THE EFFECT OF A MICRO-TEACHING TECHNIQUE ON THE ATTITUDES OF PROSPECTIVE ELEMENTARY TEACHERS TOWARD MATHEMATICS

By

DARRELL C. KILMAN

Bachelor of Science in Education
State College of Arkansas
Conway, Arkansas
1958

Master of Education in Science
University of New Mexico
Albuquerque, New Mexico
1961

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the degree of
DOCTOR OF EDUCATION
August, 1969

THE EFFECT OF A MICRO-TEACHING
TECHNIQUE ON THE ATTITUDES OF
PROSPECTIVE ELEMENTARY
TEACHERS TOWARD
MATHEMATICS

Thesis Approved:

Kenneth E. Wiggins
Thesis Adviser

Gerald K. Goff

Kenneth St. Clair

Gene L. Post

D. D. Durham
Dean of the Graduate College

PREFACE

The primary purpose of this study was to compare the effectiveness of two methods of instruction in a mathematics course designed for prospective elementary teachers. Comparisons were made with respect to attitude toward mathematics and achievement in mathematics. It is hoped that the recommendations resulting from this study will provide a basis for further investigation in these areas.

I am especially grateful to Dr. Kenneth E. Wiggins, chairman of my advisory committee, for his advice and continued encouragement throughout the program of study.

I also wish to express my thanks to the following members of my committee: Dr. Gerald K. Goff, Dr. James K. St. Clair, and Dr. Gene L. Post.

In addition, I would like to thank Dr. Cecil Garrison and his assistants who operated the video-tape equipment used in this study.

Finally, I would like to express my appreciation to all others who assisted directly or indirectly in this investigation.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Twelve years have passed since Sputnik focused public attention on the need for long overdue revisions in our elementary and secondary mathematics program. The revisions which have been made since that time have increased sharply the demands on teachers of elementary mathematics; topics once reserved for secondary students are now being presented in the elementary grades, and are being presented in a more sophisticated form. The emphasis in mathematics at all levels has shifted from computational skills and rote memory to the understanding of mathematical concepts. Most mathematics educators assume that the new methods and the revisions in content level have afforded students at all levels an opportunity to understand mathematics without loss of utility.

"New mathematics" means many things. It conveys the idea that the mathematics of the traditional program has been replaced by a content radically new. In the elementary grades, it is difficult to point out any part of the traditional mathematics curriculum and say that "this" has been omitted. However, many new properties, concepts, language and symbols have been added to provide children with tools with which to think and to express themselves mathematically.

One aspect of the new mathematics which is apparent throughout the programs is the discovery approach. Children are guided to use concepts and language previously learned to identify patterns and approaches to new situations and, eventually, to make generalizations which combine many ideas into one general statement.

The new demands on elementary teachers place a greater responsibility on teacher training programs. To meet this challenge, teacher training institutions across the country are recommending six to nine hours of mathematics for the prospective elementary teacher, and considerably more than this for students who wish to specialize in mathematics. Teacher training programs cannot stop here. Institutions preparing teachers must recognize the need for courses in methodology which will provide each teacher with such interpretations and materials concerning the use of mathematics to solve problems of everyday living for each citizen. Each teacher needs time to become interested, to rid herself of fears, to develop understanding of mathematics, and to find security in the teaching of arithmetic. She must plan to continue updating herself through inservice experiences as long as she teaches.

A number of groups have contributed significantly to the changes in the elementary mathematics program. Several of the contributors are:

1. The School Mathematics Study Group (SMSG); Director, E. G. Begle.

2. The Science Research Associates (SRA), formerly The Greater Cleveland Mathematics Plan (GCMP); Director, B. M. Gundlach.

3. The University of Illinois Arithmetic Project; Director, David Page.

4. The University of Maryland Mathematics Project; Director John R. Mayor.

5. The Madison Project; Director, Robert B. Davis.

6. The Stanford Project; Director, Patrick Suppes.

Modern mathematics contains many parts called mathematical systems. The study of mathematics is essentially the study of these 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 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. In general terms the proposed changes which are being advocated by mathematics educators today can be listed as follows (1):

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.

6. Avoid excessive emphasis on manipulation and drill.

The more progressive elementary schools are now teaching the rudiments of algebra and also some informal geometry. Even in the teaching of arithmetic, sound mathematical training is needed because the teacher's understanding affects her views and attitudes; and in the classroom, the views and attitudes of the teacher are crucial. To an untrained teacher, arithmetic is merely a collection of mechanical processes and is regarded with boredom or dislike or even fear. It is not surprising that in such cases students react to the subject in the same way. Children should be taught arithmetic for meaning and understanding as well as for skills. To teach in this way, a teacher must have the kind of training which conveys this understanding and also shows mathematics to be rewarding and worthwhile. The teacher cannot give something which she does not have (2).

Statement of the Problem

The principal objective of this study was to compare two methods of teaching a mathematics course designed for prospective elementary teachers. One method involved the use of lectures by the instructor with a minimum amount of student participation. The second method involved identical topics, but a micro-teaching technique was employed in which the students presented the course content under the supervision of the instructor.

Specifically, this study investigated two problems:

1. How are the attitudes of prospective elementary teachers affected when a micro-teaching technique is employed in a course in elementary mathematics?

2. How is student achievement affected when a micro-teaching technique is employed in a mathematics course designed for prospective elementary teachers?

Hypotheses

The principal hypotheses tested in this study were:

1. Favorable attitudes of prospective elementary mathematics teachers toward mathematics will increase significantly while they are enrolled in Mathematics 4351.

2. Attitude change of the subjects in the experimental group will be significantly more favorable than that of the subjects in the lecture group.

3. The level of achievement of the subjects in the experimental group will be significantly greater than that of the subjects in the lecture group.

Need for the Study

In recent years experiments have been conducted to provide basic materials for the continued investigation of problems in the improvement of elementary mathematics programs. The results of certain of these investigations indicated rather widespread evidence of the elementary school teachers' incomplete mastery of mathematics. As a result of many studies, more emphasis is now being placed on finding ways to remedy the situation than on the gathering of additional data to reemphasize the deficiencies of elementary teachers.

Garstens (3) stated that it is not necessary to point out to any group concerned with elementary education that an elementary teacher should have a background that is broader and deeper than the level at which she is teaching. Furthermore, educators must accept the obligation to develop appropriate mathematics courses for elementary education majors, courses that will be suitable, stimulating, and significant.

The careful preparation of prospective elementary teachers in mathematics subject matter is a prerequisite to an improved program in mathematics at the elementary school level. Therefore, the question of elementary school mathematics is one that has been raised by many mathematics educators. Much has been written to support the fact that today's elementary teachers need to improve their basic knowledge and fundamental understanding of mathematics (4, 5, 6).

Three major sources of information for evaluating teacher competence are (i) a study of their self-judgement, (ii) an actual test of their knowledge, and (iii) a study of their attitudes. Groff (7) chose the first. He investigated the pre-service elementary teachers' self-judgement of the soundness of their preparation for teaching elementary school mathematics. The teachers felt they were very well prepared in modern elementary mathematics. The results further pointed out that these future elementary teachers felt they were better prepared to teach arithmetic than anything else except reading.

Melson (6) reported the results of a study based on a test of 33 items in elementary mathematics for grades one through six. This test was given in September 1963 to 41 elementary teachers who had been graduated the previous June. The results showed the median score to be 12 correct responses out of 33, or 36%. Two of the 41 teachers scored about 75%; 27 below 50%; and 12 below 25%. The most disturbing report was that all teachers involved indicated that they had successfully completed a course in modern mathematics. Melson pointed out that this indicated either inadequate preparation of the course or faulty mastery of it.

A study by Dutton (8) which surveyed the attitudes of prospective elementary teachers toward arithmetic revealed a large amount of unfavorable feelings toward arithmetic. Seventy-four per cent 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 drill, and feelings of inferiority and insecurity. This finding, in conjunction with Melson's findings, indicated the need for further research combining self-evaluation, content understanding, and attitudes.

The development of a method of instruction that will better prepare prospective elementary teachers in the area of mathematics offers a distinct challenge to those people directly involved in mathematics education. Although the use of micro-teaching is relatively new in the field of mathematics education, its success in other subject matter areas seems to warrant further investigation in this field (9).

Limitations of the Study

1. The study was restricted to students enrolled in Mathematics 4351 at the State College of Arkansas.

2. Self-selection was the basis for group formation.

3. There was no control group.

4. The experimental group realized that they were part of a study, and this may have affected the results.

5. Each subject was administered the same pretest and posttest. Therefore, taking the pretest may have affected the posttest results. However, this effect was controlled to some extent by the time lapse between tests and the fact that other examinations were

given during the semester.

6. The generalizations drawn from this study should be limited to the population utilized.

Clarification of Terms

<u>Attitudes toward mathematics</u>

Attitudes toward mathematics refers to how an individual feels about mathematics--an emotionalized feeling for or against mathematics as exhibited through the behavior of the individual (10).

