A STUDY OF ATTITUDES OF ELEMENTARY TEACHERS TOWARD MODERN MATHEMATICS PROGRAMS

By

JIMMY MARSHALL RICE

Bachelor of Science
Eastern New Mexico University
Portales, New Mexico
1955

Master of Science
Eastern New Mexico University
Portales, New Mexico
1956

Submitted to the faculty of the Graduate School of
the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
August, 1964

A STUDY OF ATTITUDES OF ELEMENTARY TEACHERS

TOWARD MODERN MATHEMATICS PROGRAMS

Thesis Approved:

Edwin E. Vineyard
Thesis Adviser

O. H. Hamilton

Kenneth E. Wiggins

James H. Zant

J. H. Boggs
Dean of the Graduate School

PREFACE AND ACKNOWLEDGMENTS

The purpose of the study was to investigate the attitudes of elementary teachers toward mathematics and modern mathematics programs and to determine whether formal instruction in modern mathematics materials is a factor which influences these attitudes.

The writer is grateful to Dr. Edwin E. Vineyard, Chairman of the Advisory Committee, for friendly encouragement and guidance in this research. The writer also wishes to express sincere appreciation to Dr. O. H. Hamilton, Dr. Kenneth E. Wiggins, and Dr. James H. Zant for assistance and advice as members of the committee.

Special thanks are due the staff assistants of the Oklahoma State University Mathematics Department for their assistance in the collection of the data, and to the principals and teachers who participated in the study for their willing cooperation.

The writer is especially indebted to the National Science Foundation and to the administration of Fort Hays Kansas State College for making possible the opportunity for advanced study, and to those who gave the most support and encouragement during the course of the study, his children and his wife, Nelda.

J. M. R.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page
XV.	Group Attitudes Toward Mathematics	66
XVI.	Chi-Square Test to Determine Whether Attitudes Toward Modern Mathematics Programs Fit the Normal Distribution . . .	67
XVII.	Chi-Square Test to Determine Whether Attitudes Toward Mathematics Fit the Normal Distribution	67
XVIII.	Homogeneity of Variance Test Results for Group Attitudes Toward Modern Mathematics Programs	68
XIX.	Homogeneity of Variance Test Results for Group Attitudes Toward Mathematics	69
XX.	Analysis of Variance Results for Testing Primary Hypotheses	72
XXI.	Contingency Table for Hypothesis III-A . . .	76
XXII.	Contingency Table for Hypothesis III-B . . .	77
XXIII.	Contingency Table for Hypothesis III-C . . .	77
XXIV.	Contingency Table for Hypothesis III-D . . .	77
XXV.	Contingency Table for Hypothesis III-E . . .	78
XXVI.	Contingency Table for Hypothesis IV-A . . .	78
XXVII.	Contingency Table for Hypothesis IV-B . . .	79
XXVIII.	Contingency Table for Hypothesis IV-C . . .	80
XXIX.	Contingency Table for Hypothesis IV-D . . .	80
XXX.	Contingency Table for Hypothesis IV-A . . .	80
XXXI.	Contingency Table for Hypothesis V-A	81
XXXII.	Contingency Table for Hypothesis V-B	81
XXXIII.	Chi-Square Results for Testing Secondary Hypotheses	82

CHAPTER I

THE PROBLEM

Introduction

In 1952, the University of Illinois Committee on School Mathematics, looking critically at the high school program in mathematics, found much that was considered to be unsatisfactory. Along with other groups, the committee noted that some content was no longer useful, while concepts which could have put the program in harmony with modern developments were absent. There has followed a growing discontent with the mathematics program in the secondary school because it does not reflect, nor is it affected by, the development of mathematics that has been taking place during the last fifty years.

The Commission on Mathematics, appointed in 1955 by the College Examination Board, proposed in its report of 1959, a program of mathematical education compatible with our present-day scientific and technological culture. The School Mathematics Study Group, which was organized in 1958 with National Science Foundation aid, inaugurated the program by writing a series of textbooks which leaned heavily on this report. The National Science Foundation also sponsored institutes that acquainted thousands of teachers with contemporary mathematics. The result has been a revolution in school mathematics in the United States.

Although the reform in school mathematics grew out of dissatisfaction with the secondary school curriculum, the effects have not been limited to the secondary level. The School Mathematics Study Group,[1] which represents the largest united effort for improvement in the history of mathematics education, is concerned with the improvement of both elementary and secondary curriculums in mathematics. The purposes of its textbooks are to present new topics and to suggest what the writers consider to be better methods of presenting traditional topics. They focus attention on facts and skills which are thought to be important, and on basic principles that provide the logical framework of mathematics.

Sparked by the activities of the National Science Foundation and the SMSG, several other groups in various parts of the country undertook experiments and projects aimed at the improvement of the elementary curriculum. The University of Illinois Arithmetic Project is concerned both with improved content and instruction in elementary mathematics. The Greater Cleveland Mathematics Program proposes to develop an integrated and logically progressive program of improved materials for both teachers and pupils, grades K--12. The Syracuse University

---

[1]Hereinafter designated by the abbreviation SMSG.

"Madison Project" has developed materials which can be used in grades 3--9.[2]

Modern mathematics is comprised of many parts or sub-themes called mathematical systems. The study of mathematics is essentially the study of these mathematical systems and their structure. The structure of a mathematical system is usually thought of as consisting of undefined elements, unproved postulates or axioms, definitions, and the propositions or theorems which logically follow from these. Any two different interpretations of these undefined elements, postulates, and definitions are said to have the same structure. Nearly all of the modern programs place emphasis on the structure of mathematics. These programs also have other features in common. One writer believes that in general terms the proposed changes which these groups have in common and advocate can be listed as follows:

1. Emphasize the structure of mathematics.
2. Stress unifying themes.
3. Revitalize essential old topics by modernizing the language and structuring the ideas.
4. Increase emphasis on mathematical abstractions.
5. Delete obsolete topics.

---

[2]"The New Mathematics; Projects in Curriculum Revision," <u>Audiovisual Instruction,</u> VII (March, 1962), 137.

6. Avoid excessive emphasis on manipulation and drill.[3]

The exact extent to which experimental programs of all kinds have been adopted for use in the United States Schools is difficult to determine. During the school year 1959-60, SMSG sample textbooks and teachers' manuals for grades 7 through 12 were tried out in 45 states by more than 400 teachers and 42,000 pupils.[4] By the end of the 1959-60 school year the materials prepared by the University of Illinois Curriculum Study in Mathematics had been used experimentally in 25 states by 200 teachers and 10,000 pupils.[5] Wiersma[6] estimates that during the 1960-61 school year over 200,000 elementary and high school students had studied new programs in mathematics.

New secondary mathematics programs were started in Oklahoma in 1959-60 when 2500 SMSG textbooks in grades 9, 10, and 11 were used in some 23 school systems in the state. Since that time use of SMSG texts has expanded to all levels,

---

[3]William Wiersma, Jr., "A Study of National Science Foundation Institutes: Mathematics Teachers' Reactions to Institute Programs and Effects of These Programs on High School Mathematics Courses" (unpublished doctoral dissertation, The University of Wisconsin, 1962), p. 30.

[4]Kenneth E. Brown, "The Drive to Improve School Mathematics," The Revolution in School Mathematics, National Council of Teachers of Mathematics, (Washington, D. C., 1961), p. 17.

[5]Ibid., p. 19.

[6]Wiersma, p. 28.

grades 4 through 12. During 1960-61, there were 16,000 copies used and 25,000 more during 1961-62. It has been estimated that during 1962-63, perhaps 200 high schools and probably as many elementary schools made use of SMSG texts.[7]

Clarification of Terms

Selected terms used in this study are defined as follows:

Attitude. An emotionalized tendency, organized through experience, to react positively or negatively toward a psychological object.[8] Thus, attitudes are linked to emotions and may be roughly defined as feelings for or against something.

Mathematics. In this study, mathematics and arithmetic will be denoted by mathematics. The term, mathematics, will be used in accordance with the commonly accepted definition. No "modern" aspects will be indicated by the use of the term.

Modern Mathematics Programs. School mathematics programs which use materials prepared in connection with the School Mathematics Study Group Project on Elementary Mathematics, the University of Illinois Arithmetic Project, the Syracuse University "Madison Project," the Greater Cleveland Mathematics Program,

---

[7] James H. Zant, "Effect of New Mathematics Programs in the Schools on College Mathematics Courses," The American Mathematical Monthly, LXX (February, 1963), 200-202.

[8] H. H. Remmers and N. L. Gage, Educational Measurement and Evaluation (New York, 1955), p. 362.

and others. These projects either deal exclusively with some or all of the elementary grades or include some or all of the elementary grades in the project's full scope. These programs are marked by common emphases. According to Johnson they are surprisingly similar in their proposals that:

1. Mathematics be taught as an exciting field of knowledge
2. The materials be presented more rapidly and at an earlier age
3. Mathematics be taught as a field for discovery and creative activity
4. The content be presented in precise language
5. The structure of mathematics be emphasized.[9]

Need for the Study

The concern to introduce modern mathematics into the secondary school curriculum has been so great that many educators have also advocated the introduction of modern mathematics into the elementary school curriculum. They express the opinion that children who have formed thought patterns in the elementary school years will not adapt to the new high school program. They reason that the basic mathematical concepts should be developed during the formative years when the child is in the elementary school. The various groups and projects mentioned previously aim at

---

[9] Donovan A. Johnson, "The New Mathematics," Audiovisual Instruction, VII (March, 1962), 143.

developing these concepts. These experimental programs all subscribe to the position that much more mathematics can be taught to children of a given age than is now being taught and each program pursues this course.

Nationally, opinions differ on the amount of emphasis which should be placed on modern mathematics. There are teachers and mathematicians who disagree as to the details of the content. Although there is disagreement about details, the reception of the new programs may indicate that many teachers and mathematicians agree that these programs are a step forward. Howard Fehr of Columbia University believes this and says, "Teachers who have used the newer materials are enthusiastic and say they will never return to the old."[10]

In opposition to Fehr are Saunders MacLane and Morris Kline, both of whom are mathematicians of national repute. MacLane[11] says that the reform and the "modern" aspects of current programs have been oversold. Kline[12] has many criticisms of the modern programs. He accuses the modernists

---

[10]Howard Fehr, "Teaching Modern Mathematics," NEA Journal, LI (November, 1962), 44.

[11]Saunders MacLane, "The Reform Has Been Oversold," NEA Journal, LI (November, 1962), 45.

[12]Morris Kline, "The Ancients Versus the Moderns, a New Battle of the Books," The Mathematics Teacher, LI (October, 1958), 418-427.

of replacing traditional materials with such topics as symbolic logic, Boolean algebra, set theory, and postulational systems, which he classifies as peripheral material. Set theory, which permeates practically all modern materials and is looked upon by many as serving to unify and clarify mathematics, plays a very limited role in mathematics according to Kline. He also claims that the pure mathematics which the modernists wish to present is pointless mathematics, that it is a manipulation of meaningless symbols which ignores completely the primary reason for the existence of mathematics, namely, the investigation of nature.

Most of the opposition to the modern movement has come from educators and mathematicians. Little has been heard from classroom teachers who are asked to put the program into practice. Wallace Manheimer,[13] a classroom teacher, has expressed a viewpoint which he considers might be similar to that of many of his silent colleagues. Manheimer believes that the movement violates educational principles, particularly the principle which holds that learning proceeds from the concrete and specific to the abstract and general. He also criticizes the emphasis placed on mathematical structure and minimizes it as only one aspect of mathematical creativity.[14]

---

[13]Wallace Manheimer, "Some Heretical Thoughts From an Orthodox Teacher," The Mathematics Teacher, LIII (January, 1960), 22-26.

[14]Ibid., p. 25.

As with anything new, there is also controversy at the local and regional levels over the content and value of the new mathematics programs. Thus, in a sufficiently large sampling of classroom teachers, one would expect to find differences in attitudes toward modern programs. These differences might or might not be statistically significant. The controversy will be settled only after much testing, evaluation, and research. One purpose of this study is to contribute to the necessary research.

Much effort has been made to prepare teachers for teaching contemporary materials. Many elementary teachers whose preparation programs have been traditional or who do not consider themselves to be as adequately prepared to teach mathematics as they would like to be are finding the new mathematics difficult to use and consequently are also finding it difficult to accept the modern concepts. Fortunately, some National Science Foundation institutes and other forms of in-service training are available to these elementary teachers. Oklahoma State University offers in-service training in the form of extension classes taught at various instruction centers about the state. This program is in its third year and currently is reaching more than 350 teachers at eight different instruction centers. Classes are conducted weekly by staff assistants of the Oklahoma State University Mathematics Department throughout the entire academic year.

In relation to modern mathematics programs and in-service training, two questions arise: How are teacher attitudes affected by formal instruction in modern materials? How are teacher attitudes related to the success of modern programs? The primary purpose of this study is to investigate the attitudes of elementary teachers concerning modern mathematics programs and to determine the effect of formal instruction in modern materials upon these attitudes, thereby answering, within limitations, the first question. Some educators have attempted to answer the second question. Rosenbloom says, "We find that the teacher's attitude is a more important factor than his formal preparation in his effectiveness with the new courses."[15] This implies that the success of the modern programs hinges more heavily upon the teacher's acceptance of the philosophy of and techniques of teaching the new materials, rather than his formal preparation.

Banks[16] suggests that unhealthy student attitudes toward mathematics may result from a number of causes. Among these are parental attitudes, repeated failure, and attitudes of peers. But by far the most significant contributing factor is the attitude of

---

[15] P. C. Rosenbloom, "Mathematics, K-14," Educational Leadership, XIX (March, 1962), 361.

[16] J. Houston Banks, Learning and Teaching Arithmetic (Boston, 1959), pp. 16-17.

the teacher. Harrington[17] also defends this position in his dissertation. He found that teachers were overwhelmingly reported as the persons who most influenced attitude toward mathematics, and their attitude toward mathematics was reported as favorable to a significant degree. Banks goes on to point out that the teacher who feels insecure, for whom mathematics is largely rote manipulation, without understanding, cannot avoid transmitting these feelings to students. On the other hand, the teacher who has confidence, understanding, interest, and enthusiasm for mathematics has done much toward insuring the success of the program.[18]

Thus, educators support the idea that teacher attitudes are a significant factor in the success of modern mathematics programs as well as traditional programs. Recent research studies have presented evidence that modern programs are equally effective or more effective than traditional programs in mathematics. A study by Payne[19] reveals data which were sufficiently positive to cause him to recommend that school

---

[17]Lester Garth Harrington, "Attitudes Toward Mathematics and the Relationship Between Such Attitudes and Grade Obtained in a Freshman Mathematics Course" (unpublished doctoral dissertation, University of Florida, 1960).

[18]Banks, p. 17.

