Spring 1999

A Study of Elementary Teachers' Attitudes toward Mathematics Instruction and Mathematics Teaching Methods Used in the Elementary Classroom

William Otis Lacefield III

A STUDY OF ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS INSTRUCTION AND MATHEMATICS TEACHING METHODS USED IN THE ELEMENTARY CLASSROOM

William Otis Lacefield, III

May 26, 1999

To the Graduate College:

This dissertation entitled "A Study of Elementary Teachers' Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods Used in Elementary Classrooms" and written by William O. Lacefield, III is presented to the College of Graduate Studies of Georgia Southern University. I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Education with a major in Curriculum Studies.

Dr. Jane A. Page, Chairperson

We have reviewed this dissertation and recommend its acceptance:

Dr. Edmund C. Short, Member

Dr. Bryan W. Griffin, Member

Dr. Sharon E. Taylor, Member

Accepted for the College of Graduate Studies:

Dr. G. Lane Van Tassell
Associate Vice President for Academic Affairs
and Dean of Graduate Studies

A STUDY OF ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS INSTRUCTION AND MATHEMATICS TEACHING METHODS USED IN THE ELEMENTARY CLASSROOM

by

William Otis Lacefield, III

B.A., Mercer University, 1989

M.Ed., University of Southern Mississippi, 1993

Ed.S., Mercer University, 1995

A Dissertation Submitted to the College of Graduate Studies

of Georgia Southern University

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Education

in

Curriculum Studies

Statesboro, Georgia

August 1999

DEDICATION

In recognition of their loving support and encouragement,

I hereby dedicate this dissertation to my mother,

Maria Brian Clance,

and to my maternal grandmother,

Mary Evelyn Brian

ACKNOWLEDGEMENTS

My most heartfelt appreciation belongs to Dr. Jane Page. As my doctoral academic advisor and dissertation chair, she has graciously shared her time, her wisdom, her sense of humor, and her caring support.

As members of my dissertation committee, Dr. Edmund Short, Dr. Bryan Griffin, and Dr. Sharon Taylor have offered excellent judgments at critical stages of this effort. Their attention to detail and unselfish contributions in editing and polishing are most appreciated.

Margaret Faircloth, my high school mathematics teacher and my cooperating teacher during my student teaching experience, will never know the depth of my appreciation and affection for her. She has led me to more opportunities than even I realize.

Other special people deserve special acknowledgement for their loyalty over the years, steadfastness in their availability, and their individual contributions they have made to my life. My sister, Stacy Lacefield Amerson, as well as special friends Beth Joyner, Jody Harris, Andrea Miller, Carole Wheeler, Brenda Latham, Bobbie Dever, Dr. Janet Busboom, Dr. Margaret Morris, and Dr. Anne Hathaway have been exceptionally supportive as I have pursued this Doctor of Education degree.

Loving thanks also go to Dr. Cathryn Futral for her proofreading expertise and to Dr. Martha Jones for her abundance of ideas.

WILLIAM OTIS LACEFIELD, III

1049 Greentree Parkway
Macon, Georgia 31220
(912) 471-7626

Date of Birth: September 11, 1967
Place of Birth: Louisville, Kentucky

PROFESSIONAL EXPERIENCE

Instructor of Mathematics Education and Middle Grades Education, 1997-Present
School of Education, Mercer University, Macon, Georgia

Mathematics Laboratory Coordinator/Instructor, 1993-Present
Mercer University, Macon, Georgia

Mathematics Curriculum Coordinator, 1985-Present
Upward Bound Program, Mercer University, Macon, Georgia

Mathematics Tutor, 1997
Georgia Southern University Tutorial Center, Statesboro, Georgia

Elementary School Teacher, 1990-1997
Bibb County Board of Education, Macon, Georgia

Adjunct Instructor, 1996-1997
Mercer University, Macon, Georgia

English/Writing/Statistics Instructor, 1995-1996
Program for International Studies, Mercer University, Macon, Georgia

Mathematics Coordinator/Instructor, 1994-1995
Summer College for Kids, Mercer University, Macon, Georgia

Mathematics Curriculum Director/Instructor, 1989-1993
Middle Georgia Educational Opportunity Center, Macon, Georgia

EDUCATION

Doctor of Education in Curriculum Studies, 1999
Georgia Southern University, Statesboro, Georgia
Emphasis in Instructional Improvement

Specialist in Education in Early Childhood Education, 1995
Mercer University, Macon, Georgia

Master of Education in Curriculum and Instruction, 1993
University of Southern Mississippi, Hattiesburg, Mississippi

Bachelor of Arts in Mathematics, Magna Cum Laude, 1989
Mercer University, Macon, Georgia

WILLIAM OTIS LACEFIELD, III

PROFESSIONAL ASSOCIATIONS

Middle Georgia Council of Teachers of Mathematics
Phi Delta Kappa Professional Education Fraternity
National Middle School Association
Professional Association of Georgia Educators
Phi Kappa Phi Educational Honor Society
National Council of Supervisors of Mathematics
National Council of Teachers of Mathematics
Georgia Council of Teachers of Mathematics
American Educational Research Association
MENSA

AWARDS/HONORS

Outstanding Young Man of America, 1998
Gloria Washington Service Award, Phi Delta Kappa, 1998
Nominee for Presidential Award for Excellence in Mathematics and Science Teaching, 1996
Georgia Math/Science Round Table Award for Excellence in Mathematics Teaching, 1995
Macon's Good Neighbor Award, 1987
Macon's Youth Volunteer of the Year Award, 1986
Georgia Volunteer Leadership Award, 1986

PRESENTATIONS GIVEN

Quick and Easy Ways to Mingle Mathematics and Literature, National Council of Teachers of Mathematics Annual Conference, 1999
Character Education and Children's Literature...A Winning Combination, Bibb County Character Education Conference, 1998
Utilizing the Internet in the Middle Grades Classroom, Nuts and Bolts Symposium of Middle Level Education, 1998
Mingling Mathematics and Children's Literature, NCTM Southern Regional Conference, 1997
Using Children's Literature to Enhance Mathematics...And Vice Versa, Georgia Math Conference, 1996
Quick and Easy Ways to Mingle Mathematics and Children's Literature, Georgia Math Conference, 1995
Moral Dilemma in Children's Literature, Mississippi Reading Conference, 1993

PUBLICATIONS

Inclusion and the Law: Past Triumphs, Recent Controversies, and Future Directions, *Georgia Southern University Educational Forum,* Fall 1997
Attitudes of Primary and Elementary Teachers Regarding Mathematics Instruction, *Georgia Southern University Educational Forum*, Fall 1996

ABSTRACT

A STUDY OF ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS INSTRUCTION AND MATHEMATICS TEACHING METHODS USED IN THE ELEMENTARY CLASSROOM

1999

WILLIAM OTIS LACEFIELD, III

B.A., MERCER UNIVERSITY, 1989

M.Ed., UNIVERSITY OF SOUTHERN MISSISSIPPI, 1993

Ed.S., MERCER UNIVERSITY, 1995

Directed by: Professor Jane A. Page

This study involved an investigation of elementary (grades K-4) teachers' attitudes toward mathematics instruction and the mathematics teaching methods elementary teachers plan and implement in the classroom setting. The population consisted of 492 elementary teachers (grades K-4) currently teaching in the Bibb County, Georgia, Public School System. The sample represented a cluster sampling of the population and consisted of 90 elementary teachers currently teaching in six public elementary schools. One inner city school, four suburban schools, and one rural/semi-rural school were randomly selected. The research design used was a correlational design. The sets of data considered were elementary teachers' self-expressed attitudes

regarding mathematics instruction and elementary teachers' self-reported frequencies with which they plan and implement particular teaching methods in the elementary mathematics classroom.

Participants completed two Likert scale questionnaires. One questionnaire presented attitudinal statements related to the teaching of mathematics. Possible responses included "strongly agree," "agree," "undecided," "disagree," and "strongly disagree." The second questionnaire contained a list of teaching methods accompanied by frequencies from which subjects could select a response: "daily," "frequently," "occasionally," "seldom," and "never."

Pearson correlation coefficients were calculated and used to interpret the results of the questionnaires completed by the subjects of the study. Pearson correlation coefficients measured relationships between elementary teachers' attitudes toward mathematics instruction and reported frequencies of planning and implementing particular teaching methods. Teachers' attitudes toward mathematics instruction were analyzed in five areas: anxiety, confidence, enjoyment, desire for recognition, and pressure to conform. The frequencies of planning and implementing particular teaching methods were analyzed in three areas: traditional teaching methods, progressive teaching methods, and teaching methods that combine traditional and progressive approaches.

Of the 15 Pearson correlation coefficients calculated, none was significant at the $p<.05$ level of significance. Both positive and negative correlation coefficients were found, with no definite pattern being revealed. Consequently, the results of this study suggest that if there are relationships among elementary teachers' attitudes toward

mathematics instruction and the frequencies with which they plan and implement particular teaching methods in the elementary classroom, the relationships are weak and inconsistent, at best.

TABLE OF CONTENTS

Table of Contents (continued)

Table of Contents (Continued)

Table of Contents (Continued)

LIST OF TABLES

CHAPTER I

INTRODUCTION

In today's technical and ever-advancing society, the levels of knowledge in mathematics possessed by our nation's children and adults are criticized in various sources such as newspaper articles, corporate reports, formal academic presentations, and informal discussions in teachers' lounges. Although many viewpoints are submitted regarding the derivations of this problem, commonly alleged cures often focus on teachers, teachers' attitudes toward mathematics instruction, and teaching methods used on a daily basis in the classroom setting. In fact, there seems to be extensive agreement among today's educators that many young people are not receiving adequate instruction in mathematics (Swetz, 1995).

Because it is crucial that our schools provide meaningful and effective mathematics instruction, it seems decisive that educators continue to conduct high-quality research related to the teaching and learning of mathematics. Thoroughly planned and well-documented research efforts may represent movement in the direction of assuring that teachers of mathematics possess and exhibit an extensive knowledge of mathematical concepts, exemplary mathematics teaching methods (Kohn, 1998), useful assessment procedures, and positive attitudes toward mathematics instruction (Kulm, 1980). In order to better understand the current status of mathematics education in the United States of America, one would be well served to gather information not only about curriculum and

instruction, but also about those who have the most tremendous impact on how mathematics is taught--the teachers. Teachers' attitudes regarding the teaching of mathematics have the potential to impact effectiveness of their mathematics instruction.

As learning and using mathematics are lifelong processes, effective mathematics instruction must be planned and implemented throughout students' school years, including the primary and elementary levels. Therefore, it seems critical that teachers of young children possess and exhibit positive attitudes toward mathematics instruction. Because elementary school teachers have developed their attitudes and beliefs over years of being students themselves and from their own teaching experiences, it seems reasonable to assert that teachers' attitudes related to mathematics instruction may influence their choices of teaching methods used in the classroom. Naturally, if students are to learn mathematics in a meaningful manner, they must be exposed to teaching methods that will foster mathematics skill learning, conceptual development, and problem solving abilities. Teachers who have negative attitudes toward mathematics teaching may neglect some of the teaching methods that research efforts have shown to be effective. Regardless of grade level taught, if any teacher's beliefs concerning mathematics instruction are not generally positive and enthusiastic, and if teachers' choices among teaching methods are not based on such positive and enthusiastic beliefs, students' opportunities for learning mathematics may be stifled (Burns, 1998).

The Background of the Problem

Although attitudes toward mathematics instruction are typically defined by the instruments used in particular studies (Husen, 1967), it seems that at least one definition

of attitude in general has been utilized by mathematics educators who have been acclaimed in attitude research. Romberg and Wilson (1969) described attitude as follows:

> If an individual has a set of predispositions toward an object in the environment (e.g., mathematics, self, school, teacher, etc.), it is reasonable to expect that such predispositions would interact with the perception of the object in such a way as to affect the individual's response to that object (p. 151).

A number of studies related to teachers' attitudes reveals that researchers in mathematics education seem to maintain the viewpoint that attitudes regarding aspects of mathematics teaching do not differ greatly in their underlying constructs from the types of attitudes that sociologists and psychologists have aspired to define over the years (Carpenter, Fennema, & Peterson, 1987) .

Among educators, attention to the study of teachers' beliefs and attitudes was seemingly fueled by a shift in criteria for research on teaching. Promoted partially by information processing theory and other areas of development in cognitive science, research on teaching embarked upon a transformation in the 1970s from a process-product paradigm, in which the usual objective of study was teachers' behaviors, to a highlight on teachers' thinking and decision-making processes (Clark & Peterson, 1986; Shavelson & Stern, 1981). This change of focus to teachers' cognition subsequently led to an interest in recognizing and comprehending the components and formation processes

of "belief systems and conceptions," "action mind frames" (Shavelson, 1988), and "implicit theories" (Clark, 1988) underlying teachers' judgments and conclusions. In conducting studies related to beliefs, numerous researchers have expressed a lack of clarity regarding the difference (or absence of difference) between attitudes and knowledge; some studies have put forth the belief that teachers often handle their attitudes and beliefs as knowledge (Grossman, Shulman, & Wilson, 1989). As a result, a number of educators have submitted that it is not necessarily worthwhile for researchers to investigate distinctions between knowledge and attitude, but, rather, to search for whether and to what extent teachers' beliefs--or what they may take to be knowledge--influence their experiences and teaching practice (Nespor, 1987). Throughout the past few decades, several studies related to teachers' attitudes toward mathematics instruction have been conducted and published. The miscellany of purposes, methods, designs, and analytical frameworks used by researchers has led to vast variability in how teachers' attitudes and conceptions toward mathematics instruction have been portrayed.

Past studies have hypothesized that teachers' attitudes toward mathematics instruction are affected by what teachers judge to be recognized purposes of the mathematics program, their own abilities to teach and expose information to students, appropriate classroom activities, the students' roles in the teaching/learning process, desirable instructional strategies and emphases, reasonable mathematical procedures, and adequate outcomes of instruction (Thompson, 1992). A great deal of research has been conducted with preservice elementary teachers, probably because these teachers have the capability of greatly influencing future students' attitudes, and because prospective

teachers are a readily accessible population. Some researchers have reported a substantial degree of agreement between teachers' professed views of mathematics teaching and their instructional practice, whereas others have reported sharp contrasts. An expanding realization of the function that teachers' attitudes perform in teaching has led some researchers to explore how such attitudes are formed, how they evolve, and how they might be changed. While older studies generally suggest that teachers' attitudes are not easily modified, more recent investigations have suggested that programs can be formulated specifically to induce change in attitudes (Brosnan, 1994; Madsen, 1992; Lanier, Lappan, Schram, & Wilcox, 1988.) Furthermore, the curriculum implemented in a school can impact teachers' attitudes toward mathematics teaching (Brosnan, 1994; Steele, 1994). The study of teachers' attitudes toward mathematics instruction has instituted a place for itself within the mathematics education research establishment. While the attitudes of teachers of varying levels have been studied, analyses of middle school and senior high school teachers' attitudes toward mathematics instruction seem to be more prevalent than studies of such attitudes in elementary teachers (Thompson, 1992).

The National Council of Teachers of Mathematics (NCTM) published three sets of professional standards related to teaching and learning mathematics (1989, 1992, 1995). A prevailing thread throughout these standards is that teachers of mathematics possess and portray positive attitudes toward mathematics teaching so as to induce mathematical power in students. It seems reasonable that teachers with positive attitudes toward mathematics instruction are more likely to plan and implement instructional

activities that will make mathematics learning meaningful and engaging for students. The best mathematics instructional activities, according to NCTM (1989), are those that develop critical thinking abilities and problem solving strategies, that allow students to work cooperatively at appropriate times, and that encourage students to construct their own knowledge through hands-on and real world activities. More traditional teaching methods, including paper and pencil activities, drill and practice, and oral recitation, have their place in the curriculum but should be used only as a few of many options among teaching methods. In light of the relative lack of studies related to elementary teachers' attitudes regarding mathematics instruction, as well as the definite need for high quality mathematics teaching at the elementary school level, this study has been conducted to explore elementary teachers' attitudes toward mathematics instruction and how such attitudes might be related to teachers' choices of instructional methods planned and implemented in the elementary classroom.