<u>Achievement in mathematics</u>

Achievement in mathematics means a measure of the acquisition and retention of information in mathematics at the elementary level.

<u>Mathematics</u>

Mathematics, in this study, applies to both mathematics and arithmetic. The term, mathematics, is used in accordance with the commonly accepted definition.

<u>Micro-teaching</u>

Micro-teaching is a scaled-down teaching encounter which was developed at Stanford University. In this study, the subjects were required to teach brief lessons to the other members of the class. Video-tape recordings of these presentations were made and used in the critiquing sessions.

<u>Critiquing sessions</u>

Critiquing sessions are periods of time devoted to the critiquing of the video-taped recordings of the students' presentations during the previous class meetings. These sessions were conducted by the instructor and students. In order to standardize critiquing procedures, an appropriate evaluation scale was devised by the investigator. A copy of this instrument may be found in Appendix A.

Prospective elementary teacher

Prospective elementary teacher applies to an individual who is currently enrolled in an institution of higher learning while pursuing a degree in elementary education.

Mathematics 4351

Mathematics 4351 is a study of mathematical concepts and content of the elementary mathematics program.

Lecture group

Lecture group is a group of 42 students enrolled in Mathematics 4351 who were taught by the lecture method. All content was presented by the instructor.

Experimental group

Experimental group is a group of 43 students enrolled in Mathematics 4351 who were involved in the micro-teaching procedures.

Basic Assumptions

The assumptions upon which this study is based are:

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

2. The attitudes of prospective elementary teachers toward mathematics can be measured by instruments properly designed for that purpose.

3. The expressed responses of the subjects reflect their true feelings and attitudes. As Thurston (11) 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.

4. The achievement of prospective elementary teachers in mathematics can be measured by instruments properly designed for that purpose.

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

CHAPTER II

REVIEW OF RELATED LITERATURE

There are many points of disagreement among educators today, but there is one premise on which there is general agreement: The entire curriculum of the schools is in a state of constant change. Changes in the mathematics programs have been implemented so recently that time has not permitted extensive research on the impact of these changes.

For many years mathematics was taught in a traditional program: arithmetic in the first eight grades, algebra in grades 9 and 11, geometry in grades 10 and 11, and trigonometry in grade 12. The grammar school program was devoted only to arithmetic while the other subjects were taught in high school. The arithmetic program was divided into two parts. In the first six grades the children were taught the fundamental processes of addition, subtraction, multiplication, and division, with integers, fractions, and decimals. In grades 7 and 8 they learned to apply their computational skills to social, useful, or practical situations. The topics generally covered in the last two years of elementary school were areas, volumes, surfaces, percentages, taxes, commissions, insurance, installment buying, and interest. Paul Rosenbloom (12) characterized this mathematics curriculum as appropriate to the conditions of 1910 when the majority of the pupils left school before high school and when the majority of the adults were unskilled laborers.

Since 1957 many organizations, groups, and individuals have been working to change the mathematics curriculum. They have accepted the challenge to prepare children mathematically for the conditions that exist today and also for conditions that they will face in the second half of the twentieth century. In some sections of the country the mathematics curriculum of the elementary school is a completely new one that bears very little resemblance to the traditional program. The application of appropriate evaluation procedures will indicate the trends for the future.

Although many schools have experimented with new mathematics programs, many elementary teachers are still teaching the same old curriculum by the same methods. It is difficult to modify an entrenched curriculum. Regardless of the content and methodology that is proposed for a mathematics program, the knowledge and attitudes of the teachers remain the paramount factors. The well-qualified teacher must know mathematics, and in addition she must teach the subject with interest and enthusiasm. She must make the subject interesting and appealing, so that her pupils will continue to study it with enthusiasm. It is the opinion of mathematics educators that the teacher who fears and dislikes mathematics will not teach very much mathematics to her students, and they will abandon the subject at the first opportunity. One of the best ways for a teacher to attract students to the study of mathematics is for the teacher to understand the subject and have a positive attitude toward it (13, 14).

In reviewing the literature related to this study, emphasis was on comments by researchers and mathematics education specialists in areas related to attitudes toward mathematics. Some attention was also given to literature related to the theories of learning and micro-teaching.

The significance of attitudes to teaching and learning has been widely discussed in educational literature during the past several years. Many studies have been conducted concerning attitudes toward school subjects. The following studies are representative of the ones related to attitudes toward mathematics and mathematics programs.

Studies by Davis (15) revealed that teachers are in a strategic position for inducing favorable or unfavorable attitudes. Many persons have an excellent command of the thought processes which they owe, in part, to certain of their former teachers. It follows that many conditions of anti-intellectualism, lact of self-confidence, overt expression of hostility, dislike for certain subjects, or failure to appreciate abstract thought can be traced to teachers who have been instrumental in instituting certain patterns of behavior.

Dutton (8) expressed the opinion that attitudes held by prospective teachers toward the subjects that they will have to teach would seem to warrant study. In a study of 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 at Los Angeles. These statements were then tabulated under two headings: (i) factors responsible for favorable attitudes, and (ii) factors causing unfavorable attitudes.

One of the most significant factors coming out of the study was an outpouring of unfavorable feelings toward arithmetic. Seventy-four per cent 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 drill, and feelings of inferiority and insecurity. A more stable type of response was given in relation to favorable statements which were less emotionally charged than were the unfavorable statements (8).

In a second investigation, Dutton (16), of the University of California at Los Angeles, studied the attitudes of prospective teachers toward arithmetic. The conclusions were that such attitudes can be measured objectively and that useful data are obtainable for assistance in the education of prospective elementary teachers. He also concluded that the intermediate grades and junior high school are the crucial levels in the development of attitudes toward arithmetic. Several other important conclusions included the following:

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

2. Feelings toward arithmetic are developed in all grades. The most crucial levels are in grades 3 through 6 and in 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. Significant unfavorable attitudes are: not feeling secure in the subject, being afraid of word-problems, and fear of the subject in general.

Dutton (17) made a third study of attitudes, this one involving junior high school students representing a wide variety in language, ability, cultural background, and levels of parental income. The findings were that pupils' dislike for arithmetic is dependent upon a lack of understanding, difficulty in working problems, and poor achievement.

In 1962 Dutton (18) conducted a study to determine whether there were any changes in attitudes of prospective elementary teachers toward mathematics since 1954. He tested a group of college students who had completed a methods course dealing with the teaching of arithmetic. Most of them had also taken algebra I and II and geometry in high school. The instrument used in the study was a shortened form of the attitude scale used by Dutton in 1954. 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 prospective teachers in the 1962 sampling.

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

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 the elementary school, continued study should be made of the improvement of 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.

Smith (19) administered the Dutton scales to prospective elementary teachers in 1964 and found that his group was more favorably inclined toward arithmetic than Dutton's 1954 group. Smith concluded that by 1964, knowledge of the revolution in school mathematics could have evoked substantial Hawthorne effect among prospective elementary teachers.

A study of attitudes toward mathematics by Aiken (20) had some interesting results. He concluded that (i) individuals with apparently identical abilities and seemingly similar experiences with mathematics may have quite different attitudes toward the subject and (ii) attitudes are affected by the specific pattern of reward that the individual receives in mathematics. Another finding was that attitude toward mathematics is not closely related to attitudes toward other academic subjects. However, it is related to students' statements about previous mathematics teachers. A study by Aiken and Dreger (21) also revealed that students' attitudes toward mathematics are closely related to their experiences with former mathematics teachers.

Straight (22) 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 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.

Straight'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 proposes that variables such as teacher's educational background, recent training, age, or years of experience make no significant difference either in her attitude toward the teaching of arithmetic, or in the attitude of the children in the group

Rice (23) arrived at similar conclusions in his study of attitudes of in-service elementary teachers.

The purpose of a study conducted by Kane (24) was to assess the attitudinal structures of prospective elementary teachers toward mathematics and other subject matter areas in which they would be teaching. An instrument was administered to 58 elementary education majors at Purdue University at the close of their student teaching period. It was administered by a neutral person in a neutral setting to avoid bias toward any of the subject areas. Results indicate that the prospective teachers tended to have relatively favorable attitudes toward mathematics, and particularly toward teaching mathematics in the elementary school. Relatively positive attitudes toward mathematics and the desire to teach in the intermediate grades seem to be paired, while those students who indicate unfavorable attitudes toward mathematics tend to prefer assignments in the primary grades.

Almost all of the prospective teachers in Kane's study left the elementary school between 1954 and 1956, before the curriculum revision in mathematics had affected the elementary school. Most of them completed traditional secondary mathematics courses. Nevertheless, at the time the data were collected, these education majors exhibited relatively positive attitudes toward mathematics. What part of this outcome is due to publicity about "new mathematics" and reformed collegiate curricula in mathematics education is not known.