[19]Holland Ivan Payne, "A Study of Student Achievement Using SMSG and Conventional Approaches in First Year Algebra" (unpublished doctoral dissertation, Oklahoma State University, 1963).

administrators introduce some phase of modern mathematics into their curriculum. Phelps[20] concludes, on the basis of research, that SMSG materials tend to foster a better attitude toward mathematics at the grade five level than do traditional materials. If further research and experience dictate the use of modern materials throughout our schools, then it will be desirable that teachers hold favorable attitudes toward these programs. We must determine if formal instruction in modern materials is a means of changing significantly these attitudes.

Statement of the Problem

The purpose of the study is to investigate the attitudes of a group of Oklahoma elementary teachers toward mathematics and modern mathematics programs. The primary problem is to determine whether formal instruction in modern mathematics materials is a factor which influences these attitudes. The study will involve the testing of the following hypotheses stated in null form:

A. There is no significant difference between the attitudes toward modern mathematics programs of elementary teachers who have had formal instruction in modern materials and elementary teachers who have

---

[20]Jack Phelps, "A Study Comparing Attitudes Toward Mathematics of SMSG and Traditional Elementary School Students" (unpublished doctoral dissertation, Oklahoma State University, 1963).

had no such instruction.

B. Among elementary teachers who have had formal instruction in modern materials, there is no significant difference between the attitudes toward modern mathematics programs of those teachers who have taught in modern mathematics programs and those who have not taught in modern programs.

C. Among elementary teachers who have had no formal instruction in modern mathematics materials, there is no significant difference between the attitudes toward modern mathematics programs of those teachers who enrolled in the 1963 fall semester extension classes in Mathematics 253 and those teachers who were not enrolled.

D. There is no significant difference between the attitudes toward mathematics of elementary teachers who have had formal instruction in modern mathematics materials and elementary teachers who have had no such training.

E. Among elementary teachers who have had formal instruction in modern mathematics materials, there is no significant difference between the attitudes toward mathematics of those who have taught in modern mathematics programs and those who have not taught in modern programs.

F. Among elementary teachers who have had no formal instruction in modern materials, there is no significant difference between the attitudes toward mathematics of those teachers who were enrolled in the 1963 fall semester extension classes in Mathematics 253 and those teachers who were not enrolled.

The study also investigates whether age, sex, experience, and level of training are variables which are associated with significant differences in attitudes toward mathematics and modern mathematics programs.

Basic Assumptions

The assumptions upon which this study is based are:

1. Attitudes are measurable and vary along a linear continuum.

2. There will be differences in the belief and disbelief systems of those with favorable attitudes toward mathematics and modern mathematics programs and those with unfavorable attitudes. Edwards[21] defines a person's beliefs about a psychological object as all those statements relating to the object that the person agrees with or accepts. Disbeliefs are defined

---

[21] Allen L. Edwards, Techniques of Attitude Scale Construction (New York, 1957), p. 10.

similarly.

3. The attitudes of elementary teachers toward mathematics and modern mathematics programs can be measured by instruments properly designed for that purpose.

4. The expressed responses of the subjects reflected their true feelings and attitudes. As Thurstone states:

> All that we can do with an attitude scale is to measure the attitude actually expressed with the full realization that the subject may be consciously hiding his true attitude or that the social pressure of the situation has really made him believe what he expresses. This is a matter for interpretation. It is something probably worthwhile to measure an attitude expressed by opinions. It is another problem to interpret in each case the extent to which the subjects have expressed what they really believe. All that we can do is to minimize as far as possible the conditions that prevent our subjects from telling the truth, or else to adjust our interpretations accordingly.[22]

5. Attitudes are normally distributed and may be statistically treated accordingly.

Scope and Limitations

This study is an investigation of the attitudes of 400 elementary teachers toward mathematics and modern mathematics programs. The study sought to determine whether there is a significant difference between the attitudes of those teachers who have had formal instruction in modern mathematics materials and

---

[22] Louis L. Thurstone, _The Measurement of Values_ (The University of Chicago Press, 1959), p. 218.

the attitudes of those teachers who have had no such instruction. Although the writer obtained some data for teachers teaching at the junior high and high school levels, the study was limited exclusively to the consideration of the attitudes of teachers who were teaching in grades 1--6. The data collection was limited to school systems within a 120 mile radius of Oklahoma State University.[23]

There are several other factors in the study which should be viewed as limitations. According to Remmers,[24] limitations linked with attitude measurements which are not implicit in the basic assumptions include the fact that attitudes may be temporary and changeable and subject to rationalization and deception.

One must assume that variations exist which cannot be measured, but which still have a certain amount of influence on the attitudes of the subjects of the study. These factors include differences in the quality of instruction received by teachers who have had formal training in modern mathematics, variation in the emphasis placed on modern concepts by instructors, differences in the prevailing educational philosophies of the schools from which the samples were drawn, and differences in the administrative policies of the schools from which the samples

[23]See Appendix B for complete listing of schools and cities.

[24]Remmers and Gage, p. 7.

were drawn. These variations are inherent in the findings of the study and should be given consideration when conclusions are drawn from these findings. However, the effect of such variations can be minimized when the responses are considered in groups and treated statistically. Wert, Neidt, and Ahmann maintain that acceptable measures of human characteristics may be obtained in the following:

> The inability to obtain precise measures of human characteristics is a limiting factor whenever the purpose is for counseling an individual, but is a consideration of less importance in research studies involving groups of individuals. Generalizations may be drawn concerning group reaction which are entirely tenable for a group but which would be extremely dubious if applied to any individual within the group.[25]

Summary and Preview

For many years elementary school mathematics has been a study of numbers and their properties taught in terms of techniques and manipulations. In recent years a number of people and organizations have worked to change this pattern which has traditionally been followed. As a result there are now many new or modern programs in elementary school mathematics. These programs are marked by common characteristics such as increased emphasis on the structural aspects of mathematics and an attempt to show the "why" of arithmetical computations.

---

[25]James E. Wert, C. O. Neidt, and J. S. Ahmann, Statistical Methods in Educational and Psychological Research (New York, 1954), p. 2.

Another common element is an attempt to lead students to understand principles rather than merely to present to them rules for memorization. Much attention has also been given to the problem of clarifying the language of mathematics and making it more precise.

It is difficult to determine the exact extent to which modern programs have been adopted for use in the United States schools, but we do know that their use in increasing. Many teachers are finding themselves unequipped for teaching contemporary materials and many are taking advantage of in-service opportunities. Since educators agree that a teacher's effectiveness is directly related to his attitude toward the program in which he is teaching, it is of importance that studies be made to determine whether these in-service experiences foster better attitudes toward modern mathematics programs on the part of those teachers who participate in them.

The purpose of the study is to measure and compare the attitudes toward mathematics and modern mathematics programs held by 400 elementary teachers in the state of Oklahoma. Statistical procedures will be employed to determine whether formal instruction in modern materials is a factor which has an effect upon these attitudes. In this chapter the writer has developed the background of the problem, stated the problem, validated the need for the study, and indicated the scope of the study. Attention was also given to the basic assumptions in order to locate the framework within which the study was conducted.

Chapter II will be a report of selected related literature. Although no studies were found which concerned attitudes toward modern mathematics programs, there have been studies involving teacher and student attitudes toward mathematics.

Chapter III will be a description of the construction of the measuring instrument of the study. The writer was unable to obtain an instrument suitable for the present study and hence found it necessary to construct one.

Chapter IV will describe in detail the procedures used for obtaining data for the study. This chapter will also include a description of the subjects and a discussion of the statistical methods used.

The content of Chapter V will be a presentation and analysis of the data. This chapter will include tables and other illustrative devices to enable the reader to grasp the significance of the responses to the instrument of the study.

In Chapter VI the writer will summarize results, conclusions, and recommendations indicated by the data.

CHAPTER II

REVIEW OF RELATED LITERATURE

It is commonly known that the mathematics curriculum of the schools in the United States is in a state of flux. Changes in the programs of the schools have been implemented so recently that time has not permitted extensive research on the impact of these changes. This is especially true at the elementary level since the trend of change has been from the top downward. Therefore, the literature relating to studies concerned with modern mathematics programs and materials is rather limited. No studies were found which dealt directly with the relationship between teacher attitudes and modern programs. However, there have been several studies pertaining to teacher and student attitudes toward traditional mathematics. It is the purpose of this chapter to identify and summarize articles and reports of studies found in the literature which seem to be closely associated with the present study.

Since one of the problems of the study was the construction of an attitude scale, the writer investigated reports of other studies which involved attitude scale construction. Studies by Dutton on the attitudes toward arithmetic of students and of prospective teachers illustrate a commonly used method of devising attitude scales on mathematics. Although a different technique of attitude scale construction was used in the present study, Dutton's reports yielded helpful information.

Dutton[1] expresses the opinion that the attitudes held by prospective teachers toward the subjects that they will have to teach would seem to warrant study. A logical extension would include in-service teachers as well. In a study designed to investigate attitudes of prospective teachers toward arithmetic, Dutton first secured data by having students answer two questions relating to favorable and unfavorable attitudes toward arithmetic. Written statements were received from 211 students enrolled in three elementary curriculum methods classes at the University of California, Los Angeles. These statements were then tabulated under two headings: (1) factors responsible for favorable attitudes and (2) factors causing unfavorable attitudes.[2]

One of the most significant factors coming out of the data was the large amount of outpouring of unfavorable feelings toward arithmetic. Seventy-four percent of all responses were unfavorable. Causes for unfavorable attitudes seemed to be associated with lack of understanding of arithmetic processes; little application to life and social usage; poor teaching techniques involving boring

---

[1]Wilbur H. Dutton, "Attitudes of Prospective Teachers Toward Arithmetic," The Elementary School Journal, LII (October, 1951), 84.

[2]Ibid., pp. 84-91.

drill; and feelings of inferiority and insecurity.[3] A more stable type of response was given in relation to the favorable attitudes. Students seemed to express favorable statements which were less emotionally charged than were the unfavorable statements.

Dutton indicates that most of the students in the study were taught arithmetic in traditional schools and by traditional methods. He then suggests that there is need for additional research to evaluate the attitudes of students coming from more modern programs.[4]

In a second article reporting attitudes of prospective teachers toward arithmetic, Dutton[5] describes the construction of an arithmetic attitude scale used for his study. Prospective teachers enrolled in education classes at the University of California were asked to write out their feelings about arithmetic. The techniques developed by Chave and Thurstone were then used with these statements to develop an experimental scale. The experimental scale was then administered to 289 students on the campus.

Dutton felt that the main findings of his study showed that attitudes toward arithmetic may be measured objectively and that significant data may be obtained which will be helpful in the

---

[3]Ibid., p. 87.

[4]Ibid., p. 90.

[5]Wilbur H. Dutton, "Measuring Attitudes Toward Arithmetic," The Elementary School Journal, LV (September, 1954), 24-31.

education of prospective elementary school teachers.[6] Several other important conclusions included the following:

1. The techniques for measuring attitudes developed by Thurstone can successfully be applied to subjects taught in the elementary school. The process is laborious, but it will yield desirable results.

2. Feelings toward arithmetic are developed in all grades. The most crucial spots are in grades 3 through 6 and in the junior high school.

3. Real enjoyment when problems can be worked with understanding and pleasure in the challenge presented by an arithmetic problem are the most accepted favorable attitudes reported by students in the study.

4. Unfavorable attitudes of significance are: not feeling secure in the subject, being afraid of word problems, and fear of the subject in general.[7]

In a study to determine if there were changes in attitudes of prospective elementary school teachers toward arithmetic since 1954, Dutton[8] tested a group of college students in teacher training eight years later. All students had completed the methods course dealing with the teaching of arithmetic and most of them had taken Algebra I and II and Geometry in high school. The instrument used in the study was a shortened form of the attitude scale described above. Some of the findings of the study are:

1. The attitudes of prospective teachers toward arithmetic in 1954 were almost identical with attitudes held by

---

[6]Ibid., p. 30.

[7]Ibid., p. 30.

[8]Wilbur H. Dutton, "Attitude Change of Prospective Elementary School Teachers Toward Arithmetic," The Arithmetic Teacher, IX (December, 1962), 418-424.

prospective teachers in the 1962 sampling. Two conclusions on this finding seem warranted: (a) these people are the product of a type of teaching which was based upon mechanical, drill procedures; (b) instruction in the teaching of arithmetic at the university level (even when students identified their attitude toward arithmetic) did not change the attitudes held by these students. Will teaching experience and in-service educational programs change the attitudes of teachers who have unfavorable attitudes toward arithmetic?

2. Many students have ambivalent feelings toward arithmetic. The extremes, those with either very positive or very negative attitudes toward arithmetic, are exceptions to the rule.

3. There was not enough evidence found in this study to indicate any pronounced improvement in the instructional programs of public and private elementary schools directed toward the development of positive attitudes of pupils toward arithmetic. Prospective elementary school teachers reflect attitudes developed in a traditionally oriented arithmetic program.

4. Attitudes toward arithmetic, once developed, are tenaciously held by prospective elementary school teachers. Continued efforts to redirect the negative attitudes of these students into constructive channels have not been very effective. While the best antidote is probably improved teaching in each elementary school, continued study should be made of changing negative attitudes toward arithmetic at the university level and through in-service instruction while doing regular classroom teaching.

5. The aspects of arithmetic liked and disliked by prospective elementary school teachers remained approximately the same between 1954 and 1962.[9]

---

[9] Ibid., p. 424.

The Dutton Attitude Scale has been very popular with researchers. Dutton[10] also used it in a study of attitudes of junior high school pupils toward arithmetic. Stright[11] used it in determining attitudes of students and teachers toward arithmetic at the elementary level. Phelps used it in comparing attitudes toward mathematics of SMSG and traditional elementary school students. Lyda and Morse[12] used it in determining whether planned periods of "meaningful" instruction had any effect upon the attitudes and achievement of students.

Aiken and Dreger[13] also conducted a study requiring the construction of an attitude scale. Their investigation included the testing of hypotheses concerning relation of mathematics attitudes to achievement measures, relation of mathematics attitudes to personality measures, and relations of mathematics attitudes to experiences with mathematics. The Math Attitude

---

[10] Wilbur H. Dutton, "Attitudes of Junior High School Pupils Toward Arithmetic," The School Review, LXIV (January, 1956), 18-22.

[11] Virginia M. Stright, "A Study of Attitudes Toward Arithmetic of Students and Teachers in the Third, Fourth, and Sixth Grades," The Arithmetic Teacher, VII (October, 1960), 280-286.

[12] Wesley J. Lyda and Evelyn Morse, "Attitudes, Teaching Methods, and Arithmetic Achievement," The Arithmetic Teacher, X (March, 1963), 258-262.

[13] Lewis R. Aiken, Jr., and Ralph Mason Dreger, "The Effect of Attitudes on Performance in Mathematics," Journal of Educational Psychology, LII (February, 1961), 19-24.

Scale used for the study consisted of 20 items scaled according to Likert's procedure. These items were taken from paragraphs describing attitudes toward mathematics written by 310 college students.