Statement of the Problem

The purpose of this study is to explore the attitudes of elementary school teachers regarding mathematics instruction and to determine if a relationship exists between elementary teachers' self-expressed attitudes regarding mathematics teaching and the mathematics teaching methods they plan and implement in the classroom setting.

The investigation into the relationship between elementary teachers' attitudes toward mathematics instruction and the mathematics teaching methods planned and implemented in the classroom setting involved the following tasks:

1. To select a questionnaire to measure elementary teachers' attitudes toward

mathematics instruction;

2. To develop a questionnaire to measure the frequency with which particular mathematics teaching methods are planned and implemented in the elementary mathematics classroom;

3. To investigate the existence and nature of relationships between the selected elementary teachers' professed attitudes toward mathematics instruction and the mathematics teaching methods they plan and implement in the elementary classroom.

The researcher proposed that the information resulting from the study would serve the following purposes:

1. To provide baseline data on the self-reported attitudes toward mathematics instruction of a group of elementary teachers, to be utilized to inform subsequent research on mathematics instruction.

2. To enhance existing knowledge of the relationships between elementary teachers' attitudes toward mathematics instruction and the mathematics teaching methods they plan and implement in their classrooms.

Importance of the Study

Teachers' attitudes toward mathematics instruction have the potential to influence their mathematics instructional practices and effectiveness. Such attitudes may have direct bearing on the amount of time teachers devote to mathematics and to the specific methods of instruction they adopt. Therefore, it is imperative that teacher educators, principals, curriculum directors, and others who work directly with elementary school mathematics teachers be kept abreast of teachers' attitudes regarding mathematics

instruction. Teacher preparation courses and staff development training sessions should be designed and implemented to instill enthusiasm for and comfort with the teaching of mathematics. If a relationship is found among elementary teachers' attitudes toward mathematics instruction and the teaching methods elementary teachers plan and implement in the classroom setting, there is an indication that elementary teachers would be well served to reflect upon their dispositions toward teaching mathematics as well as the teaching methods they employ in their classrooms. Furthermore, if mathematics instruction training programs and materials were designed in response to self-reported teacher attitudes toward mathematics instruction and reported frequencies with which particular teaching methods are planned and implemented, it is conceivable that the ideas and information gleaned by participating educators would lead to enhanced learning for elementary school students.

Assumptions

For this study, it was assumed that the randomly selected cluster elementary schools (one inner city, one rural/semi-rural, and four suburban) are representative of all Central Georgia elementary schools and are in no way significantly different.

Furthermore, it was recognized by the researcher that his past experiences as an elementary school teacher and university instructor of mathematics education had led him to hypothesize that some elementary teachers are anxious about teaching mathematics and consequently may not plan and implement the most effective types of mathematics teaching methods in their elementary classrooms.

It was also assumed that the survey instruments used in the study were sufficient indicators of elementary teachers' attitudes toward mathematics instruction and the frequencies with which elementary teachers plan and implement specific mathematics teaching methods in their elementary classrooms.

Research Questions

Is there a relationship between elementary teachers' self-expressed anxiety related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed confidence related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed enjoyment related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed desire for recognition related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed pressure to conform related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Limitations

Because mathematics is such a vital discipline in today's technology-rich society, some survey respondents may have been reluctant to respond to an item in a manner that would indicate negativity toward mathematics instruction or unwillingness to plan and implement more traditional mathematics teaching methods.

Definition of Terms

For the purpose of this study, elementary teachers are defined as teachers who are employed as full-time instructors of students in kindergarten, grade one, grade two, grade three, or grade four.

Attitudes toward teaching mathematics instruction are self-expressed feelings and beliefs regarding levels of positiveness or negativeness toward various aspects of teaching mathematics.

Anxiety refers to nervousness or uneasiness of mind when teaching mathematics.

Confidence refers to the feeling that one will be effective when teaching mathematics.

Enjoyment refers to the pleasure or satisfaction one feels when teaching mathematics.

Desire for recognition refers to one's wish to be identified by others as an effective or outstanding teacher of mathematics.

Pressure to conform refers to outward influences that might cause one to feel uncomfortable about being considered an effective or outstanding teacher of mathematics.

Teaching methods are instructional activities planned and implemented by

elementary teachers in the mathematics classroom.

Traditional teaching methods are instructional activities that are teacher-led and focus on lectures, paper and pencil activities, recitation, memorization and repetition of basic skills.

Progressive teaching methods are instructional activities that are student-oriented or student-centered and focus on critical thinking abilities, real-life problem solving opportunities, cooperative learning, hands-on activities, the use of mathematics manipulatives, and project development.

Teaching methods that combine traditional and progressive approaches are instructional activities that are neither completely teacher-led nor completely student-centered and that incorporate traditional teaching methods with progressive teaching methods. Examples of such instructional activities would include activities that allow students creative involvement in lessons but in which the topics of discussion have been pre-selected by the teacher.

A Likert scale is a five-point scale used to register the extent of agreement or disagreement with a particular statement of an attitude, belief, or judgment.

Summary

As the new millennium approaches, it is vital that our schools provide meaningful and effective mathematics instruction, perhaps especially at the elementary school levels. Therefore, it seems equally decisive that teachers of young children possess and exhibit positive attitudes toward mathematics instruction. In recent decades, research regarding teachers' attitudes toward mathematics instruction has gradually evolved from a process-

product paradigm, in which the objective of study was teachers' behaviors, to a highlight on teachers' thinking and decision-making processes. Such thinking and decision-making processes can influence the mathematics teaching methods that are planned and implemented in elementary classrooms.

Although numerous studies concerning teachers' attitudes toward mathematics and mathematics teaching have been published in recent years, the professional literature seems to be lacking in investigations of the relationships between teachers' attitudes toward mathematics instruction and the planning and implementation of mathematics teaching methods in classroom settings. If a teacher's beliefs concerning mathematics instruction are not consistent with effective instructional methods, and if effective instructional methods are not consistently planned and carried out, students' opportunities for learning mathematics may be stifled. It is in this light that this study was conducted.

CHAPTER II

REVIEW OF RESEARCH AND RELATED LITERATURE

When teachers throughout the United States fail to plan and implement the best teaching practices available (Kohn, 1998), the students are the ones who may suffer--in the forms of inadequate mathematics knowledge, insufficient problem solving abilities, and underdeveloped critical thinking skills. Among mathematicians and mathematics educators, as well as among other professional educators and non-educators, there is extensive agreement that many of today's children are not receiving adequate instruction in mathematics (Westbury, Ethington, Sosniak, & Baker, 1994).

Because society is becoming more and more technology-oriented, and because problem-solving abilities and critical thinking skills are needed by today's citizens, schools must provide meaningful and effective mathematics instruction, beginning at elementary school levels. Teachers of all grade levels have responsibilities not only to espouse positive attitudes related to teaching mathematics, but also to teach mathematics in effective and creative manners that will engage students in the mathematics learning processes (Burns, 1998).

Historical Highlights of Research in Mathematics Education

Before considering research efforts in the areas of teachers' attitudes regarding mathematics instruction and possible relationships between such attitudes and the

mathematics teaching methods that are planned and implemented in elementary classrooms, it seems appropriate to consider the contextual framework of mathematics education research in general. Research in mathematics education has been affected and changed by numerous individuals and happenings within the larger domain of educational research. Like mathematics education itself, research in mathematics education over the years has formed an identity by which it is known. Many mathematics educators have worked at identifying and defining key issues in mathematics education and have searched for forms of inquiry that might be used in addressing them. Indeed, over the past few decades mathematics education research has been more widely published than in previous years, and mathematics education researchers have developed quite a respected name for themselves (Kilpatrick, 1992).

Research related to mathematics education seems to have first gained popularity in university settings. Although several universities had previously offered occasional courses in education, in the United States the first education professorship was not established until 1873 at the University of Iowa. Even in 1890, chairs of education in the United States were relatively few in number (Cubberley, 1920). Throughout the 1800s, numerous teachers of mathematics for secondary schools completed university education programs, but instruction in mathematics teaching methods was usually only a minuscule and seemingly unimportant portion of a teacher's preparation (Pyenson, 1983).

The importance of mathematics education as a field of study began to be recognized around the end of the nineteenth century as many universities improved and expanded their teacher education programs in order to respond to the need for high

quality teachers. By 1912, a survey by the International Commission on the Teaching of Mathematics indicated that university lectures on mathematics education were being offered in the United States (Schubring, 1987). Eventually, university instructors and students came to recognize mathematics education as a university subject. An expectation that university instructors of mathematics education should be conducting and participating in research efforts rather than only teaching led many postsecondary educators to begin undertaking research in mathematics education (Kilpatrick, 1992).

As is often the case with research, studies in mathematics education have been affected by other disciplines. Naturally, pure and applied mathematics are chief among these influential fields. Throughout the years, concerns that primary and elementary schools are not adequately preparing students in mathematics, declining enrollments in advanced mathematics courses, and threats to the status of mathematics as a school subject have prompted mathematicians to explore what the schools are doing and how mathematics programs might possibly be improved. As mathematics education has become more and more respected in universities, it has demonstrated a tendency to lure individuals whose major interest was in mathematical subject matter and who often viewed themselves as mathematicians. As a result, the growing body of research efforts in mathematics education included historical and philosophical studies, surveys, and other types of empirical research. In addition to the work of their contemporary mathematicians, the work of early mathematics educators led to many pedagogical issues that researchers in mathematics education are continuing to explore (Swetz, 1995).

Research in mathematics education has also been influenced by the discipline of

psychology. Near the beginning of the twentieth century, United States psychology departments began to show interest in empirical studies in education. As a result, psychology became a primary segment of the normal school curriculum (Cubberley, 1920). Psychology allowed professors in schools and departments of education to make use of a science with the potential to lead to the development of a set of effective research methods that could be used to improve mathematics education. Since the beginnings of educational psychology, mathematics has been a popular conduit for the investigation of the processes of learning. Several dynamics might account for the use of the mathematics discipline in this manner, including perceptions regarding the crucial nature of mathematics in school curricula, its seeming independence of influences outside of school, and the range of learning tasks mathematics can provide. Mathematics educators, as other educators, have borrowed ideas and techniques from the field of psychology throughout the years (O'Donnell, 1985).

Although the methods of the empirical-analytic tradition have dominated research in mathematics education for most of the twentieth century, it seems that the goals of mathematics education research have been more strongly focused upon the teaching and the learning of mathematics than on the scientific aspirations of explanation, control, and prediction. Despite that focus on teaching and learning, however, understanding and improving mathematics curriculum and instruction have not traditionally meant adopting the participants' views or meant considering that the instructional context may be problematic. In essence, research in mathematics education has dealt primarily with technical problems of learning and teaching as defined by individual researchers who

typically plan and implement research studies because they know of practices that should probably be better and they have visions of how such needed betterment might be attained. For the most part, research in mathematics education generally has focused on application rather than on research for its own sake (Westbury, Ethington, Sosniak, &Baker, 1994; Nisbet & Entwistle, 1973).

Definition of Attitude

A primary objective in investigating the research on attitude is to attempt to formulate a definition of attitude. Although numerous definitions have been submitted by psychologists, tendencies of many researchers have been to evade explicit definition and to decide upon operational definitions suggested by instruments measuring attitude. However, it may be useful to examine several definitions, many of which stem from research on attitudes and their measurement in sociology and psychology. An early significant definition of attitude was "a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (Allport, 1935, p. 810). The primary characteristics of this early definition have not altered greatly, as exhibited by Rokeach's more current definition, "an organization of several beliefs focused on a specific object or situation predisposing one to respond in some preferential manner" (1972, p. 159).

Other ideas regarding the definition of attitude have also surfaced throughout the years. In one of his reviews of attitudes, Aiken (1972) stated that "the term *attitude* as used in the studies referred to here means approximately the same thing as *enjoyment*,

interest, and to some extent, *level of anxiety*" (p. 229). A somewhat different conceptualization of attitude is based on concepts of probability and embraces an information-processing approach. Wyer (1974) proposed that an attitude is a subjective probability associated with (a) membership of a stimulus in a given category or (b) the relationship between the members of different categories. This definition varies from the traditional conceptualization of probability in that there is no description or prediction of behavior. Instead, the subjective character of probability inherently requires that situational variables be identified. For example, one might consider these probabilities:

P(A): Mathematics is a liked school subject.

P(B): Effective mathematics teaching takes place.

Furthermore, the probabilities P(A, then B) and P(B, then A) could also be studied.

Although attitude toward mathematics is typically either undefined or defined by the instruments used in the study (Husen, 1967), it seems that at least one definition of attitude in general has been utilized by mathematics educators who have been acclaimed in attitude research. Romberg and Wilson (1969) described attitudes as follows:

> If an individual has a set of predispositions toward an object in the environment (e.g., mathematics, self, school, teacher, etc.), it is reasonable to expect that such predispositions would interact with the perception of the object in such a way as to affect the individual's response to that object (p. 151).

It seems evident that researchers in mathematics education do not theorize that attitudes

regarding aspects of mathematics differ in their underlying constructs from the types of attitudes that sociologists and psychologists have defined throughout the years.

History of Research on Teachers' Attitudes

Among educators, attention to the study of teachers' beliefs and attitudes was kindled by a shift in standards for research on teaching. Prodded in part by information processing theory and other advancements in cognitive science, research on teaching embarked upon a shift in the 1970s from a process-product paradigm, in which the objective of study was teachers' behaviors, to a highlight on teachers' thinking and decision-making processes (Clark & Peterson, 1986; Shavelson & Stern, 1981). The shift of focus to teachers' cognition subsequently led to an interest in recognizing and comprehending the composition and formation of "belief systems and conceptions," "action mind frames" (Shavelson, 1988), and "implicit theories" (Clark, 1988) underlying teachers' judgments and conclusions.

Remaining under the control of behavioristic traditions and beliefs, there were sporadic studies in the decades of the 1960s and 1970s, handled primarily by attitude researchers, that either directly or indirectly dealt with teachers' beliefs and conceptions (Harvey, Hoffmeister, Prather, & White, 1968; Kerlinger, 1967). Nevertheless, very few studies were specifically associated with mathematics education. In the 1980s and 1990s, however, various studies in mathematics education have centered on teachers' attitudes regarding mathematics and mathematics teaching and learning. Generally, researchers involved with such studies have worked from the assumption that to understand teaching from teachers' perspectives, we must understand the attitudes with which they interpret

their work, interact with their students, and plan and implement various teaching methods (Nespor, 1987).

Despite the prevailing regard of teachers' attitudes as a topic of study, the notion of attitude has not been explained in a precise and notable manner in much of the educational research literature. In many instances, researchers have speculated that readers are able to comprehend what attitudes and beliefs are. One rationalization for the rarity of justified discussions on attitudes in the educational literature is the complication of discerning between attitudes and knowledge. Because of the close correlation that abides between beliefs and knowledge, discriminations between them are often indistinct (Scheffler, 1965). Researchers have noted that in many instances, teachers handle their attitudes and beliefs as knowledge; consequently, many who originally set out to explore teachers' knowledge have also ended up hypothesizing about teachers' beliefs (Grossman, Shulman, & Wilson, 1989).