One of the premises on which the present study is based also sparked extensive studies by Breer and Locke (25). Their theory is that the individual learns by doing, that is, by working on a task. They contend that attitudes have their roots in task experience and their theory predicts that no attitude change will take place until the individual has become actively engaged in performing his task, and that the longer he works at it (up to a point) the greater will be its effect on his attitudes. In summarizing their seven studies, they report the following:

> The overwhelming majority of the findings, from behavior through situationally specific orientations all the way to abstract beliefs, values, and preferences, confirmed the predictions made on the bases of our theory. There can be no doubt, in the laboratory, at least, that task experiences operate as an important determinant of an individuals system of attitudes. Whether or not these findings will be supported by studies conducted outside the laboratory is another matter.

Although attitudes, interests, and achievement are by no means synonymous, writers recognize a definite relationship between them. Witty (26) made the following statement concerning the role of attitudes in children's failures and successes:

> In every subject area the efficiency of instruction will be brightened by the development of an educational program which recognizes the significance of each child's attitudes.

The classroom teacher needs to be constantly alert for the attitudes students are developing. There is much evidence to support the fact that a positive correlation exists between attitudes teachers possess and attitudes their pupils acquire (27). Thus the teacher must remember that attitudes are learned and that a major function of effective teaching is to provide an environment for the growth of positive attitudes.

Since most educators agree that attitudes are learned, a brief discussion of literature related to theories of learning seems pertinent to the present study. Most writers are aware that a great deal of highly effective teaching of mathematics goes on now and has gone on over the years. How else can one explain the rapid strides made in the field of mathematics and related fields in this century? Reputable mathematicians say that more new mathematics has been developed since 1900 than was known at that time. Surely some of the students managed to avoid being stymied in their development by the loudly condemned methods claimed to be prevalent in our classrooms. The work of mathematics teachers has been widely criticized,and such criticism has been helpful. It can continue to be helpful when it is not prejudiced by special interest groups and when it is not entirely negative (28).

Throughout the first half of the twentieth century psychologists have been active in the development of learning theories. Even though there is much on which learning theorists disagree, educators have also found many points on which there seems to be general agreement. They suspect that these points of agreement constitute a sounder guide for practice than does complete adherence to any one theory (29).

After reviewing ten theories with careful documentation, Hilgard (30) develops the following points of agreement:

1. In deciding who should learn what, the capacities of the learner are very important. Brighter people can learn things less bright ones cannot learn; in general, older children can learn more readily than younger ones; the decline of ability with age in the adult years depends upon what it is that is being learned.

2. A motivated learner acquires what he learns more readily than one who is not motivated. The relevant motives include both general and specific ones, for example, desire to learn, need for achievement (general), desire for a certain reward or to avoid a threatened punishment (specific).

3. Motivation that is too intense (especially pain, fear, anxiety) may be accompanied by distracting emotional states, so that excessive motivation may be less effective than moderate motivation for learning some

kinds of tasks, especially those involving difficult discriminations.

4. Learning under the control of reward is usually preferable to learning under the control of punishment. Correspondingly, learning motivated by success is preferable to learning motivated by failure. Even though the theoretical issue is still unresolved, the practival outcome must take into account the social by-products, which tend to be more favorable under reward than under punishment.

5. Learning under intrinsic motivation is preferable to learning under extrinsic motivation.

6. Tolerance for failure is best taught through providing a backlog of success that compensates for experienced failure.

7. Individuals need practice in setting realistic goals for themselves, goals neither so low as to elicit little effort nor so high as to foreordain to failure. Realistic goal setting leads to more satisfactory improvement than unrealistic goal setting.

8. The personal history of the individual, for example, his reaction to authority, may hamper or enhance his ability to learn from a given teacher.

9. Active participation by a learner is preferable to passive reception when learning, for example, from a lecture or a motion picture.

10. Meaningful materials and meaningful tasks are learned more readily than nonsense materials and more readily than tasks not understood by the learner.

11. There is no substitute for repetitive practice in the overlearning of skills (for instance, the performance of a concert pianist), or in the memorization of unrelated facts that have to be automatized.

12. Information about the nature of a good performance, knowledge of his own mistakes, and knowledge of successful results aid learning.

13. Transfer to new tasks will be better if, in learning, the learner can discover relationships for himself, and if he has experience during learning of applying the principles within a variety of tasks.

14. Spaced or distributed recalls are advantageous in fixing material that is to be long retained.

All of Hilgard's points of agreement apply to the teaching situation in which the present study was conducted. However, points 9 and 10 seem to be especially applicable to the micro-teaching technique used in this experiment. Micro-teaching certainly requires active participation by the prospective elementary teacher. She must present content which is mathematically correct, and she must present it in a clear, concise form so that the other members of the class can understand it. During the critiquing session when the video-taped presentation is replayed, the learner gains information about the nature of her performance. The instructor points out the learner's mistakes, but the strong points in the presentation are emphasized. The immediate feedback provided by the video-tape replay increases the effectiveness of the learning situation (31).

Since micro-teaching is one of the most recent innovations in teacher education, the literature relating to this technique is limited. Developed at Stanford University by Professor Dwight W. Allen (32) and his associates, micro-teaching is designed to concentrate on the development of particular competencies on the part of the prospective teacher. The prospective teacher teaches brief lessons to small groups of students. These teaching episodes, which last from five to ten minutes, are usually video-taped and played back to the prospective teacher and his supervisor for purposes of analysis. The prospective teacher then reteaches the same concept to a new group of students. This process is repeated until competence is achieved in a particular teaching skill. The micro-teaching procedures used in the present study vary slightly from those developed at Stanford, but they are basically the same.

The purpose of micro-teaching, as it was used at Stanford, was to prepare the prospective teacher for student teaching. The act of teaching was broken down into technical skills. The emphasis during any one micro-teaching experience was on one of these skills, the idea being that the prospective teacher would make progress by improving one skill at a time.

The following nine skills were isolated at Stanford (33):

1. Establishing a set. -- This is the skill of establishing a setting for the idea to be learned. The purpose is to gain rapport between students and teacher in order to obtain immediate involvement in the lesson. Experience indicates that there is a direct relationship between effectiveness in establishing set and effectiveness of the total lesson.

2. Establishing appropriate frames of reference. -- A single frame of reference might be adequate for a student to learn, but several frames of reference deepen and broaden the general field of understanding. An example in mathematics teaching is to present, or have students present, more than one way of solving a problem.

3. Achieving closure when the major purposes, principles, and constructs of a lesson, or part of a lesson, are judged to have been learned. -- This is more than a simple summary of the lesson; it should pull together the major points, act as a cognitive link between past knowledge and new knowledge, and leave the student with the feeling that he has really learned something.

4. Using questions effectively. -- The novice teacher tends to ask questions that are so general in nature, or so vague or poorly worded, that it is impossible for the students to answer them; or he tends to ask questions that are so specific they can be answered by a single word.

5. Recognizing and obtaining attentive behavior. -- The prospective teacher learns to recognize visual cues of interest or boredom, of comprehension or bewilderment, and can practice changing class activities to regain attention.

6. Controlling participation. -- The beginner learns how to encourage or discourage classroom participation and how to analyze his positive and negative reactions

to students.

7. Providing feedback. -- The new teacher tends to get feedback on how well the lesson is being learned by calling for the feedback from too few students, usually those he soon learns will know the right answers.

8. Employing rewards and punishments. -- The major aim here is to learn how to use these for reinforcement purposes.

9. Setting a model. -- Micro-teaching makes it possible to provide good models of specific technical skills as an integral part of training.

The video-tape is a definite asset in the micro-teaching process. The visual and audio record of the teaching allows the student to see and hear her performance. Her supervisor can help her analyze the lesson so that she can practice for improvement and micro-teach again to see if she has improved (34).

The review of related literature revealed that teacher training programs must be under constant study if they are to produce teachers who are qualified in both content and methodology. Dr. John I. Goodlad (35) of UCLA, in his report on curriculum reform development, emphasizes the importance of teacher education in curriculum reform projects in the following statement:

> Broad-scale implementation of current curriculum projects depends upon both the usefulness of materials produced and the in-service education of teachers who use them. Most projects have distinguished themselves on both accounts. Continuing self-renewal of the current curriculum reform movement, however, depends upon the pre-service preparation of teachers in new content (and accompanying pedagogy), and the education of teachers of teachers who understand and are sympathetic to the place of organized subject matter in the education of the young. Current projects have not distinguished themselves on this account.

CHAPTER III

THE EXPERIMENT

Introduction

The experiment was conducted at State College of Arkansas during the first semester of the 1968-69 academic year. The purpose of the experiment was to compare the effects of two methods of instruction on two groups of prospective elementary teachers enrolled in an elementary mathematics course. The primary concern of the investigator was the effect of the two methods of instruction on the attitudes of the students toward mathematics. The effect on achievement was also considered in the study, but no attempt was made to measure the correlation between attitude and achievement in mathematics.

The classes chosen for the experimental part of the study were two sections of mathematics for elementary teachers. In the experimental group of 43 students the course content was presented by the students. The lecture group of 42 students was taught by the instructor who presented the course content by the lecture method. An attempt was made to assign the same number of students to each section, but no attempt was made to assign them randomly. There was no control group in this study. The investigator was the only instructor involved in the experiment.