The Math Attitude Scale was administered during orientation week to entering freshmen at a southeastern college who were taking general mathematics and the data were analyzed primarily by means of multiple and partial correlation and regression methods. It is interesting to note that Aiken and Dreger made use of a chi-square test of independence between Math Attitude Scale scores, dichotomized at the median, and responses to selected items on the scale.[14] The present study also employs this procedure to test hypotheses of independence between such variables as attitudes, age, sex, level of training and experience.

Among the results of the study of Aiken and Dreger were the following:

1. Confirmation of the hypothesis that mathematics attitudes are related to numerical ability.

2. Mathematics attitudes are apparently related to intellective factors and achievement, but not to temperament variables.

3. Experiences with former mathematics teachers are somewhat related to present mathematics attitudes.[15]

---

[14] Ibid., p. 23.

[15] Ibid., p. 23.

A study by Billig[16] employed much the same procedure as that used by Dutton. Essays were written by tenth-grade girls in a course in commercial arithmetic, expressing their feelings about arithmetic. From these essays, a series of statements was drawn. This study differed from Dutton's studies, in that the statements were sorted into three piles and then sorted again into three piles according to the average grade of the author of the statement. Billig next constructed a 16-item Likert-type scale from these statements. This scale was then used as a diagnostic device to predict, at the beginning of the year, the students who would do well and those who would do poorly in the course.

Bendig and Hughs[17] devised a booklet of 30 negative statements about statistics and mathematics and presented them to 71 subjects to be rated on a 5-point scale according to how well the statement reflected the respondent's feelings toward a course in introductory statistics. They then correlated the students' attitude scores with their scores on the Kuder Preference Record and with such variables as major subject, sex, amount

---

[16] Albert A. Billig, "Student Attitude as a Factor in the Mastery of Commercial Arithmetic," The Mathematics Teacher, XXXVII (April, 1944), 170-172.

[17] A. W. Bendig and J. B. Hughs, "Student Attitude and Achievement in a Course in Introductory Statistics," Journal of Educational Psychology, XCV (May, 1954), 268-275.

of high school mathematics, amount of college mathematics, and class. Five variables were selected as the best predictors of student attitudes: The Kuder Computational Scale, the Kuder Persuasive Scale, amount of high school mathematics, amount of college mathematics, and number of psychology courses. The interpretation was that the greater the familiarity with mathematics, the less the possibility of fear and a negative attitude toward a statistics course.[18]

Stright conducted a study of the attitudes toward arithmetic of students and teachers in the third, fourth, and sixth grades. The purpose of the project was to study the attitudes of teachers and children, to note changes in attitudes of children from third to fourth to sixth grade, to note trends in attitudes of both children and teacher, and to compare the attitudes of boys and girls toward arithmetic.

Stright's data led her to conclude that a large percentage of elementary teachers really enjoy teaching arithmetic and use many devices to make it interesting. She also proposes that variables such as the teacher's educational background, recent training, age, or years of experience make no significant difference in his attitude toward the teaching of arithmetic, nor the attitude of the children in the group.[19]

---

[18]Ibid., p. 274.

[19]Stright, p. 286.

Although a survey of the literature indicates no studies related to teacher attitudes and modern mathematics programs, Phelps conducted an investigation in which he compared attitudes toward mathematics of SMSG and traditional elementary school students. The primary hypothesis to be tested was that there is no significant difference in attitude toward mathematics between SMSG and traditional students. Based on analyses of variances, this hypothesis was rejected at the .05 level of confidence for fifth grade students; however, the hypothesis was not rejected for eighth grade students. The investigator also concluded that the SMSG materials can be presented to average students without causing apparent negative attitudes on the student's part.[20]

In 1959, Leissa and Fisher[21] conducted a survey of 280 high school mathematics teachers and college instructors in mathematics who attended the Third Annual Symposium on Engineering Mathematics held at Ohio State University. Each person was asked to fill out a questionnaire which contained 15 questions formulated directly from statements made in the Final Report of the Commission on Mathematics of the College

---

[20] Phelps, p. 67.

[21] Arthur W. Leissa and Robert C. Fisher, "A Survey of Teachers' Opinions of a Revised Mathematics Curriculum," The Mathematics Teacher, LIII (February, 1960), 113-118.

Entrance Examination Board. The response of each individual was then taken as an indication of the degree of acceptance of the Report.

The responses to the questionnaire indicated clearly that the teachers overwhelmingly supported the major part of the Commission's Report which presented suggestions for revising and improving the four-year curriculum in mathematics as taught in the high schools. These suggestions included the incorporation of many techniques and concepts which we now think of as being common to modern programs.

In general, the high school teachers and the college teachers agreed; however, there was an indication that the college teacher is less likely than is the high school teacher to feel that the content of the traditional high school curriculum needs to be revised extensively.[22]

One of the major goals of the present study was to determine if there is a significant difference between attitudes toward modern mathematics programs of elementary teachers who have received formal instruction in modern materials and elementary teachers who have received no such instruction. Since other factors were held as nearly constant as possible, it was assumed that any significant difference in attitudes may be

---

[22] Ibid., p. 118.

associated with the formal instruction factor. The literature indicates that many educators disagree upon this point. Openshaw[23] feels that it is important to recognize that formalized instruction has little direct influence on attitude change and that older attitude patterns are not altered appreciably by presenting new facts and information to teachers. He writes, "Enrichment or diversification of the interests of the teacher affords the greatest potential for changing attitudes. Therefore, programs of teacher improvement must become much more individual-oriented."[24] He then enlarges upon this statement by describing how each teacher must have the opportunity to help set his goals and plan the activities in which he is to participate.

In reporting a program of in-service instruction, Wright says, "We've learned that attitudes can change while knowledge is being acquired."[25] She then describes how the administration of the Bucks County Public Schools, Pennsylvania, recognized the fact that teachers cannot teach new concepts with old attitudes, and set out to gradually modify and change the traditional attitudes about mathematics through a program

---

[23]Karl Openshaw, "Attitudes for Growth," Educational Leadership, XX (November, 1962), 90-92.

[24]Ibid., p. 91.

[25]Betty Atwell Wright, "Anatomy of Change in Elementary Mathematics," The Arithmetic Teacher, X (March, 1963), 159.

which was carried out during the 1961-62 school year. Over 200 volunteers registered for a county workshop for in-service teachers. A mid-year evaluation was arranged in which teachers were given the opportunity to give their frank opinions anonymously. The information was tabulated and analyzed objectively so that apparent weaknesses could be corrected. At the same time more than 4000 elementary pupils tried out the new method and materials. Wright summarizes the whole experience as serving to demonstrate how experienced teachers on the job can be helped to put contemporary concepts and content into effect.[26]

Summary

Attitude scales have been developed and used as measuring instruments in many studies. One of the leaders in the area relating to attitudes and mathematics is Dutton, who developed the Dutton Attitude Scale. This scale has been used by him in several investigations and also by numerous other researchers. The methods used by Dutton illustrate effective techniques of devising attitude scales.

Some of the more important findings which have arisen out of Dutton's studies are the following: (1) Techniques for measuring attitudes can successfully be applied to subjects

---

[26] Ibid., pp. 158-161.

taught in the elementary school; (2) The most crucial spots for attitude development toward mathematics are in grades 3 through 6; (3) There is need for additional research to evaluate attitudes of students coming from schools teaching modern programs.

Although Dutton used techniques developed by Thurstone, the Likert technique for scale development was used with good results in studies conducted by Aiken and Dreger, and Billig. These studies were related to student attitudes toward mathematics.

On the basis of data obtained in a study of teacher attitudes, Stright concludes that educational background, age, or years of experience make no significant difference in the teacher's attitude toward the teaching of arithmetic.

Concerning the proposition that formalized instruction can influence attitudes, Openshaw believes that there is no direct influence of formalized instruction upon attitude change. Wright maintains that attitudes can be changed by such means as in-service workshops, and that traditional attitudes must be modified and changed if our teachers are going to teach contemporary materials.

CHAPTER III

CONSTRUCTION OF THE MEASURING INSTRUMENT

One of the major problems of this study concerned the construction of an instrument of measurement which would yield data compatible with the purposes and objectives of the study. Since the investigation revolved around the collection and measurement of attitudes of groups of people toward a psychological object, an attitude scale was chosen as the instrument of measurement. The best-developed methods of measuring attitudes are those which involve the listing of opinions and which then require the individual to check those which he endorses. Such lists of opinions, when they are methodically prepared, are referred to as attitude scales. They have proved to be useful in a variety of research problems.

Studies designed to collect evidence of attitude change have been conducted by numerous investigators. Many of these were related to arithmetic and mathematics and used attitude scales as measuring instruments. However, the writer could find no available scale suitable for measuring the attitudes of the individuals in which he was interested and therefore found it necessary to design and construct such a scale.

Description of the Attitude Scale

A well-constructed attitude scale consists of a number of items that have been carefully edited and selected in accordance with certain criteria. The criteria used in the present study were those suggested by Edwards as follows:

1. Avoid statements that refer to the past rather than to the present.
2. Avoid statements that are factual or capable of being interpreted as factual.
3. Avoid statements that may be interpreted in more than one way.
4. Avoid statements that are irrelevant to the psychological object under consideration.
5. Avoid statements that are likely to be endorsed by almost everyone or by almost no one.
6. Keep the language of the statements simple, clear, and direct.
7. Statements should be short, rarely exceeding 20 words.
8. Each statement should contain only one complete thought.
9. Avoid the use of words that may not be understood by those who are to be given the completed scale.
10. Avoid the use of double negatives.[1]

The items making up an attitude scale are called statements. A statement may be defined as anything that is said about a psychological object. The class of all possible statements that

---

[1]Edwards, pp. 13-14.

could be made about a given psychological object is called a universe.

Method and Procedure

The first step in the construction of an attitude scale is to obtain items that will represent the particular universe of interest. The instrument of this study was actually composed of two scales treated as an entity. One scale measured attitudes of elementary teachers toward modern mathematics programs, while the other measured attitudes of elementary teachers toward mathematics. The first scale shall be designated as Part A and the second shall be Part B.

There are various methods of compiling lists of statements from which to choose items for the final scale. The writer was able to formulate many statements himself. Additional items for Part A were selected from articles appearing in periodicals such as The Arithmetic Teacher, The Mathematics Teacher, NEA Journal, and Educational Leadership. The majority of these articles concerned modern mathematics programs in the elementary school and many were written by elementary teachers or persons who are closely associated with elementary school mathematics. Additional items for Part B were patterned after items appearing in a scale constructed by Stright[2] for a study of

---

[2] Stright, pp. 280-285.

attitudes toward arithmetic of students and teachers in the third, fourth, and sixth grades. In phrasing the statements, an attempt was made to state the essential idea in a conversational or informal manner rather than in the language of formal discourse.

During the compiling of the initial list of statements much effort was made to include statements built around features which characterize the various modern mathematics programs. Although minor differences seem large to partisans of each project, their common goals are much more important. Rosenbloom believes that they have the following in common.

1. Giving the student a coherent structure which will make it easier to learn new things and remember the old.

2. Placing emphasis on reasoning, beginning rather informally in elementary and junior high school, and leading to formal proof in algebra and geometry.

3. Presenting mathematics as a creative art, rather than as a finished product, by giving students experience in discovery.

4. Unifying subjects such as arithmetic, algebra, and geometry, which are traditionally taught separately.

5. Clarifying the language of school mathematics, which is sloppy and confused in the conventional curriculum.[3]

Several statements for Part A were phrased in terms of the above-listed features of the modern programs. Some of these were not retained as a part of the final scale, however, as item analysis procedures showed them to be nondifferentiating.

---

[3]Rosenbloom, pp. 359-363.

There was also a second factor which prevented the use of a large number of statements stated in terms of vocabulary peculiar to the modern programs. This factor was a criterion proposed by Edwards[4] which suggests that statements which are factual or capable of being interpreted as factual should be avoided.

In making the initial list of statements, Thurstone[5] suggests that 80 to 100 statements should be used. In the construction of this scale, 80 items were obtained in the manner described above and classified into four separate classes. There were 25 statements favorable to modern mathematics programs, 37 statements unfavorable to modern programs, 9 statements favorable to mathematics and 9 statements unfavorable to mathematics. It should be noted that approximately half of the statements were favorable while the other half were unfavorable. These were then distributed throughout the list in a random manner. The advantage of having both kinds of statements represented is to minimize possible response sets of subjects that might be generated if only favorable or unfavorable statements were included in the scale.

The preliminary form was then given to a group of subjects who were asked to respond to each one in terms of

---

[4]Edwards, p. 13.

[5]L. L. Thurstone, <u>The Measurement of Values</u> (Chicago, 1959), p. 226.

their own agreement or disagreement with the statements. The subjects were permitted to use any one of five categories: strongly agree, agree, undecided, disagree, or strongly disagree. The group consisted of students who were enrolled in classes for elementary school teachers during the 1963 summer session at Oklahoma State University. This group included both graduates and undergraduates, some with much teaching experience and others with none. These students also had varied backgrounds with respect to the amount of formal training which they had received in modern mathematics materials. Many had received no such training while some had earned as much as nine credit hours. This group appears to be fairly similar to the population from which the samples for the study were chosen.

Method of Scale Development

Once a set of attitude statements has been collected, there are two "classical" scaling techniques that have been extensively used in the development of attitude scales since the early 1930's--the method of equal-appearing intervals, associated with the name of L. L. Thurstone, and the method of summated ratings, due to Rensis Likert. While the Thurstone scaling procedures give absolute meaning to scale units, and therefore to an individual score achieved on an attitude instrument constructed by these procedures, no such situation exists with the Likert technique. In the latter case, an individual score can only be interpreted by reference to a set of norms for given populations. Since the central problem of this particular study involves group attitudes rather than individual attitudes, the Likert technique seemed more suitable and hence was chosen. This technique is based upon direct responses of agreement or disagreement with attitude statements. Since the response methods do not require prior knowledge of the scale values of the statements, the judging group used in the Thurstone techniques is not necessary. Studies have shown that results obtained with the Likert-type scale, as far as reliability and validity are concerned, are quite comparable to those obtained by Thurstone.[6]

The Likert system requires the development of a method of scoring. For favorable statements, the strongly agree response is given a weight of 4, the agree response a weight of 3, the undecided response a weight of 2, the disagreement response a weight of 1, and the strongly disagree response a weight of 0. For unfavorable statements, the scoring system is reversed, with the strongly disagree response being given the 4 weight and the strongly agree response the 0 weight. For each subject a total score is obtained by summating his scores for the

---

[6] H. H. Remmers, N. L. Gage, and J. Francis Rummel, <u>A Practical Introduction to Measurement and Evaluation</u> (New York, 1960), p. 296.

individual items. Because each response to a statement may be considered a rating and because these are summated over all statements, Bird[7] called the Likert method of scale construction the method of summated ratings. This term has come into rather general use.

Each subject in the pilot group who responded to the list of statements was given two total scores; one based on responses to the 18 statements concerning mathematics and one based on responses to the 62 statements concerning modern mathematics programs. Each of these scores was obtained by the previously described scoring system.