An alternate accounting for the shortage of studies in educational research literature on the character of attitudes and the differentiation between attitudes and knowledge is that the merit of searching for definitive descriptions of the two concepts is debatable. Having suffered elongation and mishandling for years, the two concepts--and the words associated with them--are so broad that to search for a conclusive characterization of either may not be useful (Wolgast, 1977). Some educators have contested that it is not worthwhile for researchers to investigate distinctions between knowledge and belief, but, rather, to search for whether and in what capacity, if at all, teachers' beliefs--or what they may take to be knowledge--influence their experience.

Because of the existence of disagreements regarding the meanings of knowledge and attitude and the relationships between the two, researchers concerned with investigating teachers' attitudes should be well served to remain abreast of the professional literature related to attitudes of teachers, both from a philosophical and a psychological position. Philosophical works can be supportive in clarifying the nature of beliefs and attitudes. Psychological studies may prove serviceable in deciphering the nature of the relationship between attitudes and behavior, as well as in perceiving the structure and organization of beliefs (Nespor, 1987; Needham, 1972). In short, the notion of attitude, while perhaps broadly understood, may have different meanings to different researchers, according to the specific topic of exploration at hand.

Overview of Research on Teachers' Attitudes Toward Mathematics Instruction

Studies of mathematics teachers' beliefs and attitudes have centered on beliefs about mathematics, beliefs about mathematics teaching and learning, or both. Although some studies have explored the relationship between teachers' beliefs and their instructional practices, the professional literature appears to be rather lacking in this area. The attitudes of elementary, middle level and secondary teachers have been studied, but analyses of middle level and senior high mathematics teachers' beliefs appear to be more numerous than those of elementary teachers. Some studies related to teachers' attitudes regarding teaching mathematics have involved pre-service teachers, while others have focused on in-service teachers (Thompson, 1992).

A great deal of the research on teachers' beliefs and attitudes about mathematics teaching is interpretive in nature and applies quantitative as well as qualitative methods of analysis. Many methods of acquiring data have been used, including Likert-scale questionnaires, interviews, classroom observations, stimulated recall interviews, linguistic analysis of teacher talk, paragraph completion tests, responses to simulation materials such as vignettes describing hypothetical students or classroom situations, and concept generation and mapping exercises (Bannister & Fransella, 1977). It seems that most studies have employed a combination of two or more techniques, rather than making use of a single technique (Thompson, 1992). A wide variety of research methods used for exploring mathematics teachers' attitudes can be located in the literature.

Not only does the professional literature reflect variability in research methods that have been implemented in studies about teachers' attitudes toward mathematics instruction, but research designs have also deviated substantially. Many different types of designs have been used depending on the objective of the study, from ethnographic case studies of a small number of teachers (Brown, 1985; Cooney, 1985) to standardized administration of a belief inventory (Carpenter, Fenema, & Peterson, 1987). Some studies have been structured to describe or outline the essence of teachers' attitudes (Helms, 1989; Oprea & Stonewater, 1988). Investigation of the phenomenon of how programs and curricula might alter teachers' conceptions of mathematics teaching has been the purpose of another set of studies (Schram & Wilcox, 1988; Thompson, 1988). While some studies have meant to survey the relationship between teachers' conceptions and instructional practice (Dougherty, 1990; Shaw, 1989; Kesler, 1985), there seem to be

relatively few studies of this nature. The miscellany of purposes, methods, designs, and analytical frameworks used by researchers has resulted in a number of marked differences in how teachers' attitudes and conceptions have been portrayed.

Research on Teachers' Attitudes Toward Mathematics Instruction

A teacher's ideas concerning effective purposes of a mathematics program, his or her own abilities in the field of teaching, appropriate curricular components, the student's role in the mathematics classroom, desirable instructional strategies and emphases, and perceived outcomes of instruction are all components of a teacher's attitude toward mathematics teaching (Thompson, 1992). Some studies have implied that differences in teachers' conceptions of mathematics seem to relate to differences in their attitudes toward mathematics instruction (Thompson, 1984; Lerman, 1983). For example, Thompson (1984) indicated that differences in the teachers' primary perceptions of mathematics were related both to differences in their views about what should be the locus of control in teaching and what should determine confirmation of mathematical understanding in their students, as well as to differences in their perceptions of the goals of mathematics instructional design.

Some studies suggest that teachers' attitudes toward mathematics instruction may reveal their views, explicit or implied, of students' mathematical knowledge, of how students study and learn mathematics, and of the broad and specific functions and missions of schools. Carpenter, Fennema, Peterson and Carey (1988), for example, observed a significant relationship between teachers' attitudes toward teaching and their

conceptions of students' mathematical knowledge.

Although it seems that efforts to teach mathematics should be linked to knowledge of how students best learn mathematics, it appears that, for most teachers it is unlikely that the two have been cultivated and explicated into a meaningful theory of instruction (Borasi, 1996). Rather, conceptions of teaching and learning tend to be complex accumulations of beliefs and views that appear to be more the consequence of teachers' years of experience in the classroom than of any type of formal or informal study. Clark (1988) emphasized this point when he noted that research on teacher thinking has established manners in which teachers develop and grasp phenomenological theories about their students, about the subject matter that they teach, about their roles and responsibilities as teachers, and about how they should behave in the mathematics classroom. Rather than appearing as neat and unabridged duplications of the educational psychology found in textbooks or lecture notes, these teachers' implicit theories are inclined to be conglomerations of cause-effect proposals from many sources, rules of thumb, generalizations drawn from personal experience, beliefs, values, biases, and prejudices.

A perusal of the literature containing research on teachers' attitudes toward mathematics instruction can lead to a discovery that a great deal of research has been conducted with pre-service teachers. At least two reasons that research on the attitudes of pre-service school teachers is both of concern and moderately profuse can be identified. First, these teachers have a potential to influence their future students' attitudes. It seems sensible that a meaningful understanding of pre-service teachers' attitudes might help

researchers hypothesize about and critically explore the development of student attitudes. A second, more pragmatic reason for the wealth of research with pre-service teachers is that prospective teachers are a readily accessible population. As a result, some studies appear to have very widespread objectives, such as determining the impact of a course on teaching methods or investigating factors that seem to be correlated to teachers' mathematics attitudes (Kulm, 1980). Among the components that seem to comprise teacher attitude, the relationship of grade-level preference and mathematics ability to attitude toward teaching mathematics has engaging ramifications. Some older studies have shown that in general, many teachers who prefer to teach elementary grades have less favorable attitudes toward teaching mathematics than teachers who teach mathematics in middle or secondary schools (Raines, 1971; Early, 1970). Of course, it has traditionally been the case that high school mathematics teachers are the most able in mathematics, as they elect to teach mathematics exclusively in preference to other subjects. A result is that teachers who can persuade student attitudes and achievement in their developmental stages may be those who have the most inadequate attitudes themselves. Sobel (1982) pointed out that the classroom teacher is generally viewed as the most important learning process factor, a role that shall surely be maintained in years to come. It seems logical that by approaching each classroom subject--and perhaps especially mathematics, which is often feared in American society--with enthusiasm and interest, teachers should be able to impact students positively. It appears that little research seems to have been conducted to determine what outcome elementary teachers with positive attitudes and high mathematics abilities have on student attitudes.

In studying the formulation of pre-service teachers' beliefs about mathematics teaching and learning, researchers have noted that those beliefs, for the most part, are formed during the teachers' schooling years and are shaped by their own experience as students of mathematics (Ball, 1988; Owens, 1987). The responsibility of altering long-held, deeply rooted impressions of mathematics and its instruction in the short period of a teaching methods course remains a major concern in mathematics teacher education.

Research on Changing Teachers' Attitudes Toward Mathematics Instruction

Growing realization of the important role that teachers' attitudes play in teaching has led researchers to explore how teachers' attitudes are formed, how they evolve, and how they might be changed. Consequently, a number of investigations have been carried out to examine how teachers' images of mathematics teaching and learning might be enhanced or changed. As a research issue, achieving modification in teachers' attitudes seems to have gained popularity in recent years. However, a few studies of this nature predate the 1980s and 1990s.

Collier (1972) used Likert scales to assess preservice elementary teachers' beliefs about mathematics and mathematics teaching along a formal-informal dimension. The formal end of the dimension was distinguished by items depicting mathematics as stiff and precise, free of obscurity and disparity, and embodying precepts and formulas for solving problems. A formal view of mathematics instruction was specified in terms of items that accentuated teacher demonstration, memorization of facts and procedures, and single approaches to the solution of problems. In contrast, the informal pole of the

dimension was characterized by items portraying mathematics as artistic, creative, and analytical in nature and as allowing for a multiplicity of approaches to the solution of problems. An informal view of mathematics instruction was characterized by an accentuation on student discovery, experimentation, and inventiveness, the use of trial-and-error methods, and the urging of original thinking. Upon completion of the study, Collier provided evidence that prospective teachers nearing the end of their preparation programs had more informal and less ambivalent views about mathematics teaching than teachers beginning the teacher preparation program. Also, prospective teachers who had been identified as high-achievers viewed mathematics as less formal and had less ambivalent views of mathematics instruction than the low-achievers. However, most scores indicated a neutral position along the formal-informal dimension. Collier concluded that, allowing for the cross-sectional nature of the samples, the results signified a slight progression in the beliefs of the teachers toward an informal view of mathematics and mathematics instruction as they advanced through a teacher preparation program.

Not all studies have revealed changes in teachers' attitudes related to mathematics instruction. In his study of four preservice elementary teachers enrolled in a mathematics methods course, Shirk (1973) found no distinguishable change in the teachers' conceptions. Shirk noticed some changes in instructional behavior, but showed that those changes were consistent with the teachers' conceptions, which had remained essentially constant throughout the duration of the study.

Prawat (1992) outlined a case study that illustrated an important change in one fifth grade teacher's views about mathematics teaching that occurred over the course of a

year as a result of California's movement to reform mathematics teaching. However, the change did not appear to be reflected in the teacher's classroom practices.

While Collier (1972), Shirk (1973), and Prawat (1992) explored how teachers' attitudes toward mathematics instruction changed or did not change over time, several other studies in the literature focus on concerted efforts to create changes in teachers' attitudes toward teaching mathematics. Larson (1983) described some techniques that might be successful in helping to alter mathematical attitudes of prospective teachers. Allowing students to work in small groups, using a diversity of instructional approaches, and developing meaning and real-life applications of mathematics concepts were among the points included.

A study scrutinizing the effect of courses on preservice elementary teachers' mathematical conceptions and attitudes was carried out by Lanier, Lappan, Schram, and Wilcox (1988). These researchers set out to examine changes in undergraduate education majors' knowledge about mathematics, mathematics learning, and mathematics teaching as they proceeded through a sequence of three innovative mathematics courses. The courses highlighted conceptual development, group work, and problem-solving activities. Changes in students' thinking about mathematics were ascribed to their participation in the courses. At the end of the courses, changes were reported in the participants' conceptions of the nature of mathematics, of the structure of mathematics classes, and of the process of learning mathematics. Schram and Wilcox (1988) extended the study carried out by Lanier, Lappan, Schram, and Wilcox (1988) by conducting case studies of two prospective elementary teachers enrolled in the innovative mathematics courses.

These case studies centered specifically on the preservice educators' views about how mathematics is learned and what it means to know mathematics. The prospective teachers' convictions were probed against a framework developed by the researchers, consisting of levels that exhibited different orientations to mathematics teaching and learning. Whereas one student changed his original views of what it means to know mathematics, the other student appeared to incorporate the new experiences and conceptual ideas by modifying them to fit into her original conceptions.

Madsen (1992) conducted a study that demonstrated that preservice teacher candidates changed their thinking about mathematics, mathematics teaching, and children's mathematics learning after completing a mathematics methods course that promoted a nontraditional approach, which concentrated on teaching mathematics from a student-centered viewpoint. This student-centered viewpoint allowed for problem-solving opportunities in which students created and solved their own problems, critical thinking events in which clear connections between mathematics and real life situations were developed, and cooperative learning activities.

Generally, studies that have dealt with reorganization of teachers' attitudes have not provided the detailed analysis necessary to cast light on the question of why it seems difficult for many teachers to internalize new ideas related to mathematics instruction. An improved understanding of the sources of this difficulty is pivotal to the design of strong, successful teacher education and enhancement programs, programs that go beyond merely raising the status of enthusiasm of participating teachers. Such detailed analyses should seek to explain why it is that of a group of teachers participating in an in-

service program, only a few typically manage to implement new ideas with some share of success. Unfortunately, the literature on teacher change, though abundant with tips, does not suggest explanations for this phenomenon (Underhill, 1988).

Research on the Relationships Among Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods

Many studies of the relationship between teachers' attitudes toward teaching and mathematics teaching methods have examined the congruence between teachers' pronounced beliefs and their observed practice. The findings have not been as consistent as findings on the relationship between teachers' conceptions of mathematics as a discipline and mathematics teaching methods. Some researchers have reported a significant degree of agreement (Grant, 1984; Shirk, 1973) between teachers' professed views of mathematics teaching and their instructional practice, whereas others have reported sharp contrasts (Shaw, 1989; Cooney, 1985).

Shirk (1973), for example, explored the conceptual frameworks of four preservice elementary teachers and their relation to the teachers' behavior when teaching mathematics to small groups of middle level students. He described the teachers' conceptual frameworks in two parts: the teachers' conceptions of mathematics teaching and their conceptions of their roles as teachers. He observed that although the teachers' conceptions had elements in common, the distinctive mixture of elements in each case justified their different teaching behaviors. He noted that the teachers' conceptions seemed to be activated in teaching situations, resulting in the teachers behaving in manners that were consistent with their conceptions. Similarly, Grant (1984) reported a

positive relationship between professed beliefs and mathematics teaching methods in the case of three secondary mathematics teachers.

Other studies have indicated differences between middle level and secondary teachers' professed beliefs about teaching mathematics and their mathematics teaching methods (Brown, 1985; Cooney, 1985). Within a single study, some secondary teachers reportedly professed beliefs about mathematics teaching that were largely consistent with their instructional practices, whereas other teachers in the same study showed a great disparity (Thompson, 1984).

Although most studies related to teachers' attitudes toward mathematics instruction and their mathematics teaching methods have been conducted with secondary or middle level teachers, a few such studies that focus on elementary teachers have been carried out. Karp (1991) described a study in which the teaching behavior and mathematics teaching methods of elementary school teachers were investigated to determine whether teachers with positive attitudes toward mathematics instruction plan and implement mathematics teaching methods that differ from the methods of those elementary teachers with negative attitudes. Overall, the study indicated that teachers with negative attitudes made use of methods that fostered dependency, whereas teachers with positive attitudes encouraged student initiative and independence.

The incongruities reported in these studies signify that teachers' conceptions of teaching and learning mathematics are not related in a rudimentary cause-and-effect way to the mathematics teaching methods they plan and implement in the classroom. Instead, most studies present a complicated relationship, with many influences at work; one such

influence is the social context in which mathematics teaching takes place, with all the constraints it imposes and the opportunities it offers. Embedded in this context are the values, beliefs, and expectations of students, parents, teachers, and administrators; the adopted curriculum; the assessment procedures used; and the values and philosophical views of the broad educational system (Thompson, 1992).