Two instruments were used in the experiment. The Dutton Arithmetic Attitude Scale and The Structure of the Number System test were administered to each group during the first week of the semester, in September. Just prior to the close of the semester, in January, the same instruments were administered to each group a second time. The statistical analyses related to the experiment were completed by using the adjusted posttest results.

Subject Matter

The subject matter involved in the experiment is commonly referred to as modern mathematics for elementary teachers. Topics covered included set theory, whole numbers, systems of numeration, integers, rational numbers, decimals, the number line and its uses, and geometry.

The following concepts were developed in the unit on set theory: set, set membership, set notation (including set-builder notation), set measurement (empty set, finite set, and infinite set), set relationships (equivalence, equality, greater than, less than, disjointedness, subset, and proper subset), universal set, complement set, set operations (union, intersection, complementation, cross product, and partition), and set operation properties (closure, commutativity, associativity, identity, and distributivity).

The following concepts were developed in the units on whole numbers: number, numeral, numeration, counting numerals, place-value, expanded notation, addition, subtraction, multiplication, division, order, and ordinal numbers. The properties of the whole numbers under addition and multiplication were also developed. These included closure, commutativity, associativity, identity, cancellation, and distributivity. Each of the above properties were developed by relating them to an appropriate concept from set theory. For example, addition was developed using the union of disjoint sets. The fact that most of the above properties did not hold for the operations of subtraction and division on the whole numbers was illustrated by using appropriate counterexamples. Finally, the algorithms for each operation were developed in great detail.

In the unit on systems of numeration the important concepts from base ten were reviewed and nondecimal systems were introduced. During this review, base ten was presented as a mathematical system consisting of ten basic symbols, a place value principle, two direct operations (addition and multiplication), and two inverse operations (subtraction and division). Grouping was used to illustrate that a given number idea may have many different symbolisms. The operations (addition, subtraction, multiplication, and division) were presented through the use of expanded notation and regrouping. Both decimal and nondecimal bases were used in these presentations. The use of nondecimal bases served to promote an understanding of the operations and procedures which would have been memorized in a base ten system. In other words, the students' previous knowledge of the operations in base ten would have tended to cause them to ignore the significance of place value as they carried out the four fundamental operations on the set of whole numbers. As closure, commutativity, associativity, identity, cancellation, and distributivity were used in nondecimal bases, it was pointed out that these properties are independent of any given system of numeration.

In order to provide closure under the operation of subtraction, the set of whole numbers had to be extended to include negative numbers.

For example, $5 - 7 = -2$ which is not a member of the set of whole numbers. This new set which includes the whole numbers and their negatives is called the set of integers. It was pointed out that this extension of the set of whole numbers not only provides closure under subtraction, but it introduces a new property, the additive inverse. The students were shown that the properties previously stated for the set of whole numbers also hold for the set of integers.

A rational number was defined as a class of ordered pairs of integers, denoted by the pairs in lowest form. It was pointed out that these ordered pairs could be written in the form (a, b) or a/b where a and b are integers and b is not equal to zero. This symbolism was then used in defining an equivalence relation, addition, subtraction, multiplication, and division. For example, addition was defined as follows: For any two rational numbers a/b and c/d, their sum is defined to be (ad + bc)/bd. The properties (closure, commutativity, associativity, identity, inverse, and distributivity) for the four fundamental operations were developed as theorems based on the above definitions and the related properties for the integers. Definitions for order and density were given and tests for ordering rational numbers in lowest form were introduced. For example, it was shown that $a/b > c/d$ if and only if $ad > bc$; and $a/b < c/d$ if and only if $ad < bc$.

The unit on decimals was probably the most traditionally treated unit presented. This unit included the following concepts: decimal notation, converting decimals to fractions, addition with decimals, subtraction with decimals, products and quotients involving powers of ten, multiplying with decimals, dividing with decimals, rounding off decimals, converting fractions to decimals, converting a repeating decimal to an equivalent fraction, and scientific notation.

The number line was presented as an arbitrary line (usually horizontal) with an arbitrary point as the origin representing the integer zero and an arbitrary unit of length for determining the position of each of the other integers. The number line was used to illustrate number facts, not to prove them. Even though the entire set of real numbers was not treated in this course, the existence of a one-to-one correspondence between the points on the number line and the set of real numbers was pointed out. Each of the four operations (addition, subtraction, multiplication, and division) on whole numbers was illustrated using the number line and examples were given. Also, certain properties of integers and fractions under these operations were illustrated using the number line.

In the unit on geometry primary emphasis was on the aspects of nonmetric geometry. Only minimum attention was given to such measurement concepts as length, area, and volume. The set concepts and language developed in the unit on set theory were used in the discussion of geometric figures as sets of points. The following geometric concepts were presented in this unit: points, segments, lines, rays, planes, angles, simple closed curves, regions, polygons and polygonal regions, and convex sets.

Methods of Instruction

Two methods of instruction were employed in the experiment. They were the "lecture" method and the "micro-teaching" method. In this report the group taught by the "lecture" method is referred to as the lecture group, while the group taught by the "micro-teaching" method is referred to as the experimental group.

In an attempt to minimize the number of variables which might influence the outcome of the experiment, the following guidelines were observed.

1. Each of the groups met two periods per week. Each period lasted 75 minutes.

2. The class periods for both groups were in the morning.

3. Both groups met in the same classroom.

4. With the exception of the video-tape recorder, the same facilities were available to both groups.

5. The investigator was in charge of all class meetings pertaining to this experiment.

6. The same textbook, Arithmetic, Its Structure and Concepts by Francis J. Mueller (36), was used and the same concepts were presented to both groups.

7. Similar teacher made tests were administered to both groups for grading purposes.

8. The same instruments for measuring the effects of the two methods of instruction on attitudes toward mathematics and achievement in mathematics were administered to both groups.

The lecture method was the method of instruction which is normally used in mathematics courses designed for prospective elementary teachers. Each new concept was first introduced through a lecture presented by the instructor. The number of concepts developed in a given 75 minute period varied in relation to the complexity of the given concepts. The lecture was then supplemented by a homework assignment which consisted of reading in the textbook and solving specified problems from the textbook which were related to the lecture. The concepts covered in the reading assignment were discussed again at the beginning of the next class meeting and the students were allowed to ask questions about concepts or assigned problems which had given them difficulty. After all questions were answered, the instructor then lectured on new concepts and a new assignment was made. This cycle was repeated throughout the entire course.

Four 50 minute examinations and a final examination were administered during the semester. Each of the four 50 minute examinations contained questions pertaining to the concepts covered since the previous examination. The two hour final examination was comprehensive in nature. Since these examinations were used primarily for grading purposes, the results were not included in the statistical analysis related to the experiment.

The experimental method involved a more active role on the part of the students. The subject matter covered was the same as that presented to the lecture group, and the same textbook was used, but most of the content was presented by the students. Each student in the experimental group gave two presentations during the semester. These presentations varied in length from five to twenty minutes, but most of them lasted about ten minutes.

During each class meeting, topics to be presented during the next class meeting were assigned to from two to four students. The assignment for the remainder of the group was the same as the one for the lecture group. These assigned topics were presented by the students during the first part of the next class meeting. Other members of the class were instructed to ask questions and make comments during the presentations. Even though class participation was encouraged during the entire semester, the more productive discussions occurred during the second half of the semester. This was probably due to the fact that each student had given one presentation during the first nine weeks and they all felt more secure in the microteaching situation as the semester progressed. After the students completed the presentation of their assigned topics, the remainder of the period was used by the instructor to review the concepts just presented, to answer questions, to make individual assignments for the next class meeting, and to make the class assignment.

All student presentations were video-taped. Critiquing sessions were scheduled for the afternoon of the day on which the students taught. These sessions were attended only by the instructor and the students who had been video-taped that day. As the tapes were replayed, the instructor pointed out strong points and weak points in both content and methodology. For example, if the student had presented a particular mathematical concept and had given appropriate examples illustrating the concept, the instructor praised the student for her knowledge of the concept and her ability to present it clearly. On the other hand, if the student failed to communicate with the other members of the class during her presentation, this weakness was pointed out. During the critiquing sessions major emphasis was on reinforcing the actions of the students which the instructor considered to be desirable. Even though each student was given suggestions as to how she might improve her next presentation, the major emphasis was on positive reinforcement.

Each tape was replayed as many times as the student desired.

In some cases the instructor would stop the tape and replay only the part which he or the student wanted to see a second time. The flexibility of the video-tape recorder allowed the instructor to stop the tape at any point in the presentation where he felt that comments would be helpful, but most of the comments and suggestions were withheld until the end of the tape.

Except for the days on which examinations were given, the above procedures were repeated during the entire semester. The examination procedures were the same as those for the lecture group.