Selection of the Items

As a basis for the selection of items to be retained in the final scale there are several forms of item analysis which may be used. Two methods of item analysis were used in the selection of items for the attitude scale of this study. The frequency distribution of scores based upon the responses to all statements concerning modern mathematics programs was first considered. Then the 33 subjects with the highest total scores were placed in one group and the 33 subjects with the lowest total scores were placed in a second group. These two groups were assumed to provide criterion groups in terms of which to

---

[7]Charles Bird, Social Psychology (New York, 1940), p. 159.

evaluate the individual statements.

In the method of summated ratings, it is desirable to find a set of statements that will differentiate between the high and low groups. Murphy and Likert[8] found that the rank ordering of statements upon the basis of the magnitude of the difference between the mean responses of a high and low group agreed very well with the ordering of the same statements according to other methods of item analysis. They considered this method of item analysis an application of the criterion of internal consistency. Since this procedure is relatively simple and convenient, it was used as one method of obtaining a rank ordering of the 62 statements concerning modern mathematics programs.

In using the criterion of internal consistency it is necessary to compute the mean score on each individual item for the high and low groups. The difference in the mean scores of the two groups is found for each item and then the items are ranked according to the magnitude of this difference. The rankings indicated by the criterion of internal consistency appear in Table I.

The second form of item analysis used was one suggested by Edwards.[9] The same two criterion groups were used and the responses of the groups to the individual statements were

---

[8]Gardner Murphy and Rensis Likert, Public Opinion and the Individual (New York, 1938), pp. 281-291.

[9]Edwards, pp. 152-155.

evaluated by finding the following ratio for each item:

$$t = \frac{\overline{X}_h - \overline{X}_l}{\sqrt{\dfrac{\sum(X_h - \overline{X}_h)^2 + \sum(X_l - \overline{X}_l)^2}{n(n-1)}}}$$

where $\overline{X}_h$ = the mean score on a given statement for the high group

$\overline{X}_l$ = the mean score on the same statement for the low group

$$\sum(X_h - \overline{X}_h)^2 = \sum X_h^2 - \frac{(\sum X_h)^2}{n}$$

$$\sum(X_l - \overline{X}_l)^2 = \sum X_l^2 - \frac{(\sum X_l)^2}{n}$$

n = the number of subjects in the high group

n = the number of subjects in the low group

The value of t is a measure of the extent to which a given statement differentiates between the high and low groups. As a crude and approximate rule of thumb, any t value equal to or greater than 1.75 indicates that the average response of the high and low groups to a statement differs significantly, provided there are 25 or more subjects in the high group and also in the low group.[10] The t values for 29 of the 30 statements about modern mathematics programs which were retained for the final scale ranged from a high of 6.68 to a low of 2.82. This caused the investigator to believe that the retained statements could all be

[10] Ibid., p. 153.

classified as significantly differentiating.

One item was included in the final list which did not appear in the initial list, consequently it had no corresponding t value. Although the writer had used various and extensive methods of securing statements for the initial list, he was aware that this list could not be considered complete. For this reason the subjects to whom the initial lists were administered were given the opportunity to express comments which might serve as bases for additional statements to be included in the final scale. One comment was mentioned often enough that it was used as a statement for the final scale. This was item 28.

The primary criterion for retaining an item in the final scale for Part A was the t value rank of the item. Edwards[11] suggests that it is doubtful whether the two methods of item analysis will result in orderings which are essentially different. However, there were four items which were used in the final scale that would not have been used if mean difference rank had been the primary criterion.

As Table I indicates, there were six items which were not used, although their t value ranks were higher than the ranks of other items which were used. There were various reasons for this. Item 78 was not included because it was too factual. Item 76 was not stated clearly. Item 46 was not included because

---

[11] Ibid., p. 155.

there was some doubt as to whether it was a favorable or unfavorable statement. For purposes of checking consistency, several pairs of similar statements were included, one stated favorably and the other stated unfavorably. However, it did not seem necessary to have a large number of such pairs. Consequently, items 7 and 72 were not used.

TABLE I

COMPARISON OF ITEM RANKINGS FOR PART A INDICATED BY TWO FORMS OF ITEM ANALYSIS

Item Number Pilot	(Final)	t Score	t Rank	Mean Diff. Rank	Mean Difference
74	(27)**	6.68	1	6	.94
58	(11)	5.94	2	1	1.21
26	(1)	5.84	3	5	.97
23	(3)**	5.75	4	2	1.15
66	(30)	5.66	5	3	1.06
22	(40)	5.30	6	10	.80
69	(12)	5.28	7	34	.55
24	(42)**	5.27	8	4	1.00
60	(44)**	4.63	9	12	.79
16	(5)	4.47	10	15	.76
19	(4)	4.45	11	11	.79
63	(17)**	4.33	12	27	.61
47	(24)**	4.22	13	19	.70
52	(7)**	4.16	14	9	.82
72*	-- **	4.06	15	16	.73
43	(8)**	4.03	16	7	.88
5	(33)**	4.01	17	17	.73
6	(20)**	3.80	18	14	.76
17	(21)	3.73	19	25	.61
64	(26)	3.68	20	21	.67

*Not used in final scale

**Unfavorable statement

TABLE I (CONTINUED)

Item Number Pilot	(Final)	t Score	t Rank	Mean Diff. Rank	Mean Difference
37	(36)**	3.63	21	13	.78
56	(25)	3.43	22	41	.46
27	(22)**	3.39	23	23	.66
32	(19)**	3.35	24	26	.61
78*	-- **	3.27	25	31	.58
55	(16)**	3.25	26	36	.54
2	(31)	3.25	27	38	.51
73	(14)	3.12	28	39	.49
15	(34)**	3.07	29	8	.85
46*	-- **	3.07	30	20	.67
76*	-- **	3.06	31	37	.52
44	(9)	3.02	32	30	.58
7*	--	2.92	33	18	.72
67*	-- **	2.90	34	28	.60
11	(29)	2.82	35	43	.46
39*	--	2.79	36	33	.58
42*	--	2.69	37	35	.55
71*	--	2.68	38	53	.34
33*	--	2.64	39	42	.46
1*	--	2.51	40	24	.63
14*	--	2.50	41	22	.67
40*	--	2.46	42	32	.58
41*	--	2.26	43	37	.51
8*	--	2.15	44	44	.45
61*	--	2.09	45	47	.38
29*	--	2.05	46	52	.34
12*	--	1.96	47	46	.43
3*	--	1.92	48	40	.48
38*	--	1.72	49	45	.45
65*	--	1.66	50	51	.35
48*	--	1.62	51	54	.30
53*	--	1.61	52	50	.35
50*	--	1.59	53	49	.36
35*	--	1.53	54	48	.37
79*	--	1.23	55	56	.24
49*	--	1.22	56	55	.25
31*	--	1.13	57	57	.18
20*	--	.94	58	58	.18

*Not used in final scale

**Unfavorable statement

TABLE I (CONTINUED)

Item Number Pilot	(Final)	t Score	t Rank	Mean Diff. Rank	Mean Difference
57*	--	.74	59	59	.16
36*	--	.71	60	60	.16
80*	--	.53	61	61	.12
4*	--	.32	62	62	.06

*Not used in final scale

As a basis for the selection of items to be retained in Part B of the final scale, the same two forms of item analysis were used. The frequency distribution of scores based upon the responses to all statements concerning mathematics was considered. Next the 33 subjects with the highest total scores were placed in one group and the 33 subjects with the lowest total scores were placed in a second group. As would be expected, these two groups provided criterion groups which were essentially different to the two criterion groups used for the selection of items in Part A.

A total of fifteen items was retained for Part B. As Table II indicates, both forms of item analysis yielded very similar rankings, therefore those items with the highest rank were retained for the scale. All of the retained items except item 30 had t values greater than 1.75. Item 30 was retained for the sake of symmetry.

TABLE II

COMPARISON OF ITEM RANKINGS FOR PART B INDICATED BY TWO FORMS OF ITEM ANALYSIS

Item Number Pilot	(Final)	t Score	t Rank	Mean Diff. Rank	Mean Difference
75	(15)**	5.14	1	4	.91
13	(39)	5.07	2	3	.94
54	(18)**	5.02	3	1	1.07
28	(6)**	4.67	4	2	1.07
21	(41)**	3.92	5	7	.64
51	(10)**	3.62	6	5	.85
34	(23)**	3.62	7	6	.82
25	(35)	3.50	8	8	.60
77	(43)**	3.43	9	11	.46
45	(37)**	3.24	10	10	.48
10	(32)**	3.31	11	9	.55
70	(13)	2.45	12	13	.40
68	(38)	2.06	13	12	.42
62	(45)	1.94	14	14	.33
30	(2)	.75	15	15	.12
9*	--	.39	16	17	.06
18*	--	.34	17	16	.09
59*	--	.20	18	18	.03

*Not used in final scale

**Unfavorable Statement

Observation of Table II raised the question whether unfavorable statements in Part B discriminate better than do favorable statements. Nine of the eleven statements having the highest discriminative values are unfavorable. In connection with this question, the following hypotheses were tested by means of the Mann-Whitney U Test.

Hypothesis 1. Based upon mean difference ranking, unfavorable statements in Part B are more discriminating than favorable statements.

Hypothesis 2. Based upon t value ranking, unfavorable statements in Part B are more discriminating than favorable statements.

Hypothesis 3. Based upon mean difference ranking, unfavorable statements in Part A are more discriminating than favorable statements.

Hypothesis 4. Based upon t value ranking, unfavorable statements in Part A are more discriminating than favorable statements.

TABLE III

RESULTS OF TESTS OF HYPOTHESES 1, 2, 3, 4
BY MEANS OF MANN-WHITNEY TEST

		Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Level	$\alpha = .05$	Do not reject	Do not reject	reject	reject
	$\alpha = .01$	reject	reject	reject	reject

Observation of the Mann-Whitney Test results listed in Table III indicates that at the .05 significance level there is insufficient evidence to cause hypothesis 1 and hypothesis 2 to be rejected.

Thus it appears that unfavorable statements in Part B are more discriminating than are favorable statements. There appears to be no significant difference in the discriminating power of unfavorable statements and the discriminating power of favorable statements on Part A of the instrument.

Summary

The instrument used in this investigation had two parts. Part I consisted of ten questions designed for the purpose of obtaining general information. The answers to these questions were used to classify the respondents according to age, teaching level, teaching experience, training, and sex.

Part II contained the attitude scale which has been discussed. For the final scale, 45 items were selected by the procedure previously described. Part A consisted of 30 items while Part B consisted of 15 items. As with the preliminary scale, approximately half of the statements were favorable while the other half were unfavorable. Items of both parts were distributed throughout the list in a random manner. A copy of the final form appears in Appendix A.

CHAPTER IV

METHODS AND PROCEDURES

The primary purpose of the study is to investigate the attitudes of a selected group of elementary teachers toward modern mathematics programs. The purpose of this particular chapter is to describe the subjects of the study, to discuss the methods of data collection, and to outline the statistical procedures employed.

Collection of the Data

Data for the study were obtained through the use of the instrument which has been discussed in the previous chapter. This instrument was administered to elementary school teachers in various school systems over the geographical area within a distance of 120 miles from Oklahoma State University.

Contact with the respondents of the study was established by the writer in several ways. In some cases arrangements were made with the school principal which permitted the writer to administer the instrument personally to the teachers in the school at some convenient time when they were gathered in a group. In other cases the principal or some other responsible person administered the instrument and then placed the results in the hands of the writer.

The data for teachers who were receiving instruction in modern mathematics materials at the time of the study were obtained through the cooperation of the staff assistants of the Oklahoma State University Mathematics Department who were teaching extension classes in Mathematics 253 during the fall semester of 1963. Responses were procured from each teacher during the first or second meeting of the class. Most of these people had no previous experience with modern mathematics materials; however, there were several who had taken previous training in modern materials. Therefore their responses were included in separate categories.

In the administration of the instrument many precautions were taken to secure honest responses. Particular emphasis was laid upon the fact that it was not necessary for the respondent to sign his name. Because names were not requested there was no pressure for approval or disapproval on certain items.

Responses were obtained from teachers of 58 different schools in 24 different school systems. In addition, responses were obtained from teachers at the eight instruction centers. The distribution of respondents by school system and instruction center appears in Appendix B. The number of responses corresponding with each instruction center will include both teachers from the instruction center school system and teachers from schools in the area surrounding the instruction center. No distinction is made between the two.

A total of 608 returns of the instrument was received by the writer; however, only 400 of these were used for the study. The remaining 208 were not used for various reasons. For example, there were 80 blanks which were so incomplete that they could not be used. Some of these were due to oversights on the part of the respondent, while others seemed deliberate. There were 27 respondents who had taught in modern programs but had no formal instruction in modern materials and hence belonged to no group included in the study. There were 49 respondents who were teaching at the junior high or high school level and since the study was limited exclusively to elementary teachers, these were not included. The 400 respondents of the study were then randomly chosen from the remaining 452 usable responses, with 100 respondents in each group. Thus, only 52 respondents were excluded from the study by the randomizing procedure employed.

Each of the 400 blanks was then scored according to the scoring procedure outlined in the previous chapter. Each subject who responded to the instrument was given two total scores; one based on responses to the statements concerning modern mathematics programs (Part A) and one based on responses to the statements concerning mathematics (Part B). These scores along with the personal information obtained from

Part I of the instrument made up the data of the study.

Subjects of the Study

For the purposes of statistical analysis the respondents of the study were classified in the following manner:

Group A. Elementary teachers who have received formal instruction in the use of modern mathematics materials, but have not taught in a modern mathematics program.

Group B. Elementary teachers who have received formal instruction in the use of modern mathematics materials and who have taught in a modern mathematics program.

Group C. Elementary teachers who were enrolled in the 1963-64 extension classes in Mathematics 253. These teachers have had no previous formal instruction in modern mathematics materials.

Group D. Elementary teachers who have had no formal instruction in modern mathematics materials and who were not enrolled in any such program at the time of the study.

Under the sampling procedure used, it was assumed that a large number of the respondents in Group A and Group B received training in the 1961-62 or the 1962-63 extension classes in Mathematics 253 offered by Oklahoma State University. Mathematics 253 is an undergraduate course designed to give the elementary teacher the foundations of arithmetic from a modern viewpoint.

Although the information in the following tables will be treated statistically in the following chapter, a tabular representation is presented here in order to give a general description of the subjects of the study. Most of the tables are clear and need no elaboration, but some deserve special comment.

Table IV gives the distribution of all respondents by age and experience. It shows that the greatest number of respondents are in the 51 to 60 age bracket and have 16 to 25 years of teaching experience. This pattern also appears in the distribution of respondents in Group A as presented by Table V. Table VI and Table VII also show that the greatest number of respondents in both Group B and Group C have 16 to 25 years of teaching experience, but the greatest number of respondents in these two groups are in the 41 to 50 age bracket. Table VIII shows the greatest number of respondents in Group D to have more than 25 years teaching experience. There is also an unusually large number of teachers in Group D who are over 60 years old.