1980s and 1990s Studies of Teachers' Attitudes Toward Mathematics Instruction

Fraser and Tobin (1988) focused on the successful and positive facets of schooling in a series of case studies. The studies involved 13 researchers in over 500 hours of intensive classroom observation of 20 exemplary teachers and a comparison group of non-exemplary teachers. The qualitative information was combined with quantitative information obtained from the administration of questionnaires assessing student perceptions of classroom environment. Interpretation of data included comparisons made between the actual classroom environment of exemplary teachers and the following: (1) the actual environment of comparison groups from past research; (2) the classroom environment preferred by exemplary teachers' classes; and (3) the actual classroom environment of non-exemplary teachers of the same grades in the same school. While the researchers did not focus exclusively on the mathematics instruction taking place in the specific classrooms, the findings of the study can be applied to elementary teachers of mathematics. It was found that exemplary teachers' classes can be distinguished from non-exemplary teachers' classes in terms of the psychosocial environment as perceived by students. Additionally, the classroom

environments created by the exemplary teachers generally were markedly more favorable than those of non-exemplary teachers. When mathematics is being taught, students are more likely to learn in a favorable environment.

Middleton (1992) examined the relationship between teachers' and students' personal constructs regarding intrinsic motivation in the mathematics class. Participants in the study were six middle school mathematics teachers and 30 students from five classes. Videotapes, direct observation, and individual interviews focused on the ways in which teachers attempted to build their students' motivations into their lessons, and the belief systems of teachers and students. Teachers and students were presented with random pairs of activities and were asked to determine what made one activity more fun than the other. Analysis of data indicated that teachers paid attention to motivating their students in developing their lesson plans, but the ways in which they attempted to build motivating exercises seemed to be more dependent upon the teachers' personal conceptions of intrinsic motivation than their beliefs about their students. Most of the teachers included in the study seemed to have little notion of the motivational beliefs of their students.

Some studies have indicated that teacher preparation programs may very well affect future teachers' attitudes toward teaching mathematics. Eisenhart (1993) explored a prospective teacher's practices and ideas, together with the messages about teaching for procedural and conceptual knowledge conveyed by the student's teacher education program. Procedural knowledge involves rote memorization of basic mathematics facts, as well as implementation of steps required to arrive at solutions to routine problems.

Conceptual knowledge, on the other hand, allows students to focus on the processes and concepts involved in mathematics as well as final answers. Activities that foster conceptual knowledge include cooperative learning, critical thinking activities, hands-on mathematics exploration, and meaningful use of technology. Eisenhart found that the student teacher taught, learned to teach, and had opportunities to learn to teach for procedural knowledge more often and more consistently than she did for conceptual knowledge.

Brosnan (1994) conducted a two-year study, the purpose of which was to document and examine changes in four teachers' beliefs and practices during their enactment of National Council of Teachers of Mathematics' (NCTM) Curriculum and Evaluation Standards (1989). Ethnographic inquiry was used to develop multiple case studies, which were analyzed individually and across cases. Data was gathered from interviews, observations, journals, attitude and belief surveys, and videotapes. The participants were four elementary-certified teachers in a suburb of a large midwestern urban area who volunteered to teach sixth grade mathematics full-time. The teachers were supported during implementation by co-workers, administrators, and professional development resources. Problems reported pertained to limited knowledge of NCTM's Curriculum and Evaluation Standards, current mathematics teaching methodologies, and mathematics content. Documented changes included an increase in student-centered activities, the use of manipulatives and calculators, and effective questioning techniques. There were also increases in student participation and the use of alternative assessment procedures, as well as changes in the beliefs of teachers about mathematics teaching and

learning.

Steele's (1994) study explored how implementing a constructivist approach in a mathematics methods class might alter prospective teachers' conceptions about mathematics and mathematics teaching and learning. The study used ethnographic and other qualitative measures: interviews, classroom observation, review of written assignments, classroom interaction, and journals of student responses for five randomly selected students from the class of 19. In addition, the study administered the Mathematics Beliefs Scales (MBS) at the beginning and end of the course. The course's major components were mathematical inquiry and investigation through problem solving in cooperative groups and whole-class discussions, reading assignments, problem assignments, student assessment interviews, constructivist teaching plans, creating alternate algorithms, final exam, and math logs. Qualitative data results indicated that cooperative groups and the use of manipulatives contributed significantly to challenging the mathematics-related conceptions of the preservice teachers involved in the study.

Rationale for Studying Elementary Teachers' Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods Used in the Elementary Classroom

Hunkler and Quast (1972) have asserted that the mathematics attitudes of prospective elementary school teachers are quite worthy of study. Furthermore, these authors pointed out that although other studies related to teachers' mathematics attitudes had been conducted in the past, there had not been a noted study completed that compared mathematics attitudes of prospective elementary school teachers who had

completed a mathematics teaching methods course versus those prospective elementary school teachers who had not completed such a course. Consequently, Hunkler and Quast (1972) conducted a study to determine if a content-method mathematics course designed for elementary education majors improves the mathematics attitudes of prospective elementary school teachers, and to determine if the mathematics attitudes of those prospective elementary school teachers who completed the course were significantly different from those prospective elementary school teachers who had not completed the course. The study made use of both quantitative and qualitative research methods.

At the college where the study was conducted, elementary education majors were required to take a three semester hour method-content mathematics course taught through the department of elementary education. The instructors teaching this course all had strong mathematics backgrounds and had been asked to display a definite interest in the subject, to indicate a desire to have the students understand the material, and to display a good control of the class without being overly strict. Such characteristics were emphasized because previous studies in education had indicated that teachers with such characteristics tend to affect students' attitudes and achievement positively.

The instrument used in this study was the Shatkin-Dohner Mathematics Attitude Scale, a Likert scale survey instrument that contains 22 attitudinal statements related to mathematics and mathematics learning. The respondent is asked to respond to each statement with "strongly agree," "agree," "neither agree nor disagree," "disagree," or "strongly disagree." Three random groups of students were formed to participate in this study: (1) those students who had completed no courses in college mathematics, (2) those

students who had completed a content course in college mathematics but had not taken the methods course required of elementary education majors, and (3) those students who were currently enrolled in the content-method course required of elementary education majors. During the first week of the semester, the students in all three groups were asked to complete the Shatkin-Dohner Mathematics Attitude Scale. The same instrument was administered to all three groups during the last week of the semester. The students in the third group were administered the survey instrument by people other than the course instructors. For all three groups, the t-test for correlated samples was used to determine if there was any significant difference between the initial and final mean scores on the mathematics attitude scale.

Upon completion of the statistical analysis, it was determined that there was a significant difference ($p<.05$) between the initial and final means in group three, the group of students who were currently enrolled in the mathematics methods course. Consequently, it was concluded that the method-content mathematics course designed for elementary education majors did improve the mathematics attitudes of the prospective teachers completing the course. Although the quantitative methods used demonstrated a significant difference in the initial and final attitudes of the prospective elementary mathematics teachers enrolled in the mathematics methods course, Hunkler and Quast (1972) enhanced their study by incorporating some qualitative methods. The researchers interviewed several students to formulate a subjective evaluation. The interviews indicated that there are certain characteristics that tend to affect students' attitudes toward mathematics. Such traits include the display of interest in the subject by the instructor,

the instructor's indication of a desire to have the students understand the material, and the instructor's display of good control of the class without undue strictness.

Clark-Meeks, Quisenberry, and Mouw (1982) have indicated that it is wise to examine the attitudes of prospective teachers regarding mathematics and mathematics teaching because of the levels of less than acceptable mathematics competence among many of the young students in the United States. The researchers decided to explore the mathematics attitudes of four groups of pre-service teachers: Early Childhood (preschool), Early Childhood (grades K-3), Intermediate (Grades 4-9), and Special Education. The type of inquiry used was quantitative. A survey known as the *Revised Math Attitude Scale* was completed by 58 students (19 in Early Childhood/Preschool, 17 in Early Childhood/Grades K-3, 16 in Intermediate/Grades 4-9, and six in Special Education) enrolled in classes titled "Philosophy of Creativity" and "Understanding the Elementary Age Child." These classes were selected because students in all four of the selected concentration areas were required to take these courses. The *Revised Math Attitude Scale* consists of 20 statements, 10 of which are worded positively and 10 of which are worded negatively, to which respondents answer using a five-point Likert scale. An answer to an item can range from "strongly agree" to "strongly disagree." Examples of statements in the survey include: "I am always under a terrible strain in a math class," "Mathematics makes me feel as though I'm lost in a jungle of numbers and cannot find my way out," "It makes me nervous to even think about having to do a math problem," and "I am happier in math class than in any other class."

The attitudes of prospective teachers in the four concentration areas were compared using analysis of variance, with a probability level of $p<.05$. Additionally, the items of the survey were measured for correlation using the Pearson Product Moment Correlation. After the surveys were administered and analyzed, it was determined that no significant differences existed among the four groups of prospective educators with regard to their attitudes toward mathematics and mathematics teaching. Percentage analyses of responses indicated that large numbers of the respondents felt negatively toward mathematics and were unlikely to enjoy teaching math. Furthermore, the Pearson Product Moment Correlation indicated that the survey items were correlated at the $p<.00001$ level, meaning that the survey items were univariate to a high degree, or that all questions on the survey worked together to measure the same concept.

Becker (1986) has expressed concern that very few research studies have been conducted to assess the attitudes of prospective elementary education teachers regarding mathematics. A particular interest of Becker's has been how the mathematics attitudes of elementary education majors might differ from the attitudes of non-education majors. In order to explore mathematics attitudes, Becker designed and implemented a study involving 81 elementary education majors enrolled in a required mathematics course and 71 other college students enrolled in a general astronomy course. The type of inquiry used was quantitative in nature. Each student was asked to complete a revised version of the Fennema-Sherman Mathematics Attitude Scales. The Fennema-Sherman Scales measure confidence in learning mathematics, attitude toward success in mathematics, perceptions of the attitudes of teachers toward the student as a learner of mathematics,

mathematics as a male domain, usefulness of mathematics, mathematics anxiety, and motivation in mathematics. The instrument's questions are presented as positively and negatively worded statements to which participants respond using a five-point scale, with responses ranging from "strongly disagree" to "strongly agree."

After the instruments were completed and analyzed, it was noted that the education students scored lower on the mathematics anxiety scale (indicating more anxiety) than any other attitude scale. In the area of anxiety, the education majors also scored significantly lower than the astronomy students. More than half of the education majors agreed or strongly agreed with the statement, "Mathematics makes me feel uneasy and confused." Seventy-one percent disagreed or strongly disagreed with the statement, "I almost never have gotten shook up during a math test."

Although several education majors indicated that they feel discomfort or anxiety when dealing with mathematics, Becker asserted that the attitudes of the elementary education majors were not so negative as to cause overt alarm. In fact, the elementary education majors revealed mathematics attitudes that were not altogether different from the mathematics attitudes of many college students in other majors. There were some particularly positive attitudes shown by the education majors. As a whole, they felt that mathematics is useful, that success in mathematics is a reachable goal, and that mathematics is not a male domain. Becker also pointed out that some past research efforts indicated that teacher attitudes in a particular discipline have less to do with student achievement than one would intuitively believe.

Karp (1989) conducted a study to investigate the teaching behavior and instructional methods of female elementary school teachers when engaged in mathematical instruction. In keeping with the meaning of ethnographic inquiry, this study used the actual classroom setting as the source of data and the researcher as the instrument. Two female teachers were selected from each of the fourth- and sixth-grade levels of a New York State public school district. Each pair had matching amounts of teaching experience as well as comparable cohorts of mathematics students, yet the scores of each reflected opposite poles of mathematics attitudinal instruments. Data were collected through the use of tape recordings, an observational framework, field notes, unstructured and formal interviews, a student attitudinal questionnaire, and artifacts during a two-month period. Findings indicated that teacher dependence, learned helplessness, and independent learning behaviors were affected by teachers' attitudes.

According to Muth (1993), much has been written regarding the integration of content areas. A great deal of the professional literature available advocates using language arts to teach mathematics and vice versa. The National Council of Teachers of Mathematics (1989, 1992, 1995) has published many statements indicating that communication skills, including reading, writing, and speaking, can and should be taught through creative mathematics lessons. In a research study, Muth (1993) proposed that teachers' attitudes toward mathematics may affect their willingness to integrate other subjects with mathematics, as well as their attitudes toward teaching mathematics in conjunction with other subject areas. She sought to assess middle school mathematics teachers' beliefs and practices related to reading in mathematics. Specifically, the study

was designed to assess mathematics teachers' knowledge about the reading process, receptiveness to teaching reading strategies that could be helpful to students, and the usefulness of the mathematics textbook in mathematics instruction. Additionally, a portion of the study was formulated to determine middle school mathematics teachers' perceptions of the usefulness of reading methods courses in their daily mathematics teaching. The study was conducted using mostly quantitative research methods, but some qualitative methods were also incorporated.

For this study, a six-part *Reading and Mathematics Questionnaire* was developed. Part one of the questionnaire asked respondents for demographic information. Part two of the questionnaire asked teachers to use five-point Likert scales to rate the usefulness of their undergraduate and, when applicable, graduate content area reading courses and to give reasons for their ratings. Part three of the questionnaire consisted of five-point Likert scales to assess teachers' beliefs about the role reading plays in mathematics learning and the role teachers should play in assisting students as they attempt to read mathematics. Part four of the questionnaire contained one completion item that asked teachers to indicate the percent of their students' learning that could be attributed exclusively to reading the mathematics textbook. Part five of the questionnaire included 14 items designed to assess the frequency with which middle school mathematics teachers use various activities (lecture, demonstrations, computer applications, etc.) in their classes. Respondents used a Likert scale to indicate from 1 (never) to 5 (daily) how frequently they use each activity. In part six of the questionnaire, teachers responded to four five-point Likert scale questions regarding their perceived sources of students'

difficulties with word problems.

The *Reading and Mathematics Questionnaire* was distributed to 114 teachers of grades six, seven, and eight. These teachers represented 14 middle schools in ten counties in a southeastern state. Ninety-nine questionnaires were returned for a response rate of 86.8 percent. After the questionnaires were read and analyzed, the researcher identified five emerging themes.

First among these themes was that although the respondents generally felt that their undergraduate and graduate content area reading courses were interesting, they did not view them as being particularly helpful to them as mathematics teachers. The primary reason given was that mathematics was never really discussed in the classes. Rather, science and social studies were heavily emphasized as courses in which students must be skillful readers. Second, the middle school mathematics teachers who participated in this study were undecided in their beliefs about the role of reading in the mathematics classroom as well as the role that teachers should play in helping their students deal with reading in mathematics. Generally, teachers were neither enthusiastic about nor resistant to the idea of assisting their students with reading activities in the mathematics classroom. Muth asserted that this undecidedness is consistent with mathematics teachers' feelings about the reading methods courses they completed while preparing to become teachers. Had these teachers been given research-based suggestions for effectively integrating mathematics and reading, they may have developed more enthusiastic feelings about using and teaching reading in mathematics lessons.

Third, responses to questionnaire items indicated that the participants do not view the textbook as a major source of learning for their students. Rather, the textbook is more frequently used as a resource for practice problems and such. Muth pointed out that there is some indication that as teachers take additional reading methods courses, they see the mathematics textbook as more important and useful. Fourth, it seems that middle school mathematics teachers use demonstrations, discussions, individual practice, and practice problems from the textbook on a nearly daily basis. Muth suggested that if middle grades teachers were made aware of research efforts that have indicated positive results of classroom discussions, small group activities, and cooperative learning, they may be inclined to use a wider variety of teaching/learning activities that could effectively incorporate reading, writing, speaking, and listening.

Fifth, the respondents indicated that they felt that comprehension was the primary source of their students' difficulty in solving word problems. Muth stated that this belief is consistent with research efforts concerning the role of reading in problem solving. Unfortunately, though, the middle grades mathematics teachers who participated in the study indicated that the reading methods courses in which they had participated had not provided adequate instruction in incorporating reading, mathematics, and problem solving instruction.