Evaluation Instruments

Two instruments were used in this experiment. The first, Wilbur H. Dutton's Arithmetic Attitude Scale, is a 22 statement Thurstone type scale designed to measure the attitude of prospective elementary teachers toward mathematics. Dutton (8) asked students enrolled in education classes at the University of California to write out their feelings toward arithmetic. Two categories were used--favorable and unfavorable attitudes. Eighty-three statements were selected from the responses collected over a five-year period. After these statements were carefully edited, 45 statements were retained for use in the sorting procedures which were used in the further selection of desirable statements. The final scale consisting of 22 statements was selected from the 45 statements of feelings toward arithemetic. The scale values of these statements range from 1.0 for the statement "I detest arithmetic and avoid using it at all times" to 10.5 for the statement "Arithmetic thrills me, and I like it better than any other subject." No attempt was made to give a total score or an average score for the scale. In this experiment, each student was instructed to respond to as many or as few of the statements as they thought applied to their feelings.

Dutton measured the reliability of the scale by the test-and-retest procedure. The correlation between the two sets of scores, taking an average scale value for the total test for each student, was 0.94. While there were enough statements for constructing a second scale and correlating the two scales, Dutton felt that this one was adequate for the purpose for which it was designed.

The second instrument, The Structure of the Number System (Form A), produced by Educational Testing Service, Cooperative Mathematics Tests Division, was used to measure the levels of achievement resulting from the two methods of instruction. This test is an achievement test designed to measure understanding of the real number system up to the rational numbers. The test consists of 40 multiple choice questions which sample the following topics: arithmetic judgement, operational properties (closure, commutativity, associativity, and distributivity), inverses and identities, properties of the integers, place value, (factors, divisors, and multiples), prime numbers, number lines, zero denominator, number systems (bases other than ten), modular arithmetic, and Roman numerals.

The Number Systems test was designed by the Educational Testing Service staff and some 46 high school and college mathematics teachers. The test was pretested throughout the country in May, 1960. After analyzing the results, it was revised in May, 1961 and repretested in May, 1962. The results from the second pretesting indicated the test was appropriate for the intended population.

This test was selected because it was the only commercially produced test directly related to the secondary objective of the experiment, that of comparing student achievement in mathematics resulting from two methods of instruction. It stresses understanding of facts, principles and relationships, and does not emphasize computational skills. Furthermore, the test is a measure of developed abilities, and thus its content validity is very important. Educational Testing Service feels they have insured this by entrusting test construction to persons well qualified to judge the relationship of test content to teaching objectives. The reliability reported by E. T. S. is a measure of internal consistency, computed by using the Kuder-Richardson Formula 20. The reliability of the test was .86 with a standard error of measurement of 2.75. The correlation of the test with the SCAT-Quantitative Test was .78. Educational Testing Service pointed out that this was lower than expected, but this was due to the fact that this test measures understanding while the SCAT-Quantitative Test emphasizes computational skills. The test had an item-total score discrimination correlation of .50. These results indicate that the test is effective in discriminating between high and low ability students (37).

Analysis

A nonrandomized pretest-posttest design was used in this experiment (38). The pretests, The Dutton Arithmetic Attitude Scale and The Structure of the Number System test, were administered to both groups during the first week of the semester in September, 1968. The posttests, The Dutton Arithmetic Attitude Scale and The Structure of the Number System test, were administered during the last week of the sémester in January, 1969. The data which were used to test the hypotheses were the pretest and posttest scores. Other data such as I.Q. scores, personality test evaluations, and A.C.T. mathematics test scores were not available for the groups.

The t test was used to determine whether or not there was a significant difference in the mean obtained when The Dutton Arithmetic Attitude Scale was administered at the beginning of the course and the mean obtained when the same scale was administered at the end of the course. Popham (39) explains the use of the t test when he states:

> The t test is used to determine just how great the difference between two means must be in order for it to be judged significant, that is, a significant departure from differences which might be expected by chance alone.

Since "intact" groups were used in the experiment, analysis of covariance was employed to test the second and third hypotheses. Garrett (40) explains the use of analysis of covariance in the following statement:

> Analysis of covariance represents an extension of the analysis of variance to allow for the correlation between initial and final scores. Covariance analysis is especially useful for experiments in the behavioral sciences where for various reasons it is impossible or quite difficult to equate control and experimental groups at the start: a situation which one often obtains in actual experiments. Through covariance analysis one is able to affect adjustments in final or terminal scores which will allow for differences in some initial variable.

Further justification for using analysis of covariance in this experiment is found in the following statement by Popham (39).

> It should be noted that analysis of covariance is often used to investigate mean differences between only two groups. This situation ordinarily, without the adjustment operation, would be treated with a t test rather than analysis of variance. This is done because there is no method of adjusting two intact groups in the t test scheme other than through

analysis of covariance.

The second hypothesis stated that attitude change of the subjects in the groups taught by the micro-teaching method would be significantly more favorable than that of the subjects taught by the lecture method. In the test of this hypothesis, the criterion or dependent variable was the posttest scores on The Dutton Arithmetic Attitude Scale, the control variable was the pretest results on the same scale, and the independent variable was the method of instruction used on each of the two groups.

The third hypothesis stated that the level of achievement of the subjects in the experimental group would be significantly greater than that of the subjects in the lecture group. In the analysis of covariance testing this hypothesis, the criterion or dependent variable was the posttest scores on The Structure of the Number System test, the control variable was the pretest results on the same test, and the independent variable was the method of instruction employed during the experiment.

As indicated previously, no attempt was made in this experiment to measure the correlation between the scores obtained on the attitude scale and those obtained on the mathematics achievement test. The statistical treatment of scores related to attitude toward mathematics was completely independent of the treatment of scores related to achievement in mathematics.

CHAPTER IV

ANALYSIS OF THE DATA

Introduction

This chapter reports the data gathered and interprets these from inferences drawn from certain statistical procedures. All data were analyzed by the Oklahoma State University Computer Center at Stillwater, Oklahoma. The .05 level was used to judge the significance of all statistical tests. The rejection of any hypothesis was directed; therefore, one-tailed tests of significance were employed. This chapter is divided into three major parts representing the three hypotheses stated in research form. Even though the same data were analyzed in the tests of the first two hypotheses, two different statistical tests were employed. Consequently, they are treated separately in this report.

Change in Attitude--One Group

The first hypothesis stated that favorable attitudes of prospective mathematics teachers toward mathematics will increase significantly while they are enrolled in Mathematics 4351. In the statement of this hypothesis, no distinction was made between subjects in the experimental group and those in the lecture group. In other words, for the purposes of this hypothesis, all 85 subjects involved in the study were combined to form one group. The test of this hypothesis was based on the pretest and posttest scores listed in Table I. Even though the scores for the experimental group and the lecture group were not treated separately in this part of the report, they are listed separately in Table I. Later reference will be made to this table, at which time it will be necessary for the scores of the two groups to be listed separately.

TABLE I

MATHEMATICS ATTITUDE INVENTORY SCORES

Experimental Group			Lecture Group		
Student	Pre	Post	Student	Pre	Post
1	6.30	5.82	1	3.56	4.25
2	3.68	4.94	2	4.63	5.25
3	6.66	6.17	3	6.06	5.60
4	4.81	4.81	4	6.20	4.60
5	5.18	5.40	5	5.39	6.00
6	5.05	5.26	6	3.33	3.78
7	3.71	3.87	7	3.60	4.97
8	4.41	6.40	8	5.44	5.64
9	7.37	6.80	9	7.33	6.79
10	4.48	5.22	10	6.61	8.21
11	6.83	5.82	11	6.66	7.64
12	7.78	6.94	12	3.72	2.66
13	5.87	6.10	13	4.64	4.89
14	6.10	5.98	14	6.24	6.99
15	4.63	6.27	15	4.48	4.63
16	4.18	5.01	16	2.72	4.15
17	5.03	6.27	17	3.88	3.83
18	5.06	5.60	18	6.83	7.83
19	6.02	6.21	19	5.65	5.22
20	6.69	4.13	20	4.49	4.72
21	4.63	4.00	21	4.04	4.91
22	4.70	5.85	22	4.71	4.07
23	3.70	4.19	23	7.96	7.45
24	3.46	3.94	24	6.36	4.90
25	8.34	8.26	25	4.13	4.71
26	6.15	7.67	26	6.10	7.57
27	4.18	4.40	27	6.68	7.32

TABLE I (Continued)

Experimental Group			Lecture Group		
Student	Pre	Post	Student	Pre	Post
28	3.91	3.76	28	5.10	5.22
29	6.98	6.51	29	5.02	6.07
30	6.55	6.61	30	4.01	3.16
31	4.58	6.07	31	5.55	5.54
32	6.61	6.07	32	5.44	6.80
33	7.80	6.44	33	6.45	6.73
34	4.68	5.58	34	4.33	6.78
35	8.01	7.72	35	3.81	5.23
36	7.08	6.86	36	6.96	6.40
37	7.88	6.10	37	7.22	7.54
38	5.18	5.88	38	6.18	6.71
39	7.43	7.49	39	3.71	5.00
40	7.13	8.00	40	4.40	3.38
41	7.22	6.95	41	3.71	4.00
42	4.54	4.16	42	5.72	6.33
43	4.42	4.48			
Mean	5.69	5.81		5.22	5.56
Gain	0.12			0.34	
Standard Deviation	1.46	1.04		1.20	1.38

A summary of the statements selected on <u>The Dutton Attitude Scale</u> by the subjects involved in this study is reported in Table II. Each statement has a scale value which indicates the intensity of the respondent's feelings. The scale values range from 1.0 (strong dislike) to 10.5 (strongly in favor).