TABLE IV

DISTRIBUTION OF ALL RESPONDENTS BY AGE AND EXPERIENCE

		Experience (in years)					
		1-3	4-8	9-15	16-25	25+	Totals
	21-30	49	12	2	0	0	63
	31-40	13	22	18	9	0	62
Age	41-50	3	11	45	48	5	112
	51-60	0	5	14	53	69	141
	60+	0	0	1	3	18	22
	Totals	65	50	80	113	92	400

TABLE V

DISTRIBUTION OF RESPONDENTS IN GROUP A BY AGE AND EXPERIENCE

		Experience (in years)					
		1-3	4-8	9-15	16-25	25+	Totals
	21-30	17	1	0	0	0	18
	31-40	4	11	3	3	0	21
Age	41-50	0	6	10	9	2	27
	51-60	0	2	6	12	11	31
	60+	0	0	0	1	2	3
	Totals	21	20	19	25	15	100

TABLE VI

DISTRIBUTION OF RESPONDENTS IN GROUP B BY AGE AND EXPERIENCE

		Experience (in years)					
		1-3	4-8	9-15	16-25	25+	Totals
	21-30	11	3	1	0	0	15
	31-40	6	3	6	3	0	18
Age	41-50	1	2	14	16	1	34
	51-60	0	2	4	10	15	31
	60+	0	0	0	1	1	2
	Totals	18	10	25	30	17	100

TABLE VII

DISTRIBUTION OF RESPONDENTS IN GROUP C BY AGE AND EXPERIENCE

		Experience (in years)					
		1-3	4-8	9-15	16-25	25+	Totals
	21-30	9	5	1	0	0	15
	31-40	3	4	7	2	0	16
Age	41-50	0	2	16	17	1	36
	51-60	0	1	1	11	16	29
	60+	0	0	1	0	3	4
	Totals	12	12	26	30	20	100

TABLE VIII

DISTRIBUTION OF RESPONDENTS IN GROUP D BY AGE AND EXPERIENCE

		Experience (in years)					
		1-3	4-8	9-15	16-25	25+	Totals
	21-30	12	3	0	0	0	15
	31-40	0	4	2	1	0	7
Age	41-50	2	1	5	6	1	15
	51-60	0	0	3	20	27	50
	60+	0	0	0	1	12	13
	Totals	14	8	10	28	40	100

In comparing the preceding tables, we see that the respondents in Group D are older and have more teaching experience than respondents in the other three groups. Remembering that Group D consists of teachers who have had no formal instruction in modern materials and have indicated no desire for such instruction, it seems that those teachers who are prepared or are being prepared to teach in modern mathematics programs are those who are younger and less experienced.

Table IX presents the distribution of all respondents by sex and level of training. Female teachers outnumber male teachers by a ratio of seven to one. The table also indicates that the male teacher is more likely than the female teacher to extend his level of training past the traditional four years.

TABLE IX

DISTRIBUTION OF ALL RESPONDENTS BY SEX AND LEVEL OF TRAINING

		Level of Training (in years)					
		2 or less	3	4	5	5+	Totals
Sex	Male	1	1	16	16	17	51
	Female	4	5	198	87	55	349
	Totals	5	6	214	103	72	400

Tables X, XI, XII, and XIII show the distribution by sex and level of training of each of the four groups of the study.

TABLE X

DISTRIBUTION OF RESPONDENTS IN GROUP A BY SEX AND LEVEL OF TRAINING

		Level of Training (in years)					
		2 or less	3	4	5	5+	Totals
Sex	Male	0	0	6	4	7	17
	Female	1	1	50	21	10	83
	Totals	1	1	56	25	17	100

TABLE XI

DISTRIBUTION OF RESPONDENTS IN GROUP B BY SEX AND LEVEL OF TRAINING

		Level of Training (in years)					
		2 or less	3	4	5	5+	Totals
Sex	Male	0	1	4	2	5	12
	Female	2	0	35	29	22	88
	Totals	2	1	39	31	27	100

TABLE XII

DISTRIBUTION OF RESPONDENTS IN GROUP C
BY SEX AND LEVEL OF TRAINING

		Level of Training (in years)					
		2 or less	3	4	5	5+	Totals
Sex	Male	0	0	2	7	4	13
	Female	0	3	57	17	10	87
	Totals	0	3	59	24	14	100

TABLE XIII

DISTRIBUTION OF RESPONDENTS IN GROUP D
BY SEX AND LEVEL OF TRAINING

		Level of Training (in years)					
		2 or less	3	4	5	5+	Totals
Sex	Male	1	0	4	3	1	9
	Female	1	1	56	20	13	91
	Totals	2	1	60	23	14	100

Statistical Procedures

With each respondent of the study there are associated two numerical scores; one based upon responses to the statements concerning modern mathematics programs, and one based upon responses to the statements concerning mathematics. For the purposes of the statistical analysis it was assumed that these attitude scores were from a normally distributed population. This assumption is supported by Garrett and Likert.

Garrett says:

> It is possible to express many kinds of qualitative data in quantitative terms, if we can assume that measures of the trait or ability which we have sampled are normally distributed in the population. Answers to statements in most questionnaires admit of several possible replies. It is often desirable to "weight" these different alternatives in accordance with the degree of divergence from the "typical answer" which they indicate. First we assume that the attitude expressed in answering a given proposition is normally distributed.[1]

Likert's Internationalism Scale furnishes an example of a technique which is based upon the assumption of a normal distribution in the population. His modification of the Thurstone method makes the assumption that attitudes are distributed normally, and on this assumption he measured attitudes using standard deviation units.[2]

It is also desirable to be assured on the basis of a statistical test that such an assumption is reasonable. For this purpose the chi-square "goodness of fit" test was used. The results of this test will be presented in the following chapter.

In addition to the assumption of normal distribution, two further assumptions were made. First, it was assumed that the respondents within each category or group were random samples. If this condition is not approximated, the effectiveness

---

[1]Henry E. Garrett, Statistics in Psychology and Education (New York, 1953), pp. 318-319.

[2]H. H. Remmers, Introduction to Opinion and Attitude Measurement (New York, 1954), p. 9.

of classification with respect to formal instruction in modern materials cannot be tested accurately. There is no statistical test which will serve as a basis for this assumption; rather, it must be justified through careful data-collection procedures. The other assumption was that the populations from which the different samples were drawn have the same variances. This assumption will be supported by the use of a computed F ratio for testing homogeneity of variances.

Once it has been established that the previous assumptions are reasonable, we may employ a statistical technique known as analysis of variance with single classification. This technique has been designed to provide an efficient test of the difference between two or more groups simultaneously and consists of contrasting the variance of individual values around the group means within equal-sized groups with the variance of the group means around the general mean of the ungrouped data. In using the single classification analysis of variance, the variance of the population from which the samples are drawn is estimated in two different ways. The first estimate is the within-groups variance estimate. These estimates are then compared in the form of an F ratio to see whether they could reasonably be considered two estimates of the same variance. If they cannot, we reject the null hypothesis that the samples were drawn from the same population.

Since the F distribution is derived on the assumption of homogeneous variances and normal distributions in the populations from which the samples were drawn, these assumptions must be fulfilled before the use of the F ratio is appropriate.[3]

The use of equal numbers of responses in the groups being compared is recommended by Wert, Neidt, and Ahmann.[4] The use of unequal numbers of responses makes the computational procedures more difficult.

The single classification analysis of variance technique was used in testing all hypotheses concerning differences between attitudes toward mathematics and modern mathematics programs of the various groups and combinations of the various groups.

When every individual in a group can be classified simultaneously on two scales, the results may be described by the use of a bivariate frequency distribution. Several such frequency distributions were obtained and used with contingency tables and chi-square to test hypotheses concerning the independence of such factors as attitude and age, attitude and experience, and attitude and level of training.

Summary

Data were collected over an area within a distance of 120 miles from Oklahoma State University. The data consisted of 608 responses from elementary teachers in 58 schools in

---

[3]Wert, p. 184.

[4]Ibid., p. 177.

24 different school systems. These included responses obtained from teachers who were enrolled at the eight instruction centers where extension classes in Mathematics 253 were offered by Oklahoma State University. After removing responses which could not be used for various reasons, the investigator had 452 usable responses from which to randomly select the 400 which were used in the study.

For the statistical treatment of the data, the technique of single classification analysis of variance was used. The chi-square statistic and contingency tables were also used to test independence of various classifications.

CHAPTER V

RESULTS OF THE STUDY

The purpose of this chapter is to present a statistical analysis of the data of the study. It will include a presentation of statistical evidence in support of the assumptions which are necessary in order for the analysis of variance technique to be appropriate. Analysis of variance will then be used to test the primary hypotheses of the study. Contingency tables and chi-square will also be used to test additional secondary hypotheses. A discussion of the correlation of responses will be included along with some observations concerning responses to individual items of the instrument of the study.

Validation of Assumptions

At this point, several pertinent statistics will be presented in tabular form for comparison purposes. These will be treated statistically later in the chapter. Therefore, no interpretation will be given here.

TABLE XIV

GROUP ATTITUDES TOWARD MODERN MATHEMATICS PROGRAMS

Group	Mean	Variance	Standard Deviation
A	81.09	163.50	12.79
B	87.94	199.69	14.13
C	70.99	115.53	10.75
D	66.73	162.08	12.73
A+B	84.52	192.47	13.87
C+D	68.86	142.66	11.94

TABLE XV

GROUP ATTITUDES TOWARD MATHEMATICS

Group	Mean	Variance	Standard Deviation
A	47.66	33.72	5.81
B	47.92	39.57	6.29
C	45.56	32.06	5.66
D	45.10	33.20	5.76
A+B	47.79	36.48	6.04
C+D	45.33	32.52	5.70

The chi-square "goodness of fit" test was used to determine how well the frequency distributions of each group fit the normal distribution. This test requires the computation of expected frequencies for each distribution in terms of the mean and standard deviation of the distribution. The expected frequencies and the observed frequencies are then used to obtain a computed chi-square. The observed frequency distributions for each group appear in Appendix C. The computed chi-square is compared with a tabulated value to determine whether the observed frequency fits the normal distribution. Tables XVI and XVII show these results.

TABLE XVI

CHI-SQUARE TEST TO DETERMINE WHETHER ATTITUDES TOWARD MODERN MATHEMATICS PROGRAMS FIT THE NORMAL DISTRIBUTION

Group	Computed Chi-Square	Degrees of Freedom	Level	Tabulated Chi-Square
A	3.34	7	.05	14.07
B	7.18	7	.05	14.07
C	8.48	6	.05	12.59
D	9.72	5	.05	11.07
A+B	3.19	7	.05	14.07
C+D	9.49	6	.05	12.59

TABLE XVII

CHI-SQUARE TEST TO DETERMINE WHETHER ATTITUDES TOWARD MATHEMATICS FIT THE NORMAL DISTRIBUTION

Group	Computed Chi-Square	Degrees of Freedom	Level	Tabulated Chi-Square
A	9.04	8	.05	15.51
B	5.94	7	.05	14.07
C	3.16	7	.05	14.07
D	6.63	7	.05	14.07
A+B	7.59	8	.05	15.51
C+D	5.92	8	.05	15.51

In all twelve cases the computed chi-square value was well within the 5 percent limits. Hence, the evidence is insufficient to indicate that the attitude scores of each group could not have resulted from a normally distributed population. On the basis of these results it was established that the normal distribution assumption was statistically sound.

In the variance analyses, several groups were compared by pairs. An F ratio was computed for each of these pairs to be used in testing the homogeneity of the variances of the groups in the pair. Each ratio was then compared with a tabulated value to determine whether the hypothesis of homogeneity was tenable. Tables XVIII and XIX show the results.

TABLE XVIII

HOMOGENEITY OF VARIANCE TEST RESULTS FOR GROUP ATTITUDES TOWARD MODERN MATHEMATICS PROGRAMS

Group Pair	Computed F Ratio	Tabulated F	Degrees of Freedom	Level of Significance
A, B	1.23	1.48	(99,99)	.05
C, D	1.40	1.48	(99,99)	.05
A+B, C+D	1.35	1.45	(199,199)	.01

TABLE XIX

HOMOGENEITY OF VARIANCE TEST RESULTS FOR GROUP ATTITUDES TOWARD MATHEMATICS

Group Pair	Computed F Ratio	Tabulated F	Degrees of Freedom	Level of Significance
A, B	1.17	1.48	(99,99)	.05
C, D	1.03	1.48	(99,99)	.05
A+B, C+D	1.12	1.32	(199,199)	.05

Since the difference between the variances of the groups in each pair was tested, it was necessary to use a two-tailed test. As the tables show, there was no evidence that any group pairs differed significantly in variability. On this basis, the validity of the variance homogeneity assumption was established.

Primary Hypotheses Tested

The following hypotheses were considered to be the most important of the study. Each of these was tested by the use of analysis of variance. The hypotheses listed under I refer to attitudes toward modern mathematics programs. The data used in the tests of these hypotheses consisted of responses to Part A of the measuring instrument. The hypotheses are:

I-A. There is no significant difference between the attitudes toward modern mathematics programs of Group A, Group B, Group C, and Group D.

I-B. There is no significant difference between the attitudes toward modern mathematics programs of Group (A+B) and Group (C+D).

I-C. There is no significant difference between the attitudes toward modern mathematics programs of Group A and Group B.

I-D. There is no significant difference between the attitudes toward modern mathematics programs of Group C and Group D.

The hypotheses listed under II all refer to attitudes toward mathematics. The data used in the tests of these hypotheses consisted of responses to Part B of the measuring instrument. The hypotheses are:

II-A. There is no significant difference between the attitudes toward mathematics of Group A, Group B, Group C, and Group D.

II-B. There is no significant difference between the attitudes toward mathematics of Group (A+B) and Group (C+D).

II-C. There is no significant difference between the attitudes toward mathematics of Group A and Group B.

II-D. There is no significant difference between the attitudes toward mathematics of Group C and Group D.

Analysis of Variance Results

The first step in the testing of the above hypotheses was to test null hypotheses I-A and II-A. Both of these were rejected at the .01 level of confidence. This was taken as an indication that there existed differences between some or all of the group means. Insufficient evidence for rejecting either hypothesis would have rendered unnecessary the testing of the other hypotheses.

In tests requiring the comparison of two group means, either F or t may be employed. Garrett[1] suggests that from the standpoint of calculation, F is somewhat easier to apply. This prompted the investigator to test the remaining hypotheses by the use of the F ratio which is found by analysis of variance.

Table XX summarizes the results of the tests of the hypotheses. The analyses of variance may be found in Appendix D.

---

[1]Garrett, p. 283.