Some researchers have expressed a belief that elementary teachers' attitudes toward teaching mathematics are related to their perceptions of their personal backgrounds in the area of mathematics. Van Voorhis and Anglin (1994) conducted a study in order to explore elementary school teachers' perceptions of their mathematics

backgrounds. A total of 45 teachers were randomly selected to participate in this study. Of these, 21 teachers taught primary grades (1-3) and 24 teachers taught intermediate grades (4-6). As the surveys were designed so that they consisted primarily of open-ended questions, this study could be classified as qualitative. Some quantitative data, however, was collected via the surveys. Such quantitative data consisted mostly of demographic information but also included self-ratings (low, average, high) of the parental support received by respondents when they were students and self-perceived effectiveness (low, average, high) of mathematics teaching ability. The open-ended questions contained in the survey included the following:

1. What mathematics experiences did you have (positive or negative) in elementary school? (Also asked for high school, college, and inservice experiences.)
2. Did your parents, guardian, or family influence (positively or negatively) your interest in mathematics? Please explain.
3. How confident do you feel about your ability to teach elementary mathematics? Please explain.

The answers to the open-ended questions were coded and analyzed. In each of the following lists, responses are given from most frequently cited to least frequently cited. The coding and analysis revealed that the teacher-respondents considered the following to be positive mathematics experiences from the elementary school days: opportunities to tutor others, personal successes, enjoyment of mathematics, and good teachers. Identified negative mathematics experiences from elementary school included: memorization of

facts, rote drill, ability grouping, seat work, and story problems. The positive mathematics experiences remembered from high school included: good teachers, success with algebra, success with geometry, enjoyment of mathematics, ability grouping, good grades, scholarship, and participation in advanced/gifted mathematics classes. Negative high school experiences were identified as poor teachers, memorization, poor grades, difficulty with algebra, difficulty with geometry, and difficulty with trigonometry.

Study participants indicated that positive college mathematics experiences included: mathematics methods courses, good mathematics teachers, enjoyment of labs, opportunities to gain knowledge bases, personal successes, opportunities to tutor friends, and challenging activities. Negative college mathematics experiences included: mathematics methods courses, poor instruction/teachers, boring activities, lack of hands-on activities, lack of challenging activities, and lack of relevance to real life. Positive family influences mentioned included: parental help with homework, parental interest in mathematics, and parental interest in money management and other mathematical life skills.

The teachers in this study indicated that their confidence in teaching mathematics is most effectively enhanced through workshops and inservice training opportunities, opportunities to increase their knowledge bases, the learning of new strategies for teaching mathematics, personal enjoyment of mathematics, ability to see the importance of mathematics, and teacher training.

Van Voorhis and Anglin (1994) indicated that the qualitative results of the study are well in line with the recommendations of the National Council of Teachers of

Mathematics. Those activities and events that were identified as negative are precisely the types of activities and events that NCTM researchers feel should be de-emphasized in today's mathematics classrooms. Those positive memories, such as cooperative learning, hands-on activities, relevant mathematics, and parental involvement, are highly advocated not only by the NCTM, but also by many other educational researchers.

Based on the results of the study, Van Voorhis and Anglin made four important recommendations. First, teachers should openly recognize their students' abilities and allow students to share their expertise with classmates. Second, our schools should provide enthusiastic, competent mathematics teachers at all levels, from elementary school through college. Third, parents and families should become involved in their students' mathematics education and should model appreciation for mathematics. Fourth, our school systems should provide continued opportunities for mathematics teachers to grow through staff development activities and professional sharing sessions.

Norwood (1994) has also indicated that many teachers who feel uncomfortable when teaching mathematics are probably responding to experiences they had as mathematics students. Furthermore, those teachers who have mathematics anxiety seem more likely to use traditional teaching methods such as drill and practice, rather than games, problem solving, small-group and individualized instruction. The purpose of one of Norwood's studies (1994) was to assess the effectiveness of an instructional program created to reduce the mathematics anxiety levels of students who completed a developmental arithmetic course at a community college. This study used a quantitative form of inquiry. Students' mathematics anxiety ratings were determined using the

Fennema-Sherman Mathematics Anxiety Scale. In this study, student achievement was also measured using the Arithmetic Skills Test of the Descriptive Tests of Mathematics Skills (DTMS), a 35 question multiple-choice computation test with a 30-minute time limit.

The sample consisted of 123 students who were placed in developmental arithmetic courses because of poor scores on college placement tests. These students were randomly divided into two groups. Each of these two groups was divided into three sections, resulting in six class sections. Three instructors participated in this study. Each instructor participated in training sessions to explore two different manners of teaching the developmental arithmetic course. One approach was the traditional, instrumental style of teaching which focuses on rules, memorization, drill, and practice. The other approach was known as the relational approach which focuses on more holistic, conceptual instruction. Rather than participating in drill and practice activities, students in relational classes work together to solve nonroutine and open-ended problems. The focus in such a class is on the processes of mathematics, rather than on final answers.

Each instructor taught two sections of the developmental arithmetic course, one of which was taught using the instrumental approach and the other of which was taught using the relational approach. The students were not aware that they were participants in a study, thus eliminating the Hawthorne Effect, which indicates that subjects tend to act differently when they know that they are being studied. At the beginning of the semester, the students completed both the Fennema-Sherman Mathematics Attitude Scale and the Arithmetic Skills Test. The Mathematics Attitude Scales were administered first, to

lessen the possibility of inflated anxiety levels caused by the arithmetic tests. At the end of the semester, the same two instruments were administered again.

Analysis of Covariance (ANCOVA) analyses were used to evaluate the outcomes of the study. Such analyses revealed that students in the instrumental courses showed a significantly different (higher) decrease in mathematics anxiety than did students in the relational courses. Norwood points out that this is probably because students with high levels of mathematics anxiety feel more comfortable in very structured and rule-oriented mathematics learning situations. She adds that this does not indicate that the instrumental style of teaching is preferred, but simply that mathematics anxious students have had experiences throughout their school years that make it uncomfortable for them to learn in open-ended, collaborative situations. They are more interested in getting the "right" answer than in understanding why mathematics works the way it does. Consequently, teachers of all levels should evaluate the manners in which they teach mathematics and the attitudes toward mathematics they demonstrate. Although Norwood's study did not specifically address teachers' attitudes toward mathematics, it contains powerful implications for teachers of mathematics, who play a crucial role in developing the mathematics attitudes of their students.

Underhill (1988) has pointed out that educators and researchers have shown an increased wide-spread interest in the belief systems of teachers and especially in the belief systems of mathematics teachers. One definition of belief that is frequently used is "an attitude consistently applied to activities in which the person holding the belief is engaged." It follows that teachers generally associate the same attitudes with the same

set of activities. Underhill has asserted that it is important to know teachers' beliefs as well as how to change teachers' beliefs. Underhill (1988) summarized a variety of quantitative and qualitative studies that have been conducted in order to examine the belief systems of mathematics teachers. He includes studies of elementary and secondary teachers, pre-service teachers, and teachers with varying levels of experience. Following are synopses of several of the studies Underhill highlighted.

In 1984, Dionne conducted a quantitative study in which 33 Canadian teachers were asked to apportion 30 points across three perceptions of school mathematics: the *traditional* perception (which views mathematics as a set of skills to be learned using calculations, rules, procedures, and formulas), the *formalist* perception (which views mathematics as logic and rigor to be learned using formal proofs and deductive reasoning), and the *constructivist* perception (which views mathematics as the development of thinking processes to be learned through inductive reasoning, real-life experiences, and exploring relationships). The *constructivist* perception was given the highest average apportionment (12.8), followed by the *traditional* perception (9.3) and then the *formalist* perception (7.9). Underhill (1988) indicated that it is crucial that elementary mathematics teachers understand where their beliefs lie, for if teachers of young children are too strongly dedicated to the *formalist* or even the *traditional* perceptions of mathematics teaching, they are likely to teach in developmentally inappropriate manners.

In 1984, Thompson conducted a qualitative ethnographic study in which she explored the belief systems of three junior high school mathematics teachers who each

had more than three years of teaching experience. The first teacher saw mathematics as rather prescriptive, consisting of static facts and procedures. The second teacher had a rather formalist view and considered the most important aspects of mathematics to be proofs, logic, and deductive reasoning processes. The third teacher viewed mathematics as a combination of formal and traditional mathematics and focused primarily on the mathematics curriculum as it was prescribed by her school system. Underhill (1988) pointed out that none of the three teachers viewed mathematics from the constructivist viewpoint.

In 1986, Jones, Henderson, and Cooney conducted ten qualitative case studies in order to explore the belief systems of secondary mathematics teachers with varying levels of teaching experience. Six teachers had one year or less of experience, and four teachers had ten years or more of experience. The case studies revealed that regardless of years of experience, the teachers held similar beliefs about mathematics and mathematics teaching. These beliefs focused primarily on formalist views but also showed some appreciation for the exploratory, constructivist aspects of mathematics. Underhill (1988) pointed out that although these teachers still highly valued the formalist views, they were somewhat flexible in that they also appreciated the open-endedness that constructivism can add to the mathematics classroom.

Eisenhart, Shrum, Harding, and Cuthbert (1988) produced an ethnographic analysis of numerous teacher belief studies conducted through the middle and late 1980s. These researchers concluded that there are four major beliefs that reflect mathematics teacher perceptions and over which mathematics teachers actually seek control. These

beliefs can be paraphrased as follows:

1. Mathematics teachers have a responsibility to create learning environments in which they can be nurturing, cordial, spontaneous, and eliciting of student mathematics work.
2. Mathematics teachers should protect the inviolability of their mathematics classrooms.
3. The most rewarding activities in the mathematics classroom are those activities that allow mathematics students to achieve visible learning success.
4. It is more important to develop students' enthusiasm and ability to continue learning mathematics than to transmit particular subject matter in the classroom.

Underhill (1988) summarized the aforementioned studies of mathematics teachers' belief systems by asserting that elementary trained teachers seem to have more diversity among their teaching beliefs than traditional secondary mathematics teachers. It seems that elementary teachers focus more on constructivism than do middle school/junior high school teachers, and that middle school/junior high school teachers include more constructivistic activities in their classrooms than do secondary mathematics teachers. Further, nearly all secondary mathematics teachers seem to adhere to a transmission model of learning, in which information is transmitted from teacher to student through lecture and other passive teaching/learning activities. Underhill (1988) asserted that while belief systems are important, the relationships between beliefs and

actions are not necessarily simple correspondences. However, knowledge of the belief systems of mathematics teachers can enrich efforts to plan and implement curricular and instructional changes that will benefit both mathematics learners and mathematics teachers.

Teachers' attitudes toward mathematics teaching may have impact upon their students' feelings about mathematics as a school subject. Shaughnessy, Halandyna, and Shaughnessy (1983) sought to examine factors that affect student attitudes toward mathematics and the learning of mathematics in the school setting. They indicated that many previous studies that have examined student attitude regarding mathematics focused only on one grade level; therefore, it might be more advantageous to study students from a variety of grade levels in order to assess not only attitude but also attitude development over time. Thus, samples of students from grades four, seven, and nine were randomly selected for this study. The samples were appropriately large, with 587 fourth-graders, 764 seventh-graders, and 730 ninth-graders included. The authors acknowledge that because of the nature of the school systems included in the study, the samples of students were rather homogeneous with regard to racial representation. Only 14.5% of the students included in the study were classified as non-white, with 5.3% American Indian and 2.6% Mexican-American.

The type of inquiry used in this study was quantitative. The researchers designated the teacher, the student, and the learning environment as three important factors affecting student attitude toward mathematics. Each of these three factors is characterized by exogenous and endogenous variables. Exogenous variables are those

variables not directly influenced by the school environment. For example, a teacher's race and the number of hours a student spends watching television at home would both be considered exogenous variables. Endogenous variables are those variables that directly influence and take place within the school environment. A teacher's enthusiasm while teaching and the classroom materials used during a lesson are examples of endogenous variables. Specific questions were formulated to be addressed in this study. Following are these questions.

1. To what extent do student, teacher, and learning environment variables of both types (exogenous and endogenous) account for the variance of a measure of students' attitude toward mathematics?

2. Are these patterns consistent across three different grade levels?

To assess the relationships of learning environment, teacher, and student to student mathematics attitudes, the researchers made use of an instrument known as the *Inventory of Affective Aspects of Schooling* (IAAS). An IAAS-trained administrator visited each classroom to administer the IAAS instrument. In each of these classrooms, the teacher was asked to exit the classroom and to complete a teacher questionnaire. In the grade four classrooms, the instrument administrator read inventory items to the students. For grades seven and nine, the IAAS was self-administered. Students who needed assistance with reading items on the inventory were offered individual assistance.

Following the administration and analysis of the IAAS, a two-stage analysis of data was implemented. In the first stage, simple product-moment correlations were computed between each predictor and criterion. A minimum correlation of .20 ($p<.01$)

was set by the researchers in order to assure that any relationships found to be significant were more likely to be true relationships than chance relationships. The second stage of analysis involved the use of the general linear model (least-squares regression analysis) to determine the relative strength of association of the statistically significant variables. This means that if, for instance, three variables related to the learning environment were found to be significant, the least-squares regression analysis could determine which of these three variables is most influential and what percentage of influence this variable holds in the combination of influential variables.

As Shaughnessy, Halandyna, and Shaughnessy (1983) expected, the exogenous variables (those not influenced by the school environment) showed little direct relationship to student attitude toward mathematics. Among the endogenous student variables, three showed consistently notable correlations with attitude toward mathematics. These were fatalism (students' perceptions of their ability to affect school success), self-confidence, and importance of mathematics. Almost all the endogenous teacher variables were highly correlated with mathematics attitude in grades seven and nine, and many were also correlated in grade four. In general, the results from grade four were not as strongly shaped as the results from the grades seven and nine. The authors offer the possible explanation that students of fourth-grade age do not tend to be consistent when completing self-evaluative measurements.

The strongest relationships of any of the variables across all three grade levels were fatalism and overall teacher quality. As aforementioned, fatalism refers to student perceptions of how they affect school success. "Teacher quality" is a scale which

attempts to measure student perceptions of their teacher's instructional ability. This variable is actually composed of four scales: *support for the individual student, teacher praise and reinforcement, teacher commitment to learning,* and *fairness to student.* In grades seven and nine, overall teacher quality reached correlational levels of .50 with mathematics attitude. Shaughnessy, Halandyna, and Shaughnessy (1983) provided evidence that the teacher is a major factor in the development of student attitudes toward mathematics.

Elementary teachers' attitudes toward mathematics instruction and possible relationships of such attitudes to the mathematics teaching methods planned and implemented in the elementary classroom are areas worthy of study and investigation. Teachers' attitudes may have direct bearing on the amount of time elementary teachers devote to mathematics and to the specific methods of instruction they adopt. If there are relationships among elementary teachers' attitudes toward mathematics instruction and the teaching methods elementary teachers plan and implement in the classroom setting, there is an indication that elementary teachers would be well served to reflect upon their dispositions toward teaching mathematics as well as the teaching methods they employ in their classrooms. Indeed, it is conceivable that carefully planned and implemented studies related to elementary teachers' attitudes toward mathematics instruction and mathematics teaching methods used in elementary classrooms can lead to enhanced mathematics teaching and learning in elementary schools.

Summary of Literature Review

Because society is becoming more and more technology-oriented, and because problem-solving abilities and critical thinking skills are needed by today's citizens, it is crucial that schools provide meaningful and effective mathematics instruction, beginning at elementary school levels. Therefore, it seems equally decisive that teachers of young children possess and exhibit positive attitudes toward mathematics instruction. Although various definitions of *attitude* have been proposed by researchers throughout the years, attitude toward mathematics and mathematics instruction is usually defined by the instruments used in a particular study. Research regarding teachers' attitudes toward mathematics instruction has gradually evolved from a process-product paradigm, in which the objective of study was teachers' behaviors, to a highlight on teachers' thinking and decision-making processes. Many researchers have struggled over the difference (or lack of difference) between attitudes and knowledge. Some educators have submitted that it is not worthwhile for researchers to investigate distinctions between knowledge and attitude, but, rather, to search for whether and how, if at all, teachers' beliefs--or what they may take to be knowledge--influence their experience.