Although the results listed in Table II show an increase in the percentage of the sample who chose positive statements with the exception of statement numbered 17, it should be noted that the change in magnitude of some of these percentages was slight. Furthermore, only a small percentage of the sample chose positive statements numbered

TABLE II

ATTITUDE TOWARD ARITHMETIC BEFORE AND AFTER COMPLETION OF A COURSE IN MATHEMATICS FOR ELEMENTARY TEACHERS

Statement	Scale Value	Percent Pre	Percent Post
1. I think about arithmetic problems outside of school and like to work them out.	9.5	10.59	18.82
2. I don't feel sure of myself in arithmetic.	3.7	62.35	54.12
3. I enjoy seeing how rapidly and accurately I can work arithmetic problems.	8.6	25.88	38.82
4. I like arithmetic, but I like other subjects just as well.	5.6	49.41	45.88
5. I like arithmetic because it is practical.	7.7	24.71	28.24
6. I don't think arithmetic is fun, but I always want to do well in it.	4.6	48.24	32.94
7. I am not enthusiastic about arithmetic, but I have no real dislike for it either.	5.3	48.24	28.24
8. Arithmetic is as important as any other subject.	5.9	89.41	86.12
9. Arithmetic is something you have to do even though it is not enjoyable.	3.3	30.59	22.35
10. Sometimes I enjoy the challenge presented by an arithmetic problem.	7.0	64.71	70.59
11. I have always been afraid of arithmetic.	2.5	34.12	35.29
12. I would like to spend more time in school working arithmetic.	9.0	8.24	18.82
13. I detest arithmetic and avoid using it at all times.	1.0	2.35	1.18
14. I enjoy doing problems when I know how to work them well.	6.7	78.82	83.53
15. I avoid arithmetic because I am not very good with figures.	3.2	31.76	16.47
16. Arithmetic thrills me, and I like it better than any other subject.	10.5	1.18	2.35

TABLE II (Continued)

Statement	Scale Value	Percent Pre	Percent Post
17. I never get tired of working with numbers.	9.8	8.24	4.71
18. I am afraid of doing word problems.	2.0	52.94	52.94
19. Arithmetic is very interesting.	8.1	40.00	49.41
20. I have never liked arithmetic.	1.5	15.29	10.59
21. I think arithmetic is the most enjoyable subject I have taken.	10.4	3.53	10.59
22. I can't see much value in arithmetic.	3.0	0.00	0.00

16, 17, and 21 on the posttest; whereas a relatively large percentage of these students selected negative statements 2 and 18.

The percentage of the sample who chose negative statements decreased on all negative statements except those numbered 11, 18, and 22. The percentage of students selecting statement numbered 11 increased slightly; whereas the pretest and posttest percentages on statements numbered 18 and 22 remained constant.

Although the results listed in Table II indicate that the mathematics course for elementary teachers cultivated a more favorable attitude toward arithmetic, the t test was used to determine if the difference between the means on the pretest and posttest was significant The results of the t test analysis are reported in Table III.

As a starting point toward testing the first hypothesis, the means of the pretest and the posttest scores on the attitude scale

TABLE III

A COMPARISON OF MATHEMATICS ATTITUDE INVENTORY SCORES

Test	Number	Standard Deviation	Mean Score	t
Pre	85	1.37	5.46	2.39*
Post	85	1.29	5.69	

*1.66 required for significance at the .05 level.

were noted. The t test was employed to test the significance of the difference between these means. The t test is a parametric statistic designed for use with interval data (41). Application of the t test required information relative to the group size, the pretest and post-test means, and the sum of the squared deviations of the scores away from the mean for each test. The data necessary for the determination of the t value were obtained from the information in Table I. It has been summarized in Table III.

The data yielded a t value of 2.39. The table value for t at the .05 level of significance with 84 degrees of freedom is 1.66. Thus, the first hypothesis stating that favorable attitudes of prospective teachers toward mathematics will increase significantly while they are enrolled in Mathematics 4351, was accepted.

Change in Attitude--Two Groups

The second hypothesis stated that attitude change of the subjects in the experimental group would be significantly more favorable than that of the subjects in the lecture group. Since it was impossible to match or equate the classes, analysis of covariance was used in the analysis of the data. This statistical method enables one to effect adjustments in the final or terminal scores which will compensate for uncontrolled variation existing originally among the groups.

The data used to test the second hypothesis was taken from Table I. The Oklahoma State University Computer Center analyzed this data using single classification analysis of covariance. The findings of this analysis are presented in Table IV.

TABLE IV

ANALYSIS OF COVARIANCE OF EXPERIMENTAL AND LECTURE MATHEMATICS STUDENTS' ATTITUDE INVENTORY SCORES

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between	1	0.19	0.19	0.27*
Within	82	55.98	0.68	
Total	83	56.17		

*3.96 required for significance at the .05 level.

From Table IV, the calculated F value is shown as 0.27 correct to two decimal places. The critical F value at the .05 level of significance, for the given degrees of freedom, is 3.96. From this it may be seen that no statistically significant difference existed between the two groups on the adjusted posttest results. Thus, the second hypothesis which stated that attitude change of the subjects in the experimental group would be significantly more favorable than that of the subjects in the lecture group was rejected.

Change in Achievement--Two Groups

The primary purpose of this study was to investigate experimentally the comparative effectiveness of two methods of instruction on the attitudes of prospective elementary teachers toward mathematics. The secondary purpose was to compare the effectiveness of the same two methods of instruction on achievement in mathematics. The data used in the test of the third hypothesis concerning achievement is listed in Table V.

TABLE V

MATHEMATICS ACHIEVEMENT TEST SCORES

Experimental Group			Lecture Group		
Student	Pre	Post	Student	Pre	Post
1	17	24	1	9	15
2	9	16	2	5	13
3	18	26	3	16	20
4	15	21	4	23	27
5	10	26	5	28	30
6	17	23	6	7	20
7	9	16	7	12	20
8	16	17	8	21	27
9	15	13	9	16	27
10	13	19	10	21	24
11	24	27	11	25	30
12	10	20	12	13	14
13	24	25	13	11	16
14	9	16	14	33	37
15	11	15	15	16	20
16	18	24	16	12	6
17	18	26	17	10	17

TABLE V (Continued)

Experimental Group			Lecture Group		
Student	Pre	Post	Student	Pre	Post
18	7	19	18	27	36
19	27	29	19	19	23
20	15	19	20	20	16
21	16	20	21	12	21
22	22	22	22	10	12
23	17	22	23	18	24
24	18	25	24	11	18
25	33	36	25	21	26
26	23	27	26	21	32
27	18	22	27	17	25
28	14	21	28	16	22
29	22	24	29	27	32
30	20	22	30	12	20
31	21	18	31	16	27
32	23	28	32	12	18
33	15	15	33	19	24
34	16	25	34	11	15
35	20	34	35	21	29
36	28	35	36	22	23
37	14	27	37	29	30
38	15	21	38	20	28
39	24	29	39	11	23
40	18	27	40	12	16
41	16	25	41	13	22
42	28	31	42	28	32
43	27	33			
Mean	17.91	23.49		17.21	22.79
Gain	5.58			5.57	
Standard Deviation	5.82	5.52		6.56	6.71

The third hypothesis stated that the level of achievement of the subjects in the experimental group would be significantly greater than that of the subjects in the lecture group. Since it was impossible to match or equate the classes, analysis of covariance was used in the analysis of the data. The analysis of covariance enables one to effect adjustments in the final or terminal scores which will compensate for uncontrolled variation existing originally among the groups.

The data used to test the third hypothesis is found in Table V. The Oklahoma State University Computer Center analyzed this data using single classification analysis of covariance. The findings of this analysis are presented in Table VI.

TABLE VI

ANALYSIS OF COVARIANCE OF EXPERIMENTAL AND LECTURE MATHEMATICS STUDENTS' ACHIEVEMENT TEST SCORES

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	F
Between	1	0.48	0.48	0.03*
Within	82	1132.99	13.82	
Total	83	1133.47		

*3.96 required for significance at the .05 level.

From Table VI, the calculated F value is shown as 0.03 correct to two decimal places. The critical F value at the .05 level of significance, for the given degrees of freedom, is 3.96. From this it may be seen that no statistically significant difference existed between the two groups on the adjusted posttest results. Thus, the third hypothesis which stated that the level of achievement of the subjects in the experimental group would be significantly greater than that of the subjects in the lecture group was rejected.

Summary

The purpose of this section is to summarize the results of the statistical analyses carried out in conjunction with the three hypotheses of the experiment. The final conclusions, limitations, and recommendations are presented in Chapter V.

Three specific hypotheses were tested in this study. Each hypothesis was related to the comparative effectiveness of two methods of teaching mathematics for elementary teachers. Comparisons of effectiveness were made in the areas of attitudes toward mathematics and achievements in mathematics.