TABLE XX

ANALYSIS OF VARIANCE RESULTS FOR TESTING HYPOTHESES

Hypothesis	Computed F	Degrees of Freedom	Tabulated F	Significance Level
I-A	57.76	(3,396)	3.83	.01
I-B	146.26	(1,398)	6.70	.01
I-C	12.92	(1,198)	6.76	.01
I-D	6.56	(1,198)	3.89	.05
II-A	5.98	(3,396)	3.83	.01
II-B	17.55	(1,398)	6.70	.01
II-C	.09	(1,198)	3.89	.05
II-D	.32	(1,198)	3.89	.05

The analysis of variance results shown in Table XX indicate that all of the hypotheses were rejected except II-C and II-D. The rejection of I-A indicated differences between some or all of the group means. This meant that further information could be obtained through comparison of group attitudes by pairs. Since hypotheses I-B, I-C, and I-D were all rejected, this indicated that there are significant differences between the attitudes toward modern mathematics programs of Group (A+B) and Group (C+D), Group A and Group B, and Group C and Group D.

The rejection of II-A indicated differences between some or all of the group attitudes toward mathematics. Again, this meant that further comparisons could yield additional information. Since hypothesis II-B was rejected there appears to be a significant difference between the attitudes toward mathematics of Group (A+B) and Group (C+D). Rejection of hypotheses II-C and II-D suggest that there is no significant difference between the attitudes toward mathematics of Group A and Group B, and there is no significant difference between the attitudes toward mathematics of Group C and Group D.

Secondary Hypotheses Tested

In addition to the primary hypotheses of the study, several other hypotheses were formulated and tested. This testing was accomplished through the use of contingency tables and chi-square. The hypotheses listed under III all refer to attitudes toward modern mathematics programs. The hypotheses are:

III-A. Among those teachers who have had formal training in modern materials, attitudes toward modern mathematics programs are independent of the amount of training in modern materials.

III-B. Among all groups, attitudes toward modern mathematics programs are independent of total amount of training.

III-C. Among all groups, attitudes toward modern mathematics programs are independent of experience.

III-D. Among all groups, attitudes toward modern mathematics programs are independent of age.

III-E. Among all groups, attitudes toward modern mathematics programs are independent of sex.

The hypotheses listed under IV all refer to attitudes toward mathematics with whatever meanings the term mathematics conveyed to the respondent. No attempt was made to differentiate between traditional and modern mathematics. The hypotheses are:

IV-A. Among those teachers who have had formal training in modern materials, attitudes toward mathematics are independent of the amount of training in modern materials.

IV-B. Among all groups, attitudes toward mathematics are independent of total amount of training.

IV-C. Among all groups, attitudes toward mathematics are independent of experience.

IV-D. Among all groups, attitudes toward mathematics are independent of age.

IV-E. Among all groups, attitudes toward mathematics are independent of sex.

The hypotheses listed under V do not pertain to classification according to attitude, but involve classification according to groups, age, and years of training. The hypotheses are:

V-A. Among all respondents, group classification and age are independent.

V-B. Among all respondents, group classification and years of training are independent.

Chi-Square Results

For the testing of hypothesis III-A all responses of Group A and Group B were pooled and dichotomized at the median according to the responses to Part A of the instrument. This produced a low group of 105 responses below 86, and a high group of 95 responses above 85. Four categories of classification according to amount of training in modern materials were first used. These were used with the high and low groups to obtain a bivariate frequency distribution which was tabulated in the form of a contingency table. This is shown in Table XXI. Chi-square was then used and the hypothesis was rejected at the .05 level of significance. Observation of the data indicated an unusually large number of low responses having 1 to 3 hours of training. This prompted the use of two categories of classification according to training; those with 3 or fewer hours and those with more than 3 hours of training. Hypothesis III-A was again rejected at the .05 level of significance. These results are shown in Table XXXIII.

TABLE XXI

CONTINGENCY TABLE FOR HYPOTHESIS III-A

	Credit Hours				
	1-3	4-6	7-9	9+	Totals
High Group	33	40	11	11	95
Low Group	64	35	2	4	105
Totals	97	75	13	15	200

For the testing of hypotheses III-B, III-C, III-D, and III-E, all responses to Part A of the instrument were dichotomized at the median. This produced a low group of 201 responses below 76 and a high group of 199 responses above 75.

Two categories of classification according to total amount of training were used with contingency tables and chi-square to test hypothesis III-B. Five categories of classification according to years of experience were used in testing hypothesis III-C. Five categories of classification according to age were used in testing hypothesis III-D. Two categories of classification according to sex were used in testing hypothesis III-E. The contingency tables corresponding with these hypotheses appear in Tables XXII, XXIII, XXIV, and XXV.

TABLE XXII

CONTINGENCY TABLE FOR HYPOTHESIS III-B

	Years of Training		
	4 or less	5 or more	Totals
High Group	97	102	199
Low Group	128	73	201
Totals	225	175	400

TABLE XXIII

CONTINGENCY TABLE FOR HYPOTHESIS III-C

	Years of Experience					
	1-3	4-8	9-15	16-25	25+	Totals
High Group	31	24	42	56	46	199
Low Group	34	26	38	57	46	201
Totals	65	50	80	113	92	400

TABLE XXIV

CONTINGENCY TABLE FOR HYPOTHESIS III-D

	Age					
	21-30	31-40	41-50	51-60	60+	Totals
High Group	34	32	55	66	14	201
Low Group	29	30	57	75	8	199
Totals	63	62	112	141	22	400

TABLE XXV

CONTINGENCY TABLE FOR HYPOTHESIS III-E

	Male	Female	Totals
High Group	23	176	201
Low Group	28	173	199
Totals	51	349	400

For the testing of hypothesis IV-A all responses of Group A and Group B were pooled and dichotomized at the median according to the responses to Part B of the instrument. This resulted in a low group of 101 responses below 49 and a high group of 99 responses above 48. Four categories of classification according to amount of training in modern materials were used in the test of the hypothesis. Table XXVI shows the contingency table for this hypothesis.

TABLE XXVI

CONTINGENCY TABLE FOR HYPOTHESIS IV-A

	Credit Hours				
	1-3	4-6	7-9	9+	Totals
High Group	43	37	9	10	99
Low Group	53	39	4	5	101
Totals	96	76	13	15	200

For the testing of hypotheses IV-B, IV-C, IV-D, and IV-E all responses to Part B of the instrument were dichotomized at the median. In the low group there were 197 responses below 47 and in the high group there were 203 above 46.

Three categories of classification according to total amount of training were used in testing hypothesis IV-B. The categories of classification for the remaining hypotheses under IV were the same as for the corresponding hypotheses under III. The contingency tables corresponding with these hypotheses appear in Tables XXVII, XXVIII, XXIX, and XXX.

TABLE XXVII

CONTINGENCY TABLE FOR HYPOTHESIS IV-B

	Years of Training			
	4 or less	5	5+	Totals
High Group	114	48	41	203
Low Group	111	55	31	197
Totals	225	103	72	400

TABLE XXVIII

CONTINGENCY TABLE FOR HYPOTHESIS IV-C

	Years of Experience					
	1-3	4-8	9-15	16-25	25+	Totals
High Group	34	24	34	68	43	203
Low Group	31	26	46	45	49	197
Totals	65	50	80	113	92	400

TABLE XXIX

CONTINGENCY TABLE FOR HYPOTHESIS IV-D

	Age					
	21-30	31-40	41-50	51-60	60+	Totals
High Group	30	30	54	73	16	203
Low Group	33	32	58	68	6	197
Totals	63	62	112	141	22	400

TABLE XXX

CONTINGENCY TABLE FOR HYPOTHESIS IV-E

	Male	Female	Totals
High Group	28	175	203
Low Group	23	174	197
Totals	51	349	400

For the testing of hypotheses V-A and V-B, group classifications were used with age and training classifications. There were 100 respondents in each group. The contingency tables obtained are shown in Table XXXI and Table XXXII. The results of the tests of all the secondary hypotheses are indicated in Table XXXIII.

TABLE XXXI

CONTINGENCY TABLE FOR HYPOTHESIS V-A

	Age					
	21-30	31-40	41-50	51-60	60+	Totals
Group A	18	21	27	31	3	100
Group B	15	18	34	31	2	100
Group C	15	16	36	29	4	100
Group D	15	7	15	50	13	100
Totals	63	62	112	141	22	400

TABLE XXXII

CONTINGENCY TABLE FOR HYPOTHESIS V-B

	Years of Training			
	4 or less	5	5+	Totals
Group A	58	25	17	100
Group B	42	31	27	100
Group C	62	24	14	100
Group D	63	23	14	100
Totals	225	103	72	400

TABLE XXXIII

CHI-SQUARE RESULTS FOR TESTING SECONDARY HYPOTHESES

Hypothesis	Computed Chi-Square	Level and Degrees of Freedom	Tabulated Chi-Square	Reject
III-A	13.80	.05,1	3.84	Yes
III-B	9.05	.05,1	3.84	Yes
III-C	.37	.05,4	9.49	No
III-D	2.68	.05,4	9.49	No
III-E	.48	.05,1	3.84	No
IV-A	4.75	.05,3	7.81	No
IV-B	1.80	.05,2	5.99	No
IV-C	6.97	.05,4	9.49	No
IV-D	4.90	.05,4	9.49	No
IV-E	.39	.05,1	3.84	No
V-A	39.38	.05,12	21.00	Yes
V-B	12.99	.05,6	12.60	Yes

Observation of the contingency tables and the chi-square results lead to the following conclusions:

1. Among teachers who have had formal training in modern materials, attitudes toward modern mathematics programs are related to the amount of training in modern materials. Those teachers with more than three credit hours may have more favorable attitudes toward modern programs.

2. Among all groups, there seems to be an association between attitudes toward modern mathematics programs and total amount of training. Teachers with more than four years of training seem to be more favorable

toward modern programs.

3. There is a relationship between group classification and age. Teachers who have had no formal instruction in modern materials and who were not enrolled in a program at the time of the study, are somewhat older than those in the other classifications.

4. There is an association between group classification and total amount of training. It appears that those teachers who have had formal instruction in modern materials and have taught in a modern mathematics program have more training than teachers in the other classifications.

Correlation of Responses

After the collection of the data, the question arose concerning the correlation of the responses to Part A and the responses to Part B of the instrument. Perhaps respondents tended to develop a response set which caused them to respond to both scales in the same manner. Under this assumption a teacher whose attitude toward modern mathematics was highly favorable could be expected to also have highly favorable attitudes toward mathematics and vice versa.

With each respondent of the study there is associated two scores; one representing the total of responses to Part A and one representing the total of responses to Part B. These two scores were correlated for every respondent of the study. Correlation coefficients for each of the four groups of the study were then obtained by correlating both scores of each respondent within each group. Additional information was gained by computing a coefficient of alienation corresponding with each correlation coefficient. The coefficient of alienation is a measure of the absence of relationship between two variables. These computations are shown in Table XXXIV.

TABLE XXXIV

CORRELATION AND ALIENATION COEFFICIENTS FOR GROUP RESPONSES TO PART A AND PART B OF THE INSTRUMENT

Group	Correlation	Alienation
Total	.54	.84
A	.49	.87
B	.71	.70
C	.46	.89
D	.39	.92

Observation of the table indicates that for all respondents there is a substantial or marked relationship between responses to Part A and responses to Part B. This is also true of Group A and Group C. For Group B there is a high correlation and for Group D there is a low relationship. It appears that those teachers who have had formal training in modern programs tend to have similar attitudes toward modern mathematics. Those teachers who have indicated no interest in modern mathematics programs and materials seem to have attitudes toward modern mathematics programs and mathematics which have a low correlation. Observation of the coefficients of alienation also leads to the same conclusions.

Response to Individual Items

The frequency distribution of all scores based upon responses to items concerning modern mathematics programs was considered. Two criterion groups consisting of the thirty lowest scores and the thirty highest scores were then chosen. The responses of these groups to individual items served to indicate characteristics of modern mathematics programs which are the most controversial.

The range for scores in the low group was 36 to 56. This group consisted of four responses from Group A, three from Group B, five from Group C, and eighteen from Group D.

The range for scores in the high group was 99 to 116. This group consisted of seven responses from Group A, nineteen from Group B, two from Group C, and two from Group D.

The mean score on each individual item was computed for the high and low groups. The difference in the mean scores of the two groups is a measure of the extent to which a given item differentiates between the high and low groups. These results are tabulated in Table XXXV.

TABLE XXXV

MEAN INDIVIDUAL ITEM RESPONSE
FOR HIGH AND LOW GROUPS

Item	High Group Mean	Low Group Mean	Mean Difference
1	3.83	1.46	2.37
3	3.80	1.60	2.20
4	3.87	1.80	2.07
5	3.67	1.63	2.04
7	3.23	1.93	1.30
8	2.46	1.27	1.19
9	3.06	1.06	2.00
11	3.70	1.16	2.56
12	3.87	2.03	1.84
14	3.16	1.83	1.33
16	3.50	1.87	1.67
17	3.47	1.93	1.54
19	3.63	2.06	1.57
20	3.90	1.37	1.53
21	3.60	1.69	1.91
22	3.37	1.16	2.21
24	3.70	1.63	2.07
25	3.87	2.83	1.04
26	3.23	1.80	1.43
27	3.97	1.57	2.40
28	3.70	1.63	2.07
29	3.47	1.53	1.94
30	3.50	1.03	1.47
31	3.74	1.70	2.04
33	3.60	1.93	1.67
34	3.47	1.57	1.90
36	3.10	1.27	1.83
40	3.64	1.90	1.74
42	3.40	1.70	1.70
44	3.54	1.43	2.09

The two items which appear to be the most controversial involve the same thing--desire or lack of desire to teach in a modern mathematics program. They are item 11 which says: "I would like to teach in a modern mathematics program," and item 30 which says: "I think it would be exciting to teach in a modern mathematics program." The high and low group mean difference for item 30 was greater than for any other item and the low group mean was smaller than for any other item. Reference to Table I also shows that these same two items ranked first and third on the preliminary scale.

Item 27 reflects disagreement among teachers as to whether their schools should teach modern mathematics. The high and low group mean difference for this item was 2.40 and of the thirty responses in the high group, all but one strongly disagreed with the statement which says: "I see little need for my school to offer a modern mathematics program."

Another item which provoked disagreement among respondents was item 1 which says: "I am enthusiastic about modern mathematics programs." The mean difference was 2.37.

The statement having the lowest mean for the high group was item 8 which says: "Modern mathematics programs arouse anxiety in both teachers and students." This statement was the only one having a high group mean lower than 3.

Among the respondents in the low group, item 22 received a rather unfavorable response. There was much agreement with the statement, "The movement toward modern mathematics has developed too rapidly." The low group mean was 1.16 for the item.

The item upon which there was the greatest agreement was item 25 which says: "A child will learn better if he is provided with a learning situation in which he discovers the meanings and concepts in mathematics." This item was considered by the writer to be favorable toward modern mathematics programs since it is the "discovery" method that most modern programs advocate. The conclusion is that although teachers may express unfavorable attitudes toward ideas and proposals clearly designated "modern," many of these same teachers are in complete agreement with characteristics common to modern programs when the "modern" term is absent. It appears that many people react to the name rather than the content.