Studies of mathematics teachers' attitudes have centered on beliefs about mathematics, beliefs about mathematics teaching and learning, or both. Practically all research on teachers' beliefs and attitudes is interpretive in nature and applies both quantitative and qualitative methods of analysis. The miscellany of purposes, methods, designs, and analytical frameworks used by researchers has led to vast variability in how teachers' attitudes and conceptions have been portrayed.

Teachers' attitudes toward mathematics instruction are affected by what teachers judge to be agreeable purposes of the mathematics program, their own capacities in teaching, suitable classroom activities, the students' roles, desirable instructional strategies and emphases, reasonable mathematical procedures, and adequate outcomes of instruction. A great deal of research has been conducted with preservice elementary teachers because these teachers have the capability of greatly influencing future students' attitudes, and because prospective teachers are a readily accessible population. Some older studies have shown that, generally, teachers who prefer to teach elementary grades have less favorable attitudes toward teaching mathematics than teachers who teach in the middle or secondary grades (Raines, 1971; Early, 1970).

Some researchers have reported a significant degree of agreement between teachers' professed views of mathematics teaching and their instructional practice, whereas others have reported sharp contrasts. An expanding realization of the function that teachers' attitudes perform in teaching has led researchers to deliberate how such attitudes are formed, how they evolve, and how they can be changed. Older studies generally suggest that teachers' attitudes are not easily modified, but more recent investigations have suggested that programs can be formulated specifically to induce change in attitudes.

It seems clear that the study of elementary teachers' attitudes toward mathematics instruction and possible relationships among these attitudes and mathematics teaching methods used in the elementary classroom has instituted a place for itself within the mathematics education research establishment. After surveying the literature, the

offerings may appear to be more gossamer than obvious. It may be that much of what this line of research has to contribute is yet unrealized. Nonetheless, there are several areas of mathematics education to which research on teachers' attitudes toward mathematics and mathematics instruction has already made important contributions. Such areas include mathematics teacher education and research on teacher education, and research on mathematics teaching and learning (Thompson, 1992).

CHAPTER III

METHODOLOGY

Learning and using mathematics are lifelong processes. Consequently, mathematics instruction should be effectively planned and implemented throughout students' school years, beginning at the primary and elementary levels. Teachers of young children have the potential to impact greatly their students' perceptions of mathematics learning processes. Elementary teachers' attitudes toward mathematics instruction and the methods elementary teachers elect to plan and implement in the elementary classroom are two major factors that influence how young students perceive mathematics and to what extent students develop abilities in computation, problem solving, critical thinking, and other mathematics skills.

Due to the fact that elementary school teachers have developed their attitudes and beliefs over years of being students themselves and from their own teaching experiences, it seems reasonable to assert that teachers' attitudes related to mathematics instruction may influence their choices of teaching methods used in the classroom. Being exposed to teaching methods that assist in mathematics skill learning, conceptual development, and problem solving abilities aids students in learning mathematics in meaningful manners. Teachers who have negative attitudes toward mathematics teaching may neglect some of the teaching methods that research efforts have shown to be effective.

If any teacher's beliefs concerning mathematics instruction are not generally positive and enthusiastic, meaningful and effective instructional methods may be replaced with "bare bones" lectures and drill. Consequently, many students' opportunities for learning mathematics may be stifled (Burns, 1998). Furthermore, because teachers' attitudes may significantly impact the amount and quality of material presented to students, professionals in education should be kept informed regarding teachers' attitudes toward mathematics instruction and the relationships of such attitudes to mathematics teaching methods used daily in classrooms. Mathematics will continue to be a discipline of tremendous value and importance, and teachers will continue to have to teach mathematics.

In this light, the author's study was conducted to explore elementary teachers' attitudes toward mathematics instruction and possible relationships of these attitudes to the mathematics teaching methods that elementary teachers elect to plan and implement in their classrooms. It was planned that the results of this investigation would be made available to Central Georgia principals and curriculum directors to be used as a possible resource in the planning and implementation of staff development training sessions focusing on mathematical theory and practice.

Research Questions

Is there a relationship between elementary teachers' self-expressed anxiety related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed confidence

related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed enjoyment related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed desire for recognition related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Is there a relationship between elementary teachers' self-expressed pressure to conform related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Definition of Terms

For the purpose of this study, elementary teachers are defined as teachers who are employed as full-time instructors of students in kindergarten, grade one, grade two, grade three, or grade four.

Attitudes toward teaching mathematics instruction are self-expressed feelings and beliefs regarding levels of positiveness or negativeness toward various aspects of teaching mathematics.

Anxiety refers to nervousness or uneasiness of mind when teaching mathematics.

Confidence refers to the feeling that one will be effective when teaching mathematics.

Enjoyment refers to the pleasure or satisfaction one feels when teaching

mathematics.

Desire for recognition refers to one's wish to be identified by others as an effective or outstanding teacher of mathematics.

Pressure to conform refers to outward influences that might cause one to feel uncomfortable about being considered an effective or outstanding teacher of mathematics.

Teaching methods are instructional activities planned and implemented by elementary teachers in the mathematics classroom.

Traditional teaching methods are instructional activities that are teacher-led and focus on lectures, paper and pencil activities, recitation, memorization and repetition of basic skills.

Progressive teaching methods are instructional activities that are student-oriented or student-centered and focus on critical thinking abilities, real-life problem solving opportunities, cooperative learning, hands-on activities, the use of mathematics manipulatives, and project development.

Teaching methods that combine traditional and progressive approaches are instructional activities that are neither completely teacher-led nor completely student-centered and that incorporate traditional teaching methods with progressive teaching methods. Examples of such instructional activities would include activities that allow students creative involvement in lessons but in which the topics of discussion have been pre-selected by the teacher.

A Likert scale is a five-point scale used to register the extent of agreement or disagreement with a particular statement of an attitude, belief, or judgment.

Data Collection

Research Design

The research design used in this investigation was a correlational design. A correlational study "involves the collection of two or more sets of data from a group of subjects with the attempt to determine the subsequent relationship between those sets of data" (Tuckman, 1994, p. 166). The sets of data considered in this study were elementary teachers' self-expressed attitudes regarding mathematics instruction and elementary teachers' self-reported frequencies with which they plan and implement particular teaching methods in the elementary mathematics classroom. The elementary teachers' self-expressed attitudes regarding mathematics instruction were divided into five areas for analysis: anxiety related to mathematics instruction, confidence related to mathematics instruction, enjoyment related to mathematics instruction, desire for recognition related to mathematics instruction, and pressure to conform related to mathematics instruction. The mathematics teaching methods were divided into three areas for analysis: traditional mathematics teaching methods, progressive mathematics teaching methods, and teaching methods that combine traditional and progressive approaches.

Population

For this study, the population consisted of 492 elementary teachers (grades K-4) currently teaching in the Bibb County, Georgia, Public School System. The Bibb County Public School System is the only public school system serving the local population of approximately 270,000 inhabiting Macon and Bibb County, Georgia. Located in the geographical center of Georgia, Macon is both an historic and progressive city,

encompassing approximately 300 square miles and serving a diverse population which is approximately 55 % Caucasian, 44 % African American and 1 % other races.

The Bibb County Public School System consists of 31 elementary schools, five middle schools, and five high schools. The elementary teachers (grades K-4) who comprise the population vary widely in professional preparation, philosophy, and teaching experience.

Sample

The sample considered in this study represented a cluster sampling of the population and consisted of 90 elementary teachers (grades K-4) currently teaching in six Bibb County public elementary schools. One inner city school, four suburban schools, and one rural/semi-rural school were randomly selected.

Instrumentation

In this study, subjects were asked to complete two Likert scale questionnaires. One questionnaire presented attitudinal statements related to the teaching of mathematics, including statements concerning anxiety associated with teaching mathematics, confidence associated with teaching mathematics, enjoyment associated with teaching mathematics, desire for recognition when teaching mathematics, and pressure to conform when teaching mathematics. This instrument is adapted from a survey instrument developed by Steven Nisbet (1991) and is partially based upon the Fennema Sherman Mathematics Attitudes Scales frequently used in studies involving high school and college students' attitudes toward mathematics as a discipline. Questionnaire responses of 155 student teachers were analyzed to develop meaningful attitude scales and to refine

this instrument. Nisbet (1991) calculated scale reliabilities for the attitude factors measured by the survey instrument. The Spearman-Brown coefficients were as follows:

statements concerning anxiety associated with teaching mathematics: .80

statements concerning confidence associated with teaching mathematics: .89

statements concerning enjoyment associated with teaching mathematics: .89

statements concerning desire for recognition when teaching mathematics: .71

statements concerning pressure to conform when teaching mathematics: .74.

On the survey instrument, the statements concerning anxiety associated with teaching mathematics are as follows: "Generally I feel secure about the idea of teaching mathematics," "Of all the subjects, mathematics is the one I worry about most in teaching," "I would get a sinking feeling if I came across a hard problem while teaching mathematics," "The thought of teaching mathematics makes me feel restless, irritable, and impatient," "Teaching mathematics makes me feel nervous," "The thought of teaching mathematics makes me feel nervous," "I am not the type of person who could teach mathematics very well," and "Mathematics is the subject I am least confident about teaching."

The statements concerning confidence in teaching mathematics are as follows: "I am confident about the methods of teaching mathematics," "I have a lot of self confidence when it comes to teaching mathematics," "I feel at ease when I am teaching mathematics," and "Teaching mathematics does not scare me at all."

The statements concerning enjoyment associated with teaching mathematics are as follows: "I enjoy the challenge of teaching a new and difficult concept in

mathematics," "Time passes quickly when I am teaching mathematics," "Teaching mathematics is enjoyable and stimulating to me," and "I like teaching mathematics."

The statements concerning desire for recognition when teaching mathematics are as follows: "It would make me happy to be recognized by other teachers as an excellent teacher of mathematics," "I would be proud to be the outstanding teacher of mathematics among my peers," and "I would like the students to recognize me as a good teacher of mathematics."

The statements concerning pressure to conform when teaching mathematics are as follows: "Being an outstanding teacher of mathematics would make me feel unpleasantly conspicuous," "My peers would think I was strange if I were an outstanding teacher of mathematics," and "I would not want to let on that I was good at teaching mathematics."

The second Likert scale questionnaire consisted of a list of teaching methods accompanied by five possible frequencies from which subjects could select a response: "daily" (once or more per school day), "frequently" (more than once per week), "occasionally" (about once per week), "seldom" (less frequently than once per week), and "never" (not at all). This instrument was designed by the researcher. Mathematics teaching methods included on the survey instrument were divided into three areas for analysis: traditional mathematics teaching methods, progressive mathematics teaching methods, and mathematics teaching methods that combine traditional and progressive approaches.

For the purpose of this study, traditional teaching methods are defined as instructional activities that are teacher-led and focus on lectures, paper and pencil

activities, recitation, memorization and repetition of basic skills. Traditional teaching methods are based primarily on a behavioral theory of how people learn. According to behaviorists, learning is linear and segmented. Skills and knowledge are acquired in a certain order. Applied to planning for teaching, behaviorist theory advocates that instruction be designed to increase competence in terms of goals usually defined by "experts"--textbook publishers, teachers, or others. When traditional teaching methods are used, it is often the case that assessment of student achievement in mathematics is conducted in order to identify deficiencies in student learning. In order to identify such deficiencies, those who espouse traditional teaching methods frequently make use of normative assessment instruments such as standardized tests.

The traditional mathematics teaching methods included in the survey instrument were as follows: teacher-focused lecture, teacher-focused demonstration on chalk board/dry erase board, teacher-focused demonstration on overhead projector, teacher-led question-and-answer session with students, skills practice with flash cards, skills practice through oral recitation, student completion of professionally produced worksheets/workbook pages, student completion of teacher-produced worksheets, student completion of mathematics problems copied from chalkboard/dry erase board, and student completion of mathematics problems copies from overhead projector.

For this study, progressive teaching methods are defined as instructional activities that are student-oriented or student-centered and focus on critical thinking abilities, real-life problem solving opportunities, cooperative learning, hands-on activities, the use of mathematics manipulatives, and project development. Progressive teaching methods are

rooted in the cognitivist view of learning. According to cognitivists, learning consists of the processes of incorporating and restructuring. Students acquire knowledge and skills through experiences that add to, interrelate, and alter existing understandings. Cognitivists consider the major goal of instruction to be the facilitation of change within an individual. Learning experiences should be planned and implemented to nurture learners in restructuring their interpretations of their environments as well as their goals. To measure student achievement, those who subscribe to progressive teaching methods design appropriate assessment opportunities to reveal the learner's perceptions of the concepts at hand. Assessment opportunities are included in the natural instructional processes so that they actually enhance instruction, rather than interrupting student learning so that some "test" may be completed. Many progressive teaching methods are constructivistic because they allow students to "construct" their own mathematics concepts. Such construction occurs when students are allowed to interact with their environments continuously, creatively, and actively (Bodner, 1986). The planning and implementation of progressive teaching methods have been supported by the work of many educational researchers, including Piaget and Vygotsky. Piaget's stages of development (1954) support the idea that teaching and learning should progress from concrete experiences to abstract experiences in a manner that is not rushed but is consistent with student development. Vygotsky's writings (1962) discuss the differences between the zone of actual development and the zone of proximal development. Regardless of students' current levels of development, they are cognitively capable of moving beyond their current intellectual development stage into a more advanced stage if

they are presented with appropriate cognitive activities. By presenting and guiding students through such activities, the teacher is a nurturer to students and supports them as they grow intellectually.

The progressive mathematics teaching methods included in the survey instrument were as follows: teacher demonstration using teacher-made mathematics manipulatives, teacher demonstration using everyday items (keys, rocks, etc.) as mathematics manipulatives, whole-class use of teacher-made manipulatives (with every student having manipulatives to use), whole-class use of everyday items (keys, rocks, etc.) as mathematics manipulatives (with every student having manipulatives to use), cooperative learning activities in which groups use teacher-produced mathematics manipulatives, cooperative learning activities in which groups use everyday items (keys, rocks, etc.) as mathematics manipulatives, creative activities in which individual students create physical examples of mathematical concepts, creative activities in which groups of students creative physical examples of mathematical concepts, activities that use children's literature to teach mathematics, activities that integrate writing and mathematics, computer activities in which students create their own problems, and calculator activities in which students create their own problems.

For this study, teaching methods that combine traditional and progressive approaches are defined as instructional activities that are neither completely teacher-led nor completely student-centered and that incorporate traditional teaching methods with progressive teaching methods. Examples of such instructional activities would include activities that allow students creative involvement in lessons but in which topics of

discussion have been pre-selected by the teacher.

The mathematics teaching methods that combine traditional and progressive approaches included in the survey instrument were as follows: student-focused demonstration on chalk board/dry erase board, student-focused demonstration on overhead projector, teacher demonstration using professionally-produced manipulatives, whole-class use of professionally-produced mathematics manipulatives (with every student having manipulatives to use), cooperative learning activities in which students complete paper/pencil activities, cooperative learning activities in which students orally discuss mathematics concepts, cooperative learning activities in which groups use professionally-produced manipulatives, computer activities using professionally-produced software, and calculator activities in which students solve given problems.

Prior to the distribution of the final questionnaires, a pilot study involving ten elementary teachers was conducted in order to provide a formative evaluation of the survey instrument. Participants in the pilot study offered suggestions related to the wording of certain survey items. The recommended corrections and refinements were executed.