The first test compared the pretest and posttest results of an attitude scale administered to 85 subjects. The calculated t value was 2.39 while the critical t value, for the given degrees of freedom, was 1.66. This result indicated that the difference in the pretest and posttest results was statistically significant. Therefore, the first hypothesis was accepted.

The second analysis compared the adjusted posttest results of an attitude scale administered to 43 subjects in the experimental group with those obtained when the same scale was administered to 42 subjects in the lecture group. The calculated F value was 0.27 while the critical F value, for the given degrees of freedom, was 3.96. Thus, the difference in the posttest results for the two groups was obviously not statistically significant. On the basis of this analysis, the second hypothesis was rejected.

The third and last analysis was a comparison of the effectiveness of two methods of instruction on achievement in mathematics.

Using the pretest and posttest results on a mathematics achievement test administered to both groups, the analysis of covariance yielded an F value of 0. 03. Since this F value was obviously not statistically significant, the third hypothesis was rejected.

The data presented in Table VII, though not included in the statistical analysis or related to the hypotheses, may be of interest to the reader.

TABLE VII

SUMMARY OF MEANS AND RANGES OBTAINED FROM RAW SCORES

	Experimental Group					Lecture Group				
		Mean		Range			Mean		Range	
	Number	Pre	Post	Pre	Post	Number	Pre	Post	Pre	Post
Males	7					7				
Attitude Scale		6.23	5.99	4.64	4.13		5.51	6.32	3.40	3.96
Achievement Test		19.28	24.57	26.00	17.00		19.42	24.57	18.00	17.00
Females	36					35				
Attitude Scale		5.60	5.78	4.55	4.24		5.11	5.40	5.24	5.17
Achievement Test		17.60	23.27	19.00	22.00		16.70	22.40	28.00	31.00
Juniors	18					15				
Attitude Scale		5.92	5.92	4.17	4.13		5.44	5.41	4.61	5.55
Achievement Test		16.94	23.44	19.00	17.00		18.60	23.00	18.00	26.00
Seniors	23					26				
Attitude Scale		5.48	5.66	4.88	4.50		4.97	5.59	4.63	4.05
Achievement Test		18.64	23.00	26.00	23.00		16.26	22.68	28.00	25.00
College Graduates	2					1				
Attitude Scale		6.35	6.65	3.33	2.14		6.45	6.73	0.00	0.00
Achievement Test		18.00	29.50	4.00	9.00		19.00	24.00	0.00	0.00

CHAPTER V

SUMMARY, LIMITATIONS, AND CONCLUSIONS

Summary

The purpose of this study was to compare the effectiveness of two methods of teaching a mathematics course designed for prospective elementary teachers. The experimental group was taught by the "micro-teaching" method, while the lecture group was taught by lectures presented by the instructor (33). The two methods are far apart on a continuum relative to student involvement in classroom activities. The students played a highly active role in the "micro-teaching" approach to learning mathematics, while the "lecture approach placed emphasis on the students "seeing and hearing" material presented by the instructor.

Eighty-five prospective elementary teachers enrolled in an elementary mathematics course were used as subjects in the experiment. Forty-three of these were enrolled in the class designated as the experimental group, and 42 were in the lecture group.

A nonrandomized pretest-posttest design was used in this experiment (38). The pretests were administered to all subjects during the first week of the semester in September, 1968. The two methods of instruction were applied during 75 minute periods twice a week for the entire semester except on days when examinations were given. The posttests were administered to all subjects during the last week of the semester in January, 1969. There was no control group in this experiment.

The independent variables were the two methods of instruction: the micro-teaching method, and the lecture method. The dependent variables were the adjusted posttest scores.

Evaluation of the instruction was accomplished through the use of The Dutton Arithmetic Attitude Scale and The Structure of the Number System (Form A) test. Both of these instruments were used as pretests and posttests. The Dutton Arithmetic Attitude Scale is a 22 statement Thurstone type scale designed by Wilbur H. Dutton (8) to measure the attitude toward mathematics. The Structure of the Number System (Form A), produced by Educational Testing Service, was used to measure the levels of achievement resulting from the two methods of instruction.

Two statistical tests were employed in the experiment: the t test and the analysis of covariance. The t test was employed to test the significance of the difference between the means of the pretest and posttest scores for both groups on The Dutton Arithmetic Attitude Scale. Since "intact" groups were used in the experiment, analysis of covariance was employed to test the significance of the difference in the adjusted posttest means of the two groups on The Structure of the Number System test.

Limitations

It is necessary to note several conditions which might impose limitations on the findings. The reader should be aware of these limitations in order to avoid overgeneralization.

First, the study was restricted to students enrolled in Mathematics 4351 at the State College of Arkansas. Therefore, the sample was not necessarily a representative sample of elementary education majors across the country.

Second, since the subjects could not be assigned to the two groups randomly, self-selection was the basis for group formation. However, initial differences in the groups were statistically controlled by employing the analysis of covariance.

Third, there was no control group. Thus, it was impossible to compare attitude and achievement changes in the two groups with changes which might have occurred in a group receiving no formal instruction.

A fourth consideration in interpreting the results of this investigation is the Hawthorne effect (42). The subjects realized that they were part of a study, and this may have affected the results.

Finally, each subject was administered the same pretests and posttests. Therefore, the effect of taking the pretests may have influenced the posttest results. However, this effect was controlled to some extent by the time lapse between tests and the fact that other examinations were given during the semester.

Conclusions

Results of this study indicate that prospective elementary teachers did develop a more favorable attitude toward mathematics while enrolled in a mathematics course designed for elementary teachers. On the basis of these results, hypothesis one was accepted. However, the reader is cautioned not to extend this result to individual subjects as both groups contained subjects who scored lower on the posttest than they did on the pretest.

Since it is generally believed that attitudes are learned and that an individual's attitudes are intimately related to his involvement in a task (25, 43), the investigator expected the attitude change of the experimental group to be significantly greater than that of the lecture group. However, the analysis of the data failed to support this conclusion. The difference in the adjusted posttest means for the two groups on the Dutton Attitude Scale was obviously not significant. This result indicated that the "micro-teaching" method of instruction characterized by active student involvement was not superior to the lecture method in the development of a more favorable attitude toward mathematics. Thus, the second hypothesis was rejected.

The third hypothesis was based on two statements by Hilgard (30) on which a majority of learning theorists agree. He stated that active participation by a learner is preferable to passive reception when learning, for example, from a lecture or motion picture. Hilgard also stated that information about the nature of a good performance, knowledge of his own mistakes, and a knowledge of successful results aid in learning. The analysis of the data related to achievement failed to support these conclusions. The results of the analysis indicated no significant difference in the level of achievement of the subjects in the experimental group and that of the subjects in the lecture group. Thus, the third hypothesis was rejected. This does not mean that the "micro-teaching" method of instruction was not effective in promoting achievement in mathematics. The scores indicated that both groups made significant gains in achievement during the period of instruction.

However, as was indicated above, the analysis of these scores showed no significant difference in the gains of the two groups.

The investigator feels that it would be improper to conclude, on the basis of the results of analyses employed, that there is no significant difference in the effectiveness of the two methods of instruction used in this experiment. The only factors considered in the evaluation of instruction were attitude toward mathematics and achievement in mathematics. It seems reasonable to assume that the experience gained by the experimental group in the preparation and presentation of mathematical topics will increase their confidence in their ability to teach mathematics in the elementary classroom. Even though the subjects were not enrolled in a methods course, the critiquing sessions should have been helpful in correcting improper teaching procedures and reinforcing desirable ones. Also, most of the students became familiar with the video-tape equipment and some of its uses in the classroom. The fact that the factors mentioned in this paragraph were not measured in the experiment does not alter their importance in the preparation of elementary mathematics teachers.

Recommendations

As a result of this study, the following recommendations are made:

1. The investigator was able to find only two attitude inventories of the type used in this study, those developed by Dutton (8) and Rice (23). It is recommended that additional research be directed toward the establishment of attitude and interest research instruments

of known validity at the elementary mathematics level.

2. In this study, the investigator was concerned primarily with two factors, attitude toward mathematics and achievement in mathematics. A similar study, in which confidence in teaching mathematics is a dependent variable is recommended.

3. There is evidence that significant attitude changes will become apparent only after a time lapse (25, 44). A study conducted over two semesters involving two content courses or a content course and a methods course would be of value.

4. It is recommended that the same theoretical design, or one similar to it, be applied to other areas of mathematics. It is is successful in these areas, then similar experimentation might be appropriate in other subject matter areas.

5. Since this study was confined to one campus with only two groups, it is recommended that an experiment, similar in nature, be conducted on two or more campuses simultaneously. There would also be some merit in confining the groups to a maximum of 25 subjects. This would allow each member to present at least three topics during the semester. A similar study might be strengthened by having a control group.

A SELECTED BIBLIOGRAPHY

(1) 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).

(2) Recommendations for the Training of Teachers of Mathematics. Washington: Mathematical Association of America, 1961.