Both the low group mean and the high group mean for item 9 were rather small, although the mean difference was reasonably large. Thus both groups disagreed with this statement more than with any other statement. The item says: "Those school systems which do not put emphasis on modern mathematics programs are not being fair to their students."

The fact that items 11 and 30 are so closely related in content and their mean differences are so nearly the same was interpreted as an indication that respondents were very consistent in their responses to the items of the instrument. The mean differences for items 5 and 31 furnish further support for this interpretation. The contents of these two items are the same although stated in different form. The mean differences are identical.

Summary

This chapter has presented the results of a statistical analysis of the data of the study. Since the single classification analysis of variance technique was used to test the primary hypotheses of the study, it was necessary to establish the validity of assumptions made in order for the analysis of variance to be appropriate. The chi-square "goodness of fit" test was used to show that data analyzed by analysis of variance procedures were normally distributed. In each of twelve tests the fit of the normal distribution to the observed data was very good.

The homogeneity of variance assumption was justified by the F ratio test. Evidence was insufficient to cause the hypothesis of homogeneous variances to be rejected for any of the groups under consideration.

The primary hypotheses of the study were stated and tested by analysis of variance procedures. Eight hypotheses were tested and all but two were rejected. The implications of these results will be discussed further in the following chapter.

Secondary hypotheses of the study were also stated and tested by means of contingency tables and chi-square. Twelve hypotheses were tested and four were rejected. The results of these tests show that attitudes toward mathematics and modern mathematics programs are independent of such factors as age, experience, and sex.

Responses to Part A and responses to Part B of the instrument were correlated. Only one group had a high positive correlation coefficient. This was for those teachers who have had training in modern materials and have also taught in modern mathematics programs. For two groups there was a marked or substantial relationship and one group showed a low positive correlation.

In considering the responses of a high group and a low group to individual test items, it was found that the greatest amount of disagreement among respondents was over the desire to teach in modern mathematics programs.

Conclusions and recommendations based upon the analysis appear in the following chapter.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Review of the Purpose of the Study

During the last decade and particularly over the past five years school mathematics in the United States has taken a course different from the traditional one. Many different groups and individuals have advocated and developed programs which they believe are designed to cure the ills of school mathematics. For the past fifty years new mathematical knowledge has been accumulating at a staggering rate, while the viewpoint of school mathematics has remained essentially unchanged. Mathematicians and educators are becoming concerned that school mathematics programs be taught which are in accord with recent developments in mathematics.

The first experimental programs were designed for the secondary level, but in recent years several have appeared on the elementary level. With the appearance of these programs there has been disagreement as to the extent to which elementary schools should teach the new materials.

Teachers realized that they would be unprepared to teach contemporary materials if and when they were called upon to do so. Many of these have taken advantage of in-service opportunities to gain acquaintance with the modern approach. Much of this has been done on the teachers' own initiative, while some has been caused by pressures brought to bear by school administrators. Other teachers have been openly critical of the movement and doubt its worth.

The purpose of this study was to investigate the attitudes of teachers toward modern mathematics programs in the elementary schools, and to determine whether formal instruction in modern materials is a factor which favorably influences these attitudes. This was accomplished by comparing the attitudes of 200 elementary teachers who had taken formal courses in modern materials, in-service and otherwise, with the attitudes of 200 elementary teachers having no such training. The study also sought to determine whether teacher attitudes toward mathematics are changed through instruction in modern materials.

The study was limited to responses from 400 elementary teachers in schools within a distance of 120 miles from Oklahoma State University.

Conclusions of the Study

The research data and the statistical analysis resulting from the present study indicate the following conclusions:

1. There is a significant difference between the attitudes toward modern mathematics programs of elementary

teachers who have had formal instruction in modern materials and teachers who have had no such training. Those with the training have more favorable attitudes. It therefore appears that efforts of educational institutions and agencies such as the National Science Foundation to acquaint teachers with modern materials through institutes and in-service instruction are worthwhile.

2. Among teachers who have had formal instruction in modern materials there is a significant difference between the attitudes toward modern mathematics programs of those who have taught in a modern program and those who have not. This is a point in favor of the modern programs. Those teachers who have had opportunities to work with modern materials and to observe their classroom effects, rather than becoming disenchanted, are more in favor of the programs.

3. Among teachers who have had no formal instruction in modern materials, the attitudes toward modern programs of those who have indicated interest in in-service training are significantly more favorable than the attitudes of those who seemingly do not desire such preparation. Perhaps this may be interpreted as an indication that those teachers who enroll for formal courses in modern materials do so primarily of their own accord. It seems

likely that if they were forced into this situation their attitudes would be unfavorably affected.

4. Those teachers who have had formal instruction in modern materials have a more favorable attitude toward mathematics in general than do teachers who have had no such instruction. Therefore, formal instruction in modern materials is a factor which influences attitudes toward mathematics as well as attitudes toward modern mathematics programs.

5. Among those teachers who have had formal instruction in modern materials, there is no difference in attitudes toward mathematics. Teaching in a modern program is not a factor which influences attitudes toward mathematics in general.

6. Among those teachers who have had no formal training in modern materials, the attitudes toward mathematics of those currently enrolled in in-service courses are no different than the attitudes of teachers who apparently want no part of modern programs, or at least have not enrolled for instruction.

7. Among those teachers who have had formal instruction in modern materials, there is a significant difference in the attitudes toward modern programs of those who have had three or fewer hours training and those who have had more than three hours training. Additional

training past a single introductory course appears to foster more favorable attitudes toward modern programs.

8. Attitudes toward modern mathematics programs are not independent of the total amount of training in all areas. The attitudes of those teachers with more than four years of college work are more favorable than the attitudes of teachers with four years or less.
9. Teachers who have enrolled for instruction in modern mathematics materials are significantly younger than teachers who have not enrolled.
10. Teachers who have taught in modern programs appear to have a greater amount of training than those who have not taught in such a program.
11. Among all teachers of the study, attitudes toward modern mathematics programs are independent of experience, age, and sex.
12. Among those teachers who have had formal instruction in modern materials, attitudes toward mathematics in general are independent of the amount of training in modern materials.
13. Among all teachers of the study, attitudes toward mathematics in general are independent of total amount of training, experience, age and sex.

14. The desire to teach in a modern mathematics program is the most controversial issue among teachers of the study.
15. There is disagreement among teachers as to whether their schools should offer modern mathematics programs.
16. Many teachers who are critical of modern mathematics programs are reacting to names and terminology rather than to actual content.
17. Among teachers who have over-all favorable attitudes toward modern mathematics programs, there is a considerable amount of agreement that these programs arouse anxiety in both teachers and students.
18. Among teachers who have unfavorable attitudes toward modern programs, a common criticism is that the movement toward modern mathematics has developed too rapidly.

Recommendations

The writer makes the following recommendations as a result of the study:

1. Efforts to acquaint elementary teachers with contemporary mathematics materials should continue and perhaps be increased.
2. Efforts should be put forth to encourage teachers to obtain more than just an introductory course in modern

materials.

3. Research is needed to determine the merits and value of modern mathematics programs in the elementary schools.

4. Studies should be made to determine whether student achievement in modern programs is affected by the training of the teacher. In obtaining data for the present study the writer found that there are many elementary teachers who are teaching in modern mathematics programs with no formal preparation. Should this be a matter of concern?

5. Further research should be conducted to determine the relationship between teacher attitudes and student achievement in modern mathematics programs.

6. Studies should be conducted to determine whether modern mathematics programs actually cause anxiety among students.

7. Additional research similar to the present study should be done in other geographical areas.

A SELECTED BIBLIOGRAPHY

Aiken, Lewis R., Jr., and Ralph Mason Dreger. "The Effect of Attitudes on Performance in Mathematics." Journal of Educational Psychology, LII (February, 1961), 19-24.

Banks, J. Houston. Learning and Teaching Arithmetic. Boston: Allyn and Bacon, Incorporated, 1959.

Bendig, A. W., and J. B. Hughes. "Student Attitude and Achievement in a Course in Introductory Statistics." Journal of Educational Psychology, XCV (May, 1954), 268-275.

Billig, Albert A. "Student Attitude as a Factor in the Mastery of Commercial Arithmetic." The Mathematics Teacher, XXXVII (April, 1944), 170-172.

Bird, Charles. Social Psychology. New York: Appleton-Century-Crofts, Incorporated, 1940.

Blalock, Hubert M. Social Statistics. New York: McGraw-Hill Book Company, Incorporated, 1960.

Brown, Kenneth E. "The Drive to Improve School Mathematics." The Revolution in School Mathematics. Washington, D. C.: National Council of Teachers of Mathematics, 1961, pp. 15-29.

________________. "The New Mathematics." Audiovisual Instruction, VII (March, 1962), 138-140.

Dutton, Wilbur H. "Attitude Change of Prospective Elementary School Teachers Toward Arithmetic." The Arithmetic Teacher, IX (December, 1962), 418-424.

________________. "Attitudes of Junior High School Students Toward Arithmetic." The School Review, LXIV (January, 1956), 18-22.

________________. "Attitudes of Prospective Teachers Toward Arithmetic." The Elementary School Journal, LII (October, 1951), 84-91.

_______________. "Measuring Attitudes Toward Arithmetic." *The Elementary School Journal*, LV (September, 1954), 24-31.

Edwards, Allen L. *Techniques of Attitude Scale Construction.* New York: Appleton-Century-Crofts, Incorporated, 1957.

_______________, and Katheryn Claire Kenney. "A Comparison of the Thurstone and Likert Techniques of Attitude Scale Construction." *Journal of Applied Psychology*, XXX (February, 1946), 72-83.

Fehr, Howard. "Teaching Modern Mathematics." *NEA Journal*, LI (November, 1962), 44-45.

Garrett, Henry E. *Statistics in Psychology and Education.* New York: Longmans, Green, and Company, 1953.

Harrington, Lester Garth. "Attitudes Toward Mathematics and the Relationship Between Such Attitudes and Grade Obtained in a Freshman Mathematics Course." (Unpublished doctoral dissertation, University of Florida, 1960).

Johnson, Donovan A. "The New Mathematics." *Audiovisual Instruction*, VII (March, 1962), 142-143.

Kline, Morris. "The Ancients Versus the Moderns, a New Battle of the Books." *The Mathematics Teacher*, LI October, 1958), 418-427.

Leissa, Arthur W., and Robert C. Fisher. "A Survey of Teachers' Opinions of a Revised Mathematics Curriculum." *The Mathematics Teacher*, LIII (February, 1960), 113-118.

Lyda, Wesley J., and Evelyn Morse. "Attitudes, Teaching Methods, and Arithmetic Achievement." *The Arithmetic Teacher*, X (March, 1963), 258-262.

MacLane, Saunders. "The Reform Has Been Oversold." *NEA Journal*, LI (November, 1962), 45-46.

Manheimer, Wallace. "Some Heretical Thoughts From An Orthodox Teacher." *The Mathematics Teacher*, LIII (January, 1960), 22-26.

Marlin, Lillian. "SMSG - One Point of View." *The Mathematics Teacher*, LV (October, 1962), 476-478.

Murphy, Gardner, and Rensis Likert. Public Opinion and the Individual. New York: Harper and Brothers, 1938.

Nunnally, Jum C., Jr. Tests and Measurements. New York: McGraw-Hill Book Company, Incorporated, 1959.

Openshaw, Karl. "Attitudes for Growth." Educational Leadership, XX (November, 1962), 90-92.

Payne, Holland Ivan. "A Study of Student Achievement Using SMSG and Conventional Approaches in First Year Algebra." (Unpublished doctoral dissertation, Oklahoma State University, 1963).

Phelps, Jack. "A Study Comparing Attitudes Toward Mathematics of SMSG and Traditional Elementary School Students." (Unpublished doctoral dissertation, Oklahoma State University, 1963).

Remmers, H. H. Introduction to Opinion and Attitude Measurement. New York: Harper and Brothers, 1954.

________________, and N. L. Gage. Educational Measurement and Evaluation. New York: Harper and Brothers, 1955.

________________, N. L. Gage, and J. Francis Rummel. A Practical Introduction to Measurement and Evaluation. New York: Harper and Brothers, 1960.

Rosenbloom, Paul C. "Mathematics: K-14." Educational Leadership, XIX (March, 1962), 359-363.

Rummel, J. Francis. An Introduction to Research Procedures in Education. New York: Harper and Brothers, 1958.

Rundquist, Edward A., and Raymond F. Sletto. Personality in the Depression. Minneapolis: The University of Minnesota Press, 1936.

Stone, Marshall. "Fundamental Issues in the Teaching of Elementary School Mathematics." The Arithmetic Teacher, VI (October, 1959), 177-179.

Stright, Virginia M. "A Study of Attitudes Toward Arithmetic of Students and Teachers in the Third, Fourth, and Sixth Grades." The Arithmetic Teacher. VII (October, 1960), 280-286.

"The New Mathematics; Projects in Curriculum Revision." Audiovisual Instruction, VII (March, 1962), 137.

Thesis Writing Manual, A Guide for Graduate Students. (rev. R. MacVicar) Stillwater: Oklahoma State University, 1960.

Thurstone, L. L. The Measurement of Values. Chicago: The University of Chicago Press, 1959.

Weaver, J. Fred. "Improvement Projects Related to Elementary School Mathematics." The Arithmetic Teacher, VII (October, 1960), 311-315.

__________. "The School Mathematics Study Group Project on Elementary School Mathematics." The Arithmetic Teacher, VIII (January, 1961), 32-35.

__________. "The School Mathematics Study Group Project on Elementary School Mathematics, Grades K-3." The Arithmetic Teacher, IX (December, 1962), 459-461.

Wert, James E., Charles O. Neidt, and J. Stanley Ahmann. Statistical Methods in Educational and Psychological Research. New York: Appleton-Century-Crofts, Incorporated, 1954.

Wiersma, William, Jr. "A Study of National Science Foundation Institutes: Mathematics Teachers' Reactions to Institute Programs and Effects of These Programs on High School Mathematics Courses." (Unpublished doctoral dissertation, The University of Wisconsin, 1962).

Wright, Betty Atwell. "Anatomy of Change in Elementary Mathematics." The Arithmetic Teacher, X (March, 1963), 158-161.

Zant, James H. "Effect of New Mathematics Programs in the Schools on College Mathematics Courses." The American Mathematical Monthly, LXX (February, 1963), 200-202.

APPENDIXES

APPENDIX A

INSTRUMENT OF THE STUDY

Part I

The following questions are to obtain general information. For the purposes of this instrument we shall describe modern mathematics programs as those school mathematics programs which use materials prepared by SMSG, UICSM, Ball State, and other similar groups. Please answer the following questions in accordance with this definition.