Procedures

After permission to conduct the study was granted by the Deputy Superintendent of the Bibb County Public School System, six schools were randomly selected for inclusion in the study. In order to include teachers of children who represent a general cross section of the school district, the researcher selected one inner city school, four suburban schools, and one rural/semi-rural school. The researcher met with principals of

these six schools to discuss the study and to obtain authorization to distribute surveys during a scheduled faculty meeting.

Prior to the distribution of the final questionnaires, a pilot study involving ten elementary teachers was conducted in order to provide a formative evaluation of the survey instrument. Participants in the pilot study offered a few suggestions related to the wording of certain survey items. The recommended corrections and refinements were executed.

The finalized Likert scale surveys were distributed during faculty meetings of the six Central Georgia schools randomly selected for inclusion in the sample. In order to protect the privacy and confidentiality of the respondents, the researcher provided envelopes for the return of the surveys.

Data Analysis

To facilitate statistical calculations for this study, the researcher assigned numeric values to Likert scale responses. On the survey pertaining to attitudes toward mathematics instruction, there were positively phrased and negatively phrased statements. For the positively phrased statements, the following numeric values were assigned: "strongly agree" = 5, "agree" = 4, "undecided" = 3, "disagree" = 2, and "strongly disagree" = 1. For the negatively phrased statements, the following numeric values were assigned: "strongly disagree" = 5, "disagree" = 4, "undecided" = 3, "agree" = 2, and "strongly agree" = 1. For the survey pertaining to teaching methods used in the elementary classroom, the following numeric values were assigned: "daily" = 5, "frequently" = 4, "occasionally" = 3, "seldom" = 2, and "never" = 1. Because there were

multiple responses related to each of the eight variables in the study (anxiety, confidence, enjoyment, desire for recognition, pressure to conform, traditional teaching methods, progressive teaching methods, and traditional/progressive teaching methods), a participant's composite score for a particular variable was obtained by totaling the numeric values of the participant's responses to each item related to the variable. For each variable, the maximum possible composite score and the minimum possible composite score depended upon the number of survey items relating to the variable.

Once participants' composite scores for all variables were calculated, Pearson correlation coefficients were calculated and used to interpret the results. The Pearson correlation coefficients measured the relationships between elementary teachers' attitudes toward mathematics instruction and elementary teachers' reported frequencies of planning and implementing particular teaching methods in the elementary mathematics classroom. The researcher set the statistical significance level at $p<.05$, and each calculated Pearson correlation coefficient was examined for statistical significance based on this criterion.

The teachers' attitudes toward mathematics instruction were analyzed in five areas: anxiety related to mathematics instruction, confidence related to mathematics instruction, enjoyment of mathematics instruction, desire for recognition related to mathematics instruction, and pressure to conform in mathematics instruction. The frequencies of planning and implementing particular teaching methods were analyzed in three areas: traditional teaching methods, progressive teaching methods, and teaching methods that combine traditional and progressive approaches. Results were made

available to principals, curriculum directors, and teacher educators to be used as a possible resource in the planning and implementation of education courses and staff development training sessions focusing on mathematics teaching.

CHAPTER IV

REPORT OF DATA AND DATA ANALYSIS

The purpose of this study was to explore the attitudes of elementary school teachers (grades K-4) regarding mathematics instruction and to determine if a relationship exists between elementary teachers' self-expressed attitudes regarding mathematics teaching and the mathematics teaching methods they plan and implement in the classroom setting.

For this study, the population consisted of 492 elementary teachers (grades K-4) currently teaching in the Bibb County, Georgia, Public School System. The sample considered in the study represented a cluster sampling of the population and consisted of 90 elementary teachers (grades K-4) currently teaching in six Bibb County public elementary schools. One inner city school, four suburban schools, and one rural/semi-rural school were randomly selected. The research design used in this investigation was a correlational design. The sets of data considered were elementary teachers' self-expressed attitudes regarding mathematics instruction and elementary teachers' self-reported frequencies with which they plan and implement particular teaching methods in the elementary mathematics classroom.

Participants in this study were asked to complete two Likert scale questionnaires. One questionnaire presented attitudinal statements related to the teaching of mathematics,

including statements concerning anxiety associated with teaching mathematics, confidence associated with teaching mathematics, enjoyment associated with teaching mathematics, desire for recognition when teaching mathematics, and pressure to conform when teaching mathematics. The second Likert scale questionnaire consisted of a list of teaching methods accompanied by five possible frequencies from which subjects could select a response: "daily" (once or more per school day), "frequently" (more than once per week), "occasionally" (about once per week), "seldom" (less frequently than once per week), and "never" (not at all). Mathematics teaching methods included on the survey instrument were divided into three areas for analysis: traditional mathematics teaching methods, progressive mathematics teaching methods, and mathematics teaching methods that combine traditional and progressive approaches.

Research Questions

The following questions guided this research:

1. Is there a relationship between elementary teachers' self-expressed anxiety related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

2. Is there a relationship between elementary teachers' self-expressed confidence related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

3. Is there a relationship between elementary teachers' self-expressed enjoyment related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

4. Is there a relationship between elementary teachers' self-expressed desire for recognition related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

5. Is there a relationship between elementary teachers' self-expressed pressure to conform related to mathematics instruction and the frequency with which they plan and implement particular teaching methods in the classroom setting?

Findings

Pearson correlation coefficients were calculated and used to interpret the results of the Likert scale surveys completed by the subjects of the study. The Pearson correlation coefficients measured the relationships between elementary teachers' attitudes toward mathematics instruction and elementary teachers' reported frequencies of planning and implementing particular teaching methods in the elementary mathematics classroom. The teachers' attitudes toward mathematics instruction were analyzed in five areas: anxiety related to mathematics instruction, confidence related to mathematics instruction, enjoyment of mathematics instruction, desire for recognition related to mathematics instruction, and pressure to conform in mathematics instruction. The frequencies of planning and implementing particular teaching methods were analyzed in three areas: traditional teaching methods, progressive teaching methods, and teaching methods that combine traditional and progressive approaches.

The five areas of elementary teachers' attitudes toward mathematics instruction and the three areas of teaching methods resulted in 15 relationships. For each of these relationships, the Pearson correlation coefficient was calculated. "The Pearson

correlation coefficient quantifies the magnitude and direction of the linear relationship between two variables" (Glass and Hopkins, 1996, p. 106). The value of the Pearson correlation coefficient (signified as *r* when referring to samples) can range from -1.0 for a perfect inverse or negative relationship, through 0 for no correlation, and up to +1.0 for a perfect direct or positive relationship (Glass and Hopkins, 1996).

Descriptive Statistics

The variables explored in this study included anxiety related to mathematics instruction, confidence related to mathematics instruction, enjoyment of mathematics instruction, desire for recognition related to mathematics instruction, pressure to conform in mathematics instruction, traditional teaching methods, progressive teaching methods, and teaching methods that incorporate traditional and progressive approaches.

The descriptive statistics calculated for these eight variables are presented in Table 1. Included in the descriptive statistics is the calculated value of Cronbach's alpha for each variable. Cronbach's alpha is a measure of internal consistency, based on the average inter-item correlation. It uses the responses of the members of the sample (n=90) to provide information regarding the extent to which the questionnaire items that were planned to measure the same variable are actually related to one another.

Table 1

Descriptive Statistics for Variables in the Study

Variable	Minimum Possible Score	Maximum Possible Score	Minimum Obtained Score	Maximum Obtained Score	Mean	Standard Deviation	Cronbach's Alpha
Anxiety	8	40	8	36	16.2111	6.0420	.9242
Confidence	4	20	7	20	16.2667	2.7141	.8631
Enjoyment	4	20	5	20	15.7111	3.0840	.8893
Desire for Recognition	3	15	7	15	12.2333	1.9024	.7517
Pressure to Conform	3	15	3	10	6.0556	1.8685	.6411
Traditional Teaching Methods	10	50	18	48	34.9778	6.3316	.7881
Progressive Teaching Methods	12	60	16	55	31.9889	7.0734	.8382
Traditional/ Progressive Teaching Methods	9	45	17	41	28.0778	4.5524	.6680

Correlations Among Variables in the Study

Table 2 presents a full correlation matrix for all variables in the study.

Table 2

Correlations Among Variables in the Study

Variables	Anxiety	Confidence	Enjoyment	Desire for Recognition	Pressure to Conform	Traditional Teaching Methods	Progressive Teaching Methods	Traditional/ Progressive Teaching Methods
Anxiety	--	-.765 (<.001)	-.776 (<.001)	-.265 (.011)	.350 (.001)	-.136 (.203)	.045 (.674)	-.056 (.599)
Confidence	-.765 (<.001)	--	.734 (<.001)	.332 (.001)	-.326 (.002)	.136 (.202)	-.116 (.275)	.076 (.479)
Enjoyment	-.776 (<.001)	.734 (<.001)	--	.488 (<.001)	-.370 (<.001)	.106 (.320)	-.063 (.555)	.063 (.555)
Desire for Recognition	-.265 (.011)	.332 (.001)	.488 (<.001)	--	-.544 (<.001)	-.066 (.538)	-.131 (.219)	-.083 (.439)
Pressure to Conform	.350 (.001)	-.326 (.002)	-.370 (<.001)	-.544 (<.001)	--	.121 (.257)	.023 (.830)	-.031 (.773)
Traditional Teaching Methods	-.136 (.203)	.136 (.202)	.106 (.320)	-.066 (.538)	.121 (.257)	--	-.017 (.877)	.454 (<.001)
Progressive Teaching Methods	.045 (.674)	-.116 (.275)	-.063 (.555)	-.131 (.219)	.023 (.830)	-.017 (.877)	--	.490 (<.001)
Traditional/ Progressive Teaching Methods	-.056 (.599)	.076 (.479)	.063 (.554)	-.083 (.439)	-.031 (.773)	.454 (<.001)	.490 (<.001)	--

Note. Correlations presented with p-values in parentheses.
N=90

Construct Validity of Attitude Questionnaire

Each correlation between two types of attitudes (anxiety, confidence, enjoyment, desire for recognition, and pressure to conform) was significant at the $p<.05$ level of significance. In addition to showing significant correlations, the types of attitudes were related in the direction the researcher assumed they would be.

For example, one might reason that teachers with high levels of anxiety related to mathematics instruction would have low levels of confidence and enjoyment. Such would be demonstrated by negative correlations. The correlation between anxiety and confidence was -.765 ($p<.001$), and the correlation between anxiety and enjoyment was -.776 ($p<.001$). Also, one might hypothesize that teachers who feel high levels of pressure to conform would experience high levels of anxiety, or that teachers who have high levels of confidence would also have high levels of enjoyment. Such would be demonstrated by positive correlations. The correlation between pressure to conform and anxiety was .350 ($p=.001$), and the correlation between confidence and enjoyment was .734 ($p<.001$). The levels of significance of these correlations, and of others as shown in Table 2, provide evidence of construct validity of the questionnaire that was designed to measure elementary teachers' attitudes toward mathematics instruction.

Relationships Between Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods Used in the Classroom

Table 3 summarizes the findings of the Pearson correlation coefficients calculated for attitudes toward teaching mathematics (anxiety, confidence, enjoyment, desire for recognition, and pressure to conform) and the planning and implementation of traditional teaching methods, progressive teaching methods, and teaching methods that incorporate traditional and progressive approaches.

Table 3

Correlations Between Attitudes Toward Mathematics Instruction and Types of Teaching Methods Used

Variables	Traditional Teaching Methods	Progressive Teaching Methods	Traditional/ Progressive Teaching Methods
Anxiety	-.136 (.203)	.045 (.674)	-.056 (.599)
Confidence	.136 (.202)	-.116 (.275)	.076 (.479)
Enjoyment	.106 (.320)	-.063 (.555)	.063 (.554)
Desire for Recognition	-.066 (.538)	-.131 (.219)	-.083 (.439)
Pressure to Conform	.121 (.257)	.023 (.830)	-.031 (.773)

Note. Correlations reported with p-values in parentheses.
N=90

None of the correlations between attitudes toward teaching mathematics (anxiety, confidence, enjoyment, desire for recognition, and pressure to conform) and the planning and implementation of various teaching methods (traditional, progressive, and traditional/progressive) was significant at the $p<.05$ level of significance.

CHAPTER V

SUMMARY, CONCLUSIONS AND IMPLICATIONS

Summary of Study

This study involved an investigation of elementary (grades K-4) teachers' attitudes toward mathematics instruction and the mathematics teaching methods elementary teachers plan and implement in the classroom setting. The population consisted of 492 elementary teachers (grades K-4) currently teaching in the Bibb County, Georgia, Public School System. The sample represented a cluster sampling of the population and consisted of 90 elementary teachers (grades K-4) currently teaching in six Bibb County public elementary schools. One inner city school, four suburban schools, and one rural/semi-rural school were randomly selected. The research design used in this investigation was a correlational design. The sets of data considered were elementary teachers' self-expressed attitudes regarding mathematics instruction and elementary teachers' self-reported frequencies with which they plan and implement particular teaching methods in the elementary mathematics classroom.

Participants in this study completed two Likert scale questionnaires. One questionnaire presented attitudinal statements related to the teaching of mathematics. Possible responses included "strongly agree," "agree," "undecided," "disagree," and "strongly disagree." The second Likert scale questionnaire consisted of a list of teaching

methods accompanied by five possible frequencies from which subjects could select a response: "daily" (once or more per school day), "frequently" (more than once per week), "occasionally" (about once per week), "seldom" (less frequently than once per week), and "never" (not at all).

Pearson correlation coefficients were calculated and used to interpret the results of the Likert scale surveys completed by the subjects of the study. The Pearson correlation coefficients measured the relationships between elementary teachers' attitudes toward mathematics instruction and elementary teachers' reported frequencies of planning and implementing particular teaching methods in the elementary mathematics classroom. The teachers' attitudes toward mathematics instruction were analyzed in five areas: anxiety related to mathematics instruction, confidence related to mathematics instruction, enjoyment of mathematics instruction, desire for recognition related to mathematics instruction, and pressure to conform in mathematics instruction. The frequencies of planning and implementing particular teaching methods were analyzed in three areas: traditional teaching methods, progressive teaching methods, and teaching methods that combine traditional and progressive approaches.

Of the 15 Pearson correlation coefficients calculated by the researcher, none was significant at the $p<.05$ level of significance. Both positive and negative correlation coefficients were found, with no definite pattern being revealed. Consequently, based on the results of this study, it appears that if there are relationships among elementary teachers' attitudes toward mathematics instruction and the frequencies with which they plan and implement particular teaching methods in the elementary classroom, the

relationships are weak and inconsistent, at best.

Discussion of Research Findings

As reported in Chapter II, several past studies of relationships among teachers' attitudes toward mathematics instruction and teachers' mathematics teaching methods have examined the congruence between teachers' pronounced beliefs and their actual practice. The findings have not been consistent. Some researchers have reported a significant degree of agreement (Grant, 1984; Shirk, 1973) between teachers' professed views of mathematics teaching and their instructional practice, whereas others have reported sharp contrasts (Shaw, 1989; Cooney, 1985).

Other studies have indicated differences between middle level and secondary teachers' professed beliefs about teaching mathematics and their mathematics teaching methods (Brown, 1985; Cooney, 1985). Within a single study, some secondary teachers reportedly professed beliefs about mathematics teaching that were largely consistent with their instructional practices, whereas other teachers in the same study showed a great disparity (Thompson, 1984). Grant (1984) reported a positive relationship between professed beliefs and mathematics teaching methods in the case of three secondary mathematics teachers.