(3) Garstens, H. L. "Mathematics and Elementary Education Majors." The Arithmetic Teacher, XII (December, 1964), 540-542.

(4) Brown, J. A. and J. K. Mayor, "The Academic and Professional Preparation of Teachers of Mathematics." Review of Educational Research. XXVII (October, 1957), 296-301.

(5) De Vault, V. M. Improving Mathematics Programs. Columbus, Ohio: Charles E. Merrill Books, Inc., 1959.

(6) Melson, R. "How Well Are Colleges Preparing Teachers for Modern Mathematics." The Arithmetic Teacher, XII (January, 1965), 51-55.

(7) Groff, P. J. "Self-Estimates of Ability to Teach Arithmetic." The Arithmetic Teacher, X (December, 1963), 479-480.

(8) Dutton, Wilbur H. "Attitudes of Prospective Teachers Toward Arithmetic." Elementary School Journal, LII (October, 1951), 84-90.

(9) Lowry, William C. "Some Innovations in the Professional Preparation of Teachers." The Arithmetic Teacher, XV (December, 1968), 727-734.

(10) Remmers, H. H. and N. L. Gage, Educational Measurement and Evaluation. New York: Harper and Brothers, 1954.

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

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

(13) Rappaport, David. Understanding and Teaching Elementary School Mathematics. New York: John Wiley and Sons, 1966.

(14) The Revolution in School Mathematics. Washington: National Council of Teachers of Mathematics, 1961.

(15) Davis, Robert B. "Emotions and Thoughts: Subtle Influences." Improving Mathematics Programs: Trends and Issues in the Elementary School, Ed. M. Vere De Vault. Columbus, Ohio: Charles E. Merrell Books, Inc., 1961.

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

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

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

(19) Smith, Frank. "Prospective Teachers' Attitudes Toward Arithmetic." The Arithmetic Teacher, XI (November, 1964), 474-477.

(20) Aiken, Lewis R. "Personality Correlates of Attitudes Toward Mathematics." Journal of Educational Research, LVI (May, 1963), 476-480.

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

(22) Straight, 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.

(23) Rice, Marshall J. "A Study of Attitudes of Elementary Teachers Toward Modern Mathematics Programs." (Unpublished doctoral dissertation, Oklahoma State University, 1964).

(24) Kane, Robert B. "Attitudes of Prospective Elementary Teachers Toward Mathematics and Three Other Subject Areas." The Arithmetic Teacher, XV (February, 1968), 169-175.

(25) Breer, Paul E. and Edwin A. Locke. Task Experience as a Source of Attitudes. Homewood, Illinois: The Dorsey Press, 1965.

(26) Witty, Paul A. "The Role of Attitude in Children's Failures and Successes." NEA Journal, XXXVII (October, 1948), 422-423.

(27) Banks, J. Houston. Learning and Teaching Arithmetic. Boston: Allyn and Bacon, 1964.

(28) Lankford, Francis, Jr. "Implications of the Psychology of Learning for the Teaching of Mathematics." National Council of Teachers of Mathematics: Twenty-Fourth Yearbook, 1959.

(29) Fehr, Howard E. "Theories of Learning Related to the Field of Mathematics." National Council of Teachers of Mathematics: Twenty-First Yearbook, 1953.

(30) Hilgard, Ernest R. Theories of Learning. 2nd ed. New York: Appleton-Century-Crofts, Inc., 1956.

(31) De Cecco, John P. Educational Technology. New York: Holt, Rhinehart and Winston, Inc., 1964.

(32) Allen, Dwight W. and Richard E. Gross. "Micro-Teaching." NEA Journal, LV (December, 1964), 25-29.

(33) Bush, Robert N. and Dwight W. Allen. "Micro-Teaching: Controlled Practice in the Training of Teachers." Micro-Teaching, a Description. Stanford, California: Stanford University, Secondary Education Program, Summer 1966 (mimeographed).

(34) Allen, Dwight W. and Jimmie C. Fortune. "An Analysis of Micro-Teaching: A New Procedure in Teacher Education." Micro-Teaching, a Description. Stanford, California: Stanford University, Secondary Education Program, Summer 1966 (mimeographed).

(35) Goodlad, John I. School Curriculum Reform in the United States. New York: The Fund for the Advancement of Education, 1964.

(36) Mueller, Francis J. Arithmetic, Its Structure and Concepts. Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1964.

(37) Educational Testing Service. Cooperative Mathematics Tests Handbook. Princeton, New Jersey: Education Testing Service, 1964.

(38) Van Dalen, Deabold B. Understanding Educational Research. New York: McGraw-Hill Book Company, Inc., 1962.

(39) Popham, W. James. Educational Statistics. New York: Harper and Row, Inc., 1967.

(40) Garrett, H. E. Statistics in Psychology and Education. 5th ed. New York: David McKay Company, Inc., 1958.

(41) Siegel, Sidney. Nonparametric Statistics for the Behavioral Sciences. New York: McGraw-Hill Book Company, Inc., 1956.

(42) Zaleznik, A. and D. Moment. The Dynamics of Interpersonal Behavior. New York: John Wiley and Sons, 1964.

(43) Sherif, Carolyn, Muzafer Sherif, and Roger Nebergall. Attitude and Attitude Change. Philadelphia: W. B. Saunders Company, 1965.

(44) Craig, Gerald S. Science for the Elementary School Teacher. New York: Ginn and Company, 1958.

(45) Amidon, Edmond J. and John B. Hough. Interaction Analysis: Theory, Research, and Application. Reading, Massachusetts: Addison-Wesley Publishing Company, 1967.

(46) Bruner, Jerome S. The Process of Education. New York: Vintage Books, 1960.

(47) Davitz, Joel R. and Lois Jean Davitz. A Guide for Evaluating Research Plans in Psychology and Education. New York: Teachers College Press, 1967.

(48) Fehr, Howard F. and Thomas J. Hill. Contemporary Mathematics for Elementary Teachers. Boston: D. C. Heath and Company, 1966.

(49) Ferguson, George A. Statistical Analysis in Psychology and Education. New York: McGraw-Hill Book Company, 1966.

(50) Goodlad, John I. The Changing School Curriculum. New York: The Georgian Press, Inc., 1966.

(51) Kerlinger, Fred N. Foundations of Behavioral Research. New York: Holt, Rhinehart and Winston, Inc., 1966.

(52) Mager, Robert F. Preparing Educational Objectives. Palo Alto, California: Fearon Publishers, 1962.

(53) Neidt, C. D. and D. D. Sjogren. "Changes in Student Attitudes During a Course in Relation to Instructional Media." AV Communication Review, XVI (Fall 1968), 268-279.

(54) Olson, Waldemar. Methods of Teaching Elementary School Mathematics. Minneapolis, Minnesota: Burgess Publishing Company, 1968.

(55) Stone, James C. and Frederick W. Schneider. Readings in the Foundations of Education. New York: Thomas Y. Crowell Company, 1965.

APPENDIX

STUDENT PRESENTATION EVALUATION SCALE

STUDENT PRESENTATION EVALUATION SCALE

1. Introduction of Topic 1 2 3 4 5
2. Knowledge of Topic 1 2 3 4 5
3. Enthusiasm for Topic 1 2 3 4 5
4. Use of Examples 1 2 3 4 5
5. Communication Effectiveness 1 2 3 4 5
6. Use of Visual Aids 1 2 3 4 5
7. Movements and Gestures 1 2 3 4 5
8. Sense of Humor 1 2 3 4 5
9. General Clarity 1 2 3 4 5
10. Class Response 1 2 3 4 5

Comments: ____

____

____

____

____

____

____

VITA

Darrell Clark Kilman

Candidate for the Degree of

Doctor of Education

Thesis: THE EFFECT OF A MICRO-TEACHING TECHNIQUE ON THE ATTITUDES OF PROSPECTIVE ELEMENTARY TEACHERS TOWARD MATHEMATICS

Major Field: Secondary Education

Biographical:

Personal Data: Born in Bald Knob, Arkansas, February 2, 1934, the son of Mr. and Mrs. Oren K. Kilman.

Education: Graduated from Bald Knob High School, Bald Knob, Arkansas, in May 1952; received the Bachelor of Science in Education degree from State College of Arkansas in 1958, with a major in mathematics; awarded National Science Foundation Academic Year Institute, The University of New Mexico, in 1959; received the Master of Education in Science degree from the University of New Mexico in 1961, with a major in mathematics; attended summer session, The University of Mississippi, in 1961; awarded National Science Foundation Academic Year Institute, Oklahoma State University in 1964; completed requirements for the Doctor of Education degree at Oklahoma State University in August, 1969.

Professional Experience: Mathematics teacher, Mountain View High School, 1957-58; mathematics teacher, Wynne High School, 1958-59; instructor of mathematics, Arkansas Agricultural and Mechanical College, 1960-62; assistant professor of mathematics, State College of Arkansas, 1962-67; graduate teaching assistant, Oklahoma State University, 1967-68; presently employed as associate professor of mathematics at State College of Arkansas.