1. Age
   ( ) 30 or under
   ( ) 31--40
   ( ) 41--50
   ( ) 51--60
   ( ) Over 60

2. Sex
   ( ) Male
   ( ) Female

3. Have you taught in what would be described as a modern mathematics program?
   ( ) Yes
   ( ) No

4. Your last enrollment as student in regular semester or summer session
   ( ) Within past year
   ( ) Within past three years
   ( ) Within past five years
   ( ) Within past ten years
   ( ) Over ten years ago

5. Teaching level
   ( ) 1-- 3
   ( ) 4-- 6
   ( ) 7-- 8
   ( ) 9--12

6. Size of community in which your school is located
   ( ) Less than 300
   ( ) 300 to 1,000
   ( ) 1,000 to 5,000
   ( ) 5,000 to 15,000

7. Teaching experience
   ( ) 1 to 3 years
   ( ) 4 to 8 years
   ( ) 9 to 15 years
   ( ) 16 to 25 years
   ( ) More than 25 years

8. Years of training
   ( ) 2 years or less
   ( ) 3 years
   ( ) 4 years
   ( ) 5 years or Master's degree
   ( ) More than 5 years

9. Your last enrollment in workshop, extension, or in-service classes
   - ( ) Within past year
   - ( ) Within past two years
   - ( ) Within past four years
   - ( ) Within past six years
   - ( ) Over six years ago

10. Amount of formal training which you have received in modern mathematics materials (not necessarily for credit)
   - ( ) None
   - ( ) 1--3 hours or equivalent
   - ( ) 4--6 hours or equivalent
   - ( ) 7--9 hours or equivalent
   - ( ) Over 9 hours

Part II

The following pages contain a number of statements about which there is no general agreement. People differ widely in the way they feel about each item. There are no right answers. Read each item carefully and indicate the choice which best expresses your feeling about the statement. Wherever possible, let your own personal experience determine your answer. In answering statements which use the term, "modern mathematics programs," you may use the definition which was given at the beginning of Part I. The term, "mathematics," is used in the commonly accepted sense.

The five following categories will be used to indicate your feelings about each statement:

(SA) strongly agree
(A) agree
(U) undecided
(D) disagree
(SD) strongly disagree

Please check one category for each item.

SA A U D SD

__ __ __ __ __ 1. I am enthusiastic about modern mathematics programs.

__ __ __ __ __ 2. Mathematics serves the needs of a large number of boys and girls.

__ __ __ __ __ 3. I hope I never have to teach in a modern mathematics program.

SA A U D SD

__ __ __ __ __ 4. Students who are taught in modern programs have a better general overview of mathematics.

__ __ __ __ __ 5. The modern mathematics programs are better than the old ones.

__ __ __ __ __ 6. I didn't like mathematics in school and I still don't.

__ __ __ __ __ 7. I think parents would prefer that their children not be given instruction in a modern mathematics program.

__ __ __ __ __ 8. Modern mathematics programs arouse anxiety in both teachers and students.

__ __ __ __ __ 9. Those school systems which do not put emphasis on modern mathematics programs are not being fair to their students.

__ __ __ __ __ 10. I like to teach mathematics but I prefer to teach other subjects.

__ __ __ __ __ 11. I would like to teach in a modern mathematics program.

__ __ __ __ __ 12. Modern mathematics is challenging and intriguing.

__ __ __ __ __ 13. I feel that I make mathematics interesting to most of my pupils.

__ __ __ __ __ 14. I think set theory helps to clarify and unify mathematics.

__ __ __ __ __ 15. Sometimes I give extra assignments in mathematics as punishment.

__ __ __ __ __ 16. Placement of concepts and learning tasks in modern mathematics programs is not well-adapted to student maturity level.

__ __ __ __ __ 17. Modern mathematics programs encourage inappropriate departmentalized instruction in the elementary school.

__ __ __ __ __ 18. I wish I did not have to teach mathematics.

SA A U D SD

__ __ __ __ __19. Traditional mathematics programs are better suited to the philosophy and objectives of today's society.

__ __ __ __ __20. I think the emphasis on modern mathematics will cause more children to be afraid of mathematics.

__ __ __ __ __21. I think most students would be enthusiastic about a modern mathematics program.

__ __ __ __ __22. The movement toward modern mathematics has developed too rapidly.

__ __ __ __ __23. Mathematics is the subject I like least of all to teach.

__ __ __ __ __24. I think the emphasis on modern mathematics may result in such concern for mathematics that the child as a learner will be overlooked.

__ __ __ __ __25. A child will learn better if he is provided with a learning situation in which he discovers the meanings and concepts in mathematics.

__ __ __ __ __26. I would enjoy studying set theory.

__ __ __ __ __27. I see little need for my school to offer a modern mathematics program.

__ __ __ __ __28. Modern mathematics programs cause too many transitional problems.

__ __ __ __ __29. All elementary teachers should have formal training in the use of modern mathematics program materials.

__ __ __ __ __30. I think it would be exciting to teach in a modern mathematics program.

__ __ __ __ __31. That mathematics which is taught in modern programs is most appropriate to the world today.

__ __ __ __ __32. I have the feeling that my students hate mathematics.

SA	A	U	D	SD		
___	___	___	___	___	33.	Modern mathematics programs introduce many concepts and processes at too low a grade level.
___	___	___	___	___	34.	I get frustrated when I study modern mathematics materials.
___	___	___	___	___	35.	Mathematics is very practical.
___	___	___	___	___	36.	Modern programs over-stress terminology.
___	___	___	___	___	37.	I can teach mathematics well without reading mathematics magazines and methods books.
___	___	___	___	___	38.	I believe that students at the elementary level are capable of learning more mathematics than they are presently being taught.
___	___	___	___	___	39.	I really enjoy teaching mathematics.
___	___	___	___	___	40.	Teaching in a modern program represents a challenge for me.
___	___	___	___	___	41.	Mathematics is just a skill with little practical application.
___	___	___	___	___	42.	Concepts and materials stressed in modern mathematics programs are more difficult for students.
___	___	___	___	___	43.	I see no practical purpose in emphasizing mathematics.
___	___	___	___	___	44.	Many concepts presented in modern programs are too abstract for the students at the level for which they are intended.
___	___	___	___	___	45.	Mathematics is one of the most useful subjects I know.

APPENDIX B

The following tables describe the distribution of respondents in the different groups by school system or instruction center. The asterisk indicates locations which served as instruction centers for the 1963-64 extension classes in Mathematics 253 offered by Oklahoma State University. The corresponding number will therefore include respondents from other school systems in the area surrounding the instruction center.

DISTRIBUTION OF RESPONDENTS IN GROUP A BY SCHOOL SYSTEM OR INSTRUCTION CENTER

System	Number	System	Number
Blackwell	4	Inola	1
Chandler *	2	Kingfisher	8
Chickasha	1	Lamont	5
Choctaw *	4	Mustang *	4
Claremore	1	Newkirk *	2
Cleveland	2	Oklahoma City	9
Cushing	8	Owasso *	4
Drumright	2	Pawnee	3
El Reno *	7	Perkins	2
Fairfax	1	Perry *	4
Guthrie	4	Prague	2
Hennessey	6	Sand Springs	6
Hominy	4	Stillwater	4

DISTRIBUTION OF RESPONDENTS IN GROUP B BY SCHOOL SYSTEM OR INSTRUCTION CENTER

System	Number	System	Number
Blackwell	6	Mustang *	4
Chickasha	13	Newkirk *	1
Cushing	6	Oklahoma City	19
Dover	2	Pawnee	1
Drumright	2	Perkins	1
El Reno *	1	Prague	1
Fairfax	1	Sand Springs	3
Guthrie	7	Stillwater	14
Hennessey	6	Watonga	7
Kingfisher	5		

DISTRIBUTION OF RESPONDENTS IN GROUP C BY INSTRUCTION CENTER

System	Number	System	Number
Chandler *	9	Newkirk *	5
Choctaw *	19	Owasso *	10
El Reno *	25	Perry *	8
Mustang *	9	Pryor *	15

DISTRIBUTION OF RESPONDENTS IN GROUP D BY SCHOOL SYSTEMS

System	Number	System	Number
Blackwell	1	Inola	5
Bushyhead	2	Kingfisher	2
Claremore	6	Lamont	1
Cleveland	6	Oklahoma City	6
Cushing	7	Pawnee	6
Drumright	4	Perkins	2
Fairfax	8	Prague	5
Guthrie	7	Sand Springs	5
Hennessey	4	Sperry	8
Hominy	5	Stroud	10

DISTRIBUTION OF ALL RESPONDENTS BY SCHOOL SYSTEM OR INSTRUCTION CENTER

System	Number	System	Number
Blackwell	11	Kingfisher	15
Bushyhead	2	Lamont	6
Chandler *	11	Mustang *	17
Chickasha	14	Newkirk *	8
Choctaw *	23	Oklahoma City	34
Claremore	7	Owasso *	14
Cleveland	8	Pawnee	10
Cushing	21	Perkins	5
Dover	2	Perry *	12
Drumright	8	Prague	8
El Reno *	33	Pryor *	15
Fairfax	10	Sand Springs	14
Guthrie	18	Sperry	8
Hennessey	16	Stillwater	18
Hominy	9	Stroud	10
Inola	6	Watonga	7

APPENDIX C

DISTRIBUTION OF ALL RESPONSES TO PART A OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-51	15	82- 86	44
52-56	17	87- 91	35
57-61	27	92- 96	31
62-66	44	97-101	17
67-71	56	102-106	7
72-76	52	107-120	13
77-81	42		
	Mean = 76.69	S. D. = 15.12	

DISTRIBUTION OF GROUP A RESPONSES TO PART A OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-61	5	82- 86	20
62-66	6	87- 91	12
67-71	10	92- 96	7
72-76	16	97-101	6
77-81	13	102-120	5
	Mean = 81.09	S. D. = 12.72	

DISTRIBUTION OF GROUP B RESPONSES TO PART A OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-68	6	89- 93	15
69-73	7	94- 98	9
74-78	6	99-103	9
79-83	14	104-108	7
84-88	21	109-120	6
	Mean = 87.94	S. D. = 14.13	

DISTRIBUTION OF GROUP C RESPONSES TO PART A OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-56	5	73- 76	15
57-60	7	77- 80	11
61-64	14	81- 84	5
65-68	14	85- 88	2
69-72	20	89-120	7
	Mean = 70.99	S. D. = 10.75	

DISTRIBUTION OF GROUP D RESPONSES TO PART A OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-51	7	72- 76	13
52-56	13	77- 81	3
57-61	16	82- 86	4
62-66	18	87- 91	3
67-71	17	92-120	6
	Mean = 66.73	S. D. = 12.73	

DISTRIBUTION OF ALL RESPONSES TO PART B OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-36	18	47- 48	49
37-38	15	49- 50	41
39-40	22	51- 52	41
41-42	46	53- 54	30
43-44	42	55- 56	27
45-46	54	57- 60	15
	Mean = 46.56	S. D. = 5.99	

DISTRIBUTION OF GROUP A RESPONSES TO PART B OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-40	8	49-50	16
41-42	13	51-52	10
43-44	9	53-54	12
45-46	11	55-56	5
47-48	9	57-60	7
	Mean = 47.66	S. D. = 5.81	

DISTRIBUTION OF GROUP B RESPONSES TO PART B OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-40	9	49-50	10
41-42	5	51-52	15
43-44	10	53-54	8
45-46	11	55-56	12
47-48	16	57-60	4
	Mean = 47.92	S. D. = 6.29	

DISTRIBUTION OF GROUP C RESPONSES TO PART B OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-38	12	47-48	9
39-40	6	49-50	10
41-42	13	51-52	8
43-44	13	53-54	5
45-46	17	55-60	7
	Mean = 45.56	S. D. = 5.66	

DISTRIBUTION OF GROUP D RESPONSES TO PART B OF THE INSTRUMENT

Interval	Frequency	Interval	Frequency
0-38	10	47-48	15
39-40	10	49-50	8
41-42	15	51-52	8
43-44	10	53-54	5
45-46	15	55-60	7
	Mean = 45.10	S. D. = 5.76	

APPENDIX D

ANALYSIS OF VARIANCE FOR HYPOTHESIS I-A

Source	df	SS	MS	F
Total	399	91199.94		
Groups	3	27761.41	9253.80	57.76**
Within	396	63438.53	160.20	

ANALYSIS OF VARIANCE FOR HYPOTHESIS I-B

Source	df	SS	MS	F
Total	399	91199.94		
Groups	1	24507.91	24507.91	146.26**
Within	398	66692.03	167.57	

ANALYSIS OF VARIANCE FOR HYPOTHESIS I-C

Source	df	SS	MS	F
Total	199	38301.96		
Groups	1	2346.13	2346.13	12.92**
Within	198	35955.83	181.60	

**Significant at .01 level.

ANALYSIS OF VARIANCE FOR HYPOTHESIS I-D

Source	df	SS	MS	F
Total	199	28390.08		
Groups	1	907.38	907.38	6.56*
Within	198	27482.70	138.31	

ANALYSIS OF VARIANCE FOR HYPOTHESIS II-A

Source	df	SS	MS	F
Total	399	14337.06		
Groups	3	620.94	206.98	5.98**
Within	396	13716.12	34.63	

ANALYSIS OF VARIANCE FOR HYPOTHESIS II-B

Source	df	SS	MS	F
Total	399	14337.06		
Groups	1	605.66	605.66	17.55**
Within	398	13731.40	34.50	

ANALYSIS OF VARIANCE FOR HYPOTHESIS II-C

Source	df	SS	MS	F
Total	199	7259.18		
Groups	1	3.38	3.38	.09
Within	198	7255.80	36.65	

*Significant at .05 level.
**Significant at .01 level.

ANALYSIS OF VARIANCE FOR HYPOTHESIS II-D

Source	df	SS	MS	F
Total	199	6472.22		
Groups	1	10.58	10.58	.32
Within	198	6461.64	32.63	

VITA

JIMMY MARSHALL RICE

Candidate for the Degree of

Doctor of Education

Thesis: A STUDY OF ATTITUDES OF ELEMENTARY TEACHERS TOWARD MODERN MATHEMATICS PROGRAMS

Major Field: Mathematics

Biographical:

Personal Data: Born at Portales, New Mexico, January 25, 1933, the son of C. N. and Nola Rice.

Education: Attended elementary school at Portales, New Mexico; graduated from Portales High School in 1951; received the Bachelor of Science degree from Eastern New Mexico University, Portales, New Mexico, 1955, with majors in mathematics and physics and a minor in secondary education; received the Master of Science degree from Eastern New Mexico University in 1956, with a major in mathematics; did graduate work in mathematics at Fort Hays Kansas State College, Hays, Kansas; did graduate work in mathematics at The University of Kansas, Lawrence, Kansas; completed requirements for the Doctor of Education degree at Oklahoma State University, Stillwater, Oklahoma, August, 1964.

Professional Experience: Employed by Douglas Aircraft Company, El Segundo, California, as Computing Analyst for IBM 701 and 704 computers from 1956 to 1957; employed in 1957 by Fort Hays Kansas State College as Instructor in Mathematics; presently employed as Assistant Professor of Mathematics at Fort Hays Kansas State College.

Professional Organization: Mathematical Association of America.