as follows:
1. The two teaching methods, the model designed on six widely accepted principles of learning, and the model proposed by the authors of the texts used in the study, are equally effective for pupils of "low" intelligence.

2. Factors, other than teaching methods, must by themselves, or along with teaching methods, affect performance in mathematics for pupils of "low" intelligence.

Recommendations.—The conclusions and implications of this research would appear to warrant the following recommendations:

1. That more experimental studies with teaching methods be used on pupils of low intelligence index and cultural disadvantaged status.

2. That further research on the effectiveness of the two teaching methods, the model designed on six widely accepted principles of learning, and the model proposed by the authors of the text used in the study, be extended over a longer period of time.
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Name: Willie Cecelia Perrin Turner

Education: B. S. Degree (English, Business and Secondary Education), West Virginia State College, Institute, West Virginia, 1946. Graduate study at Atlanta University, Atlanta, Georgia.

Experience: Former teacher of sixth grade (East End Elementary School, Greenwood, South Carolina), eighth grade and music (Hill High School, LaFayette, Georgia), arithmetic, English and Music (Villa Rica, Georgia), and presently employed as Arithmetic, Health-Science Teacher for eighth grade and Choral Directress, Trinity High School, Decatur, Georgia.

Personal Information: Member of St. Paul of the Cross Catholic Church, Georgia Teachers Association, and American Teachers Association.
**A Teaching Model Designed on Six Widely Accepted Principles of Learning**

**Orientation and Exploration**

1. Establish the standard operating procedure.
   a) Inform pupils precisely what will be expected of them.
   b) Inform pupils on what they can expect from the teacher.
   c) Give an overview of the work with enthusiastic discussion of the importance of the subject.

   **Principle II (Motivation) -- Linguistic teacher behavior.**

2. Challenge self-esteem of pupils, i.e., stating faith in pupils' ability to learn.

   **Principle II (Motivation) -- Linguistic teacher behavior based on readiness an independent variable.**

3. Establish a frame of reference (lead from familiar to new).

   **Principle II (Motivation)**

4. Present instances of the item of knowledge to be taught so that pupils may form hypotheses.
   a) Present items skillfully and enthusiastically.
   b) Present items in logical sequence.
   c) Clarify the goals for the day.

   **Principle VI (The learner makes the response)**
   Expressive and linguistic teacher-pupil behavior
   Development of mediating responses, an independent variable.
   **Principle II (Motivation).**

5. Have pupils infer from the instances of the items of knowledge to be taught.
   a) Have pupils answer orally, when necessary, questions
designed to test correctness of their hypotheses.

b) Present large numbers of problems of varying degrees of difficulty, involving item of knowledge being taught.

c) Let pupils select problems they can master from class text and outside materials.

d) Rely on pupils imitating where incorrect hypotheses persist and understanding fails to take place.

Principle VI (The learner makes the response)
Principle III (Practice in applying a principle)
Principle IV (Learner works according to his capacity)
Principle V (Some learning can occur by imitation)

Linguistic pupil behavior
Performative teacher behavior

6. Evaluate pupils' responses by grading papers.

a) Use praise for desired responses, blame for undesired responses, and teacher-approval which will elicit pupil-approval.

b) Display pupils' work.

c) Have pupils keep individual progress charts.

Principle I (Reinforcers)
Principle II (Motivation)
Expressive teacher-pupil behavior

7. Present evidence - perhaps more instances serving either to approve or disprove the various hypotheses the pupils formulate.

8. Have pupils at a later time restate the item of knowledge taught.

Hendrix's "Unverbalized Awareness Method"
Response Variable

9. Summarize major points of the lesson.

10. Test for transfer of training when the occasion arises.
THE TEACHING MODEL PROPOSED

by McSwain, Brown Gundlach

and Cooke. Authors of "Mathematics"

(Eighth-Grade Text) Trinity

High School, Decatur.

Georgia. 1966-1967

"Tell - And - Do"

1. State the item of knowledge to be taught.

2. Clarify, if necessary, the meaning of sentences used to express the knowledge.

3. Justify the item, i.e., establish the truth of the item, if it has a truth value (diagrams, demonstrations, etc.), or argue that the item is a means to some acceptable end, if it is a prescription.

4. Clinch the understanding (have pupils work problems through written exercises based on knowledge taught or have them react orally to questions based on the knowledge taught).

5. Make a transition to the next item to be taught.

6. Test at the end of each major topic of mathematics.