Most studies related to teachers' attitudes toward mathematics instruction and their mathematics teaching methods have been conducted with secondary or middle level teachers; however, a few such studies focusing on elementary teachers have been published. Shirk (1973) explored the conceptual frameworks of four preservice elementary teachers and their relation to the teachers' behavior when teaching

mathematics to small groups of middle level students. He noted that the teachers' conceptions seemed to be activated in teaching situations, resulting in the teachers behaving in manners that were consistent with their conceptions. Karp (1991) described a study in which the teaching behavior and mathematics teaching methods of elementary school teachers were investigated to determine whether teachers with positive attitudes toward mathematics instruction plan and implement mathematics teaching methods that differ from the methods of those elementary teachers with negative attitudes. Overall, the study indicated that teachers with negative attitudes made use of methods that fostered dependency, whereas teachers with positive attitudes encouraged student initiative and independence.

The inconsistencies among studies suggest that teachers' conceptions of teaching and learning mathematics are not related in a rudimentary cause-and-effect way to the mathematics teaching methods they plan and implement in the classroom. Instead, most relationships are complex, with many influences at work. According to Thompson (1992), such influences include the social context in which mathematics teaching takes place, which embeds the values, beliefs, and expectations of students, parents, teachers, and administrators; the adopted curriculum; the assessment procedures used; and the values and philosophical views of the broad educational system.

The present study found no significant relationships among elementary teachers' attitudes toward mathematics instruction and teaching methods planned and implemented in the mathematics classroom. The weak relationships found may be due to the instrumentation used. For each variable, Cronbach's alpha was calculated to measure

inter-item correlation. The alpha levels found ranged from .6411 to .9242, with a mean alpha level of .7955. Instruments with stronger Cronbach's alpha levels may have produced different results.

In general, the present study seems to confirm the inconsistencies associated with previous studies. As aforementioned, the results of this study suggest that if there are relationships among elementary teachers' attitudes toward mathematics instruction and the frequencies with which they plan and implement particular teaching methods in the elementary classroom, the relationships are weak and inconsistent, at best.

Conclusions

The results of this study indicate that elementary teachers' attitudes toward mathematics instruction and the methods they plan and implement in the elementary classroom do not seem to be related in a simple fashion, but are more likely affected by a multitude of factors. The inconsistencies of the relationships provide evidence that elementary teachers' attitudes toward mathematics instruction may not determine the teaching methods they use, nor might the teaching methods that elementary teachers elect to plan and implement in the classroom determine the types of attitudes toward mathematics instruction they espouse.

Although intuition might lead one to believe that those teachers who feel positively toward mathematics instruction might make use of more progressive, student-centered teaching methods, and that those teachers with more negative attitudes toward mathematics instruction might rely heavily upon traditional teaching methods, the calculated correlations do not support these assumptions. It seems feasible that a teacher

who has positive attitudes toward mathematics instruction might make use of traditional teaching methods, perhaps because that is how he or she learned mathematics in school. Similarly, a teacher who does not feel positively about mathematics instruction might employ some progressive teaching methods, perhaps because he or she wishes to instill positive dispositions toward mathematics within students. In short, respondents reported a wide variety of attitudes toward mathematics instruction and the use of many different types of teaching methods, but there were no clear relationships established.

Implications

Although no statistically significant correlations were found in this study, it seems logical that elementary teachers' attitudes toward mathematics instruction have some bearing on the amount of time teachers devote to mathematics and to the specific methods of instruction they adopt. Naturally, it is desirable that all teachers of mathematics possess positive attitudes toward mathematics instruction and that they be willing to plan and implement a variety of mathematics teaching methods according to the needs of their students. Because teachers' deeply held values and beliefs inform their choices of instructional strategies and other personal and professional behaviors, teacher educators might consider making efforts to help teachers identify their values and beliefs, recognize the impact of such values and beliefs on their attitudes and behaviors, and adjust them to the degree that they find possible and desirable.

For all students, the learning of mathematics should be engaging and meaningful. It is doubtful that drill and practice will create within young learners a fervent desire to learn more mathematics. The researcher believes that the traditional methods of teaching

mathematics--teacher demonstration, drill, practice, and homework in the form of more practice--are partially responsible for the large numbers of people who experience mathematics anxiety or who consider themselves mathematically incompetent. In our society, if a person indicates that he or she cannot read or write, others immediately feel a need to "educate" that person. There are numerous adult literacy programs throughout our country, and some of these programs are producing wonderful results. However, if a person indicates that he or she does not perform well in mathematics, there is usually little or no concern. It is likely that a listener may respond, "Oh, I was never any good at mathematics, either." The researcher considers this response to be most disheartening. Just as it is not desirable for a person to be illiterate, it is also not acceptable for a person to lack skills in mathematics. It seems likely that teachers with positive attitudes toward mathematics instruction who are willing to plan and implement a wide variety of appropriate teaching methods can help improve both the mathematics attitudes and mathematics achievement of students. Effective and engaging instruction must begin in the early grades.

Dissemination of Study Results

The surveys used in this study were developed to measure elementary teachers' attitudes toward mathematics instruction in five areas (anxiety, confidence, enjoyment, desire for recognition, and pressure to conform) and the frequencies with which elementary teachers plan and implement three types of mathematics teaching methods (traditional, progressive, and traditional/progressive combinations). Results of this study might be used as a possible resource in the planning and implementation of staff

development training sessions focusing on mathematical theory and practice in relationship to instructional attitudes. Therefore, results have been made available to any Central Georgia principals, curriculum directors, and staff development personnel who might be interested in such information.

Recommendations

Based upon the findings and conclusions of this study, the researcher wishes to make the following recommendations:

1. This study made use of self-report data concerning elementary teachers' attitudes toward mathematics instruction and the mathematics teaching methods they plan and implement in the elementary classroom. It is conceivable that some teachers might endorse attitudes they do not espouse or teaching methods they do not employ because failure to do so might be construed as an indictment of their professionalism. Others might give very accurate self-reports that can be trusted as evidence that they espouse the attitudes and utilize the teaching methods they endorse. Because it is difficult to determine which self-reports are dependable and which are not, future research in this area would be enhanced through the triangulation of data. Other forms of data that might be considered in studies related to teachers' attitudes and methods include interviews and classroom observations.

2. Future research studies related to teachers' attitudes toward mathematics instruction and possible relationships between such attitudes and mathematics teaching methods planned and implemented in the classroom might be well served to include larger samples of teachers than the sample used in this investigation.

3. Because the weak relationships found in the present study may have been due to the instrumentation used, future researchers might elect to use instruments with higher inter-item correlations. This would increase the probability that survey items that supposedly measure the same variable are strongly related to one another.

4. Future researchers into the areas of teachers' mathematics attitudes and mathematics teaching methods or any areas related to these concerns might consider exploring the following areas: connections between teachers' experiences as mathematics students and their attitudes as mathematics instructors, achievement levels of students who are taught by teachers with differing mathematics attitudes, mathematics attitudes of students taught using traditional teaching methods versus progressive teaching methods, the relationship between teachers' mathematics attitudes and the instructional support they offer students, the effect of efforts to confront and change teachers' attitudes toward mathematics instruction through inservice education, the effects of data triangulation on self-report data related to attitudes toward mathematics instruction and mathematics teaching methods, and the effects of gender on attitudes toward mathematics and mathematics instruction.

REFERENCES

Aiken, L. R. (1972). Research on attitudes toward mathematics. Arithmetic Teacher, 19, 229-234.

Allport, G. W. (1935). Attitudes. In C. Murchison (Ed.), A handbook of social psychology. Worcester, MA: Clark University Press.

Ball, D. L. (1988). Unlearning to teach mathematics. For the Learning of Mathematics, 8 (1), 40-48.

Bannister, J., & Fransella, F. (1977). A manual for repertory grid technique. London: Academic Press.

Becker, J. R. (1986). Mathematics attitudes of elementary education majors. Arithmetic Teacher, 33 (5), 50-51.

Bodner, G. M. (1986). Constructivism: A theory of knowledge. New York: Wiley.

Borasi, R. (1996). Reconceiving mathematics instruction: A focus on errors. Norwood, NJ: Ablex Publishing Corporation.

Brosnan, P. (1994). An exploration of change in teachers' beliefs and practices during implementation of mathematics standards (Report No. SE054442). Columbus, OH: Ohio State University. (ERIC Document Reproduction Service No. ED372949)

Brown, C. A. (1985). A study of the socialization to teaching of a beginning mathematics teacher. Unpublished doctoral dissertation, University of Georgia, Athens.

Burns, M. (1998). Math: Facing an American phobia. Sausalito, CA: Math Solutions Publications.

Carey, D. A., Carpenter, T. P., Fennema, E., & Peterson, P. L. (1988). Teachers' pedagogical content knowledge in mathematics. Journal for Research in Mathematics Education, 19, 385-401.

Carpenter, T. P., Fennema, E., & Peterson, P. L. (1987). Teachers' pedagogical content beliefs in mathematics. Paper presented at the AERA Conference, Washington, D.C.

Clark, C. (1988). Asking the right questions about teacher preparations: Contributions of research on teacher thinking. Educational Researcher, 17 (2), 5-12.

Clark, C. M., & Peterson, P. L. (1986). Teachers' thought processes. In M.C. Wittrock (Ed.), Handbook of research on teaching (3rd ed., pp. 255-296). New York: Macmillan.

Clark-Meeks, L. F., Quisenberry, N. L., & Mouw, J. T. (1982). A look at the mathematics attitudes of prospective teachers in four concentration areas. School Science and Mathematics, 82, 317-320.

Collier, C. P. (1972). Prospective elementary teachers' intensity and ambivalence of beliefs about mathematics and mathematics instruction. Journal for Research in Mathematics Education, 3, 155-163.

Cooney, T. J. (1985). A beginning teacher's view of problem solving. Journal for Research in Mathematics Education, 16, 324-336.

Cubberley, E. P. (1920). The history of education. Boston: Houghton Mifflin.

Dionne, J. (1984). The perception of mathematics among elementary school teachers. In J. Moser (Ed.), Proceedings of the Sixth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (pp. 223-228). Madison: University of Wisconsin.

Dougherty, B. J. (1990). Influences of teacher cognitive/conceptual levels on problem-solving instruction. In G. Booker (Ed.), Proceedings of the Fourteenth Conference for the Psychology of Mathematics Education (pp. 119-126). Oaxtepec, Mexico: International Group for the Psychology of Mathematics Education.

Early, J. E. (1970). A study of the grade level teaching preferences of prospective elementary teachers with respect to their attitudes toward arithmetic and achievement in mathematics (Doctoral Dissertation, University of Tennessee, 1969). Dissertation Abstracts International, 30, 3345A-3346A.

Eisenhart, M. (1988). The ethnographic research tradition and mathematics education research. Journal for Research in Mathematics Education, 16, 324-336.

Eisenhart, M. (1993). Conceptual knowledge falls through the cracks: Complexities of learning to teach mathematics for understanding. Journal for Research in Mathematics Education, 24 (1), 8-40.

Eisenhart, M., Shrum, J., Harding, J., & Cuthbert, A. (1988). Teacher beliefs about their work activities: Policy implications. Theory into Practice, 27 (2), 137-144.

Fraser, B., & Tobin, K. (1988, April). Psychosocial environment in exemplary teachers' classrooms. Paper presented at the meeting of the American Educational Research Association, New Orleans, LA.

Glass, G. V., & Hopkins, K. D. (1996). Statistical methods in education and psychology. Needham Heights, MA: Allyn and Bacon.

Grant, C. E. (1984). A study of the relationship between secondary mathematics teachers' beliefs about the teaching-learning process and their observed classroom behaviors (Doctoral dissertation, University of North Dakota, 1984). Dissertation Abstracts International, 46, 3615B.

Grossman, P., Shulman, L., & Wilson, S. (1989). Teachers of substance: Subject matter knowledge for teaching. In M. C. Reynolds (Ed.), Knowledge base for the beginning teacher (pp. 23-34). Oxford: Pergamon Press.

Harvey, O., Hoffmeister, J., Prather, M., & White, B. (1968). Teacher' beliefs, classroom atmosphere, and student behavior. American Educational Research Journal, 5, 151-166.

Helms, J. M. (1989). Preservice secondary mathematics teachers' beliefs about mathematics and the teaching of mathematics : Two case studies. Unpublished doctoral dissertation, University of Georgia, Athens.

Hunkler, R., & Quast, W. G. (1972). Improving the mathematics attitudes of prospective elementary school teachers. School Science and Mathematics, 72, 709-714.

Husen, T. (Ed.). (1967). International study of achievement (Vol 1). New York: Wiley.

Jones, D., Henderson, E., & Cooney, T. (1986). Mathematics teachers' beliefs about mathematics and about teaching mathematics. In G. Lappan & R. Even (Eds.), Proceedings of the Eighth Annual Meeting of the International Group for the Psychology

of Mathematics Education (pp. 274-279). East Lansing: Michigan State University.

Karp, K. (1989, March). Elementary school teachers' attitudes toward mathematics: Impact on students' autonomous learning skills. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.

Karp, K. S. (1991). Elementary school teachers' attitudes toward mathematics: The impact on students' autonomous learning skills. School Science and Mathematics, 91, 265-270.

Kerlinger, F. N. (1967). Social attitudes and their criterial referents: A structural theory. Psychological Review, 74, 110-122.

Kesler, R. (1985). Teachers' instructional behavior related to their conceptions of teaching and mathematics and their level of dogmatism: Four case studies. Unpublished doctoral dissertation, University of Georgia, Athens.

Kilpatrick, J. (1992). A history of research in mathematics education. In D.A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 3-38). New York: Macmillan.

Kohn, A. (1998). What to look for in a classroom. San Francisco: Jossey-Bass Publishers.

Kulm, G. (1980). Research on mathematics attitude. In R. J. Shumway (Ed.), Research in mathematics education (pp. 356-387). Reston, VA: National Council of Teachers of Mathematics.

Lanier, P., Lappan, G., Schram, P., & Wilcox, S. (1988). Changing mathematical conceptions of preservice teachers: A content and pedagogical intervention (Research

Report No. 1988-4). East Lansing, MI: National Center for Research on Teacher Education.

Larson, C. N. (1983). Teacher education: Techniques for developing positive attitudes in preservice teachers. Arithmetic Teacher, 31 (2), 8-9.

Lerman, S. (1983). Problem solving or knowledge centered: The influence of philosophy on mathematics education. International Journal of Mathematical Education in Science and Technology, 14 (1), 59-66.

Madsen, A. L. (1992). Preparing elementary teacher candidates to teach mathematics nontraditionally. Teacher Education and Practice, 8 (1), 75-100.

Middleton, J. (1992, April). Teachers vs. students' beliefs regarding intrinsic motivation in the mathematics classroom: A personal constructs approach. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.

Muth, K. D. (1993). Reading in mathematics: Middle school mathematics teachers' beliefs and practices. Reading Research and Instruction, 32 (2), 76-83.

National Council of Teachers of Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1992). Professional standards for teaching mathematics. Reston, VA: National Council of Teachers of Mathematics.

National Council of Teachers of Mathematics. (1995). Assessment standards for school mathematics. Reston, VA: National Council of Teachers of Mathematics.

Needham, R. (1972). Belief, language, and experience. Oxford: Basil Blackwell.

Nespor, J. (1987). The role of beliefs in the practice of teaching. Journal of Curriculum Studies, 19, 317-328.

Nickson, M. (1992). The culture of the mathematics classroom: An unknown quantity? In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 101-114). New York: Macmillan.

Nisbet, J. D., & Entwistle, N. J. (1973). The psychologist's contribution to educational research. In W. Taylor (Ed.), Research perspectives in education (pp. 113-120). London: Routledge and Kegan Paul.

Nisbet, S. (1991). A new instrument to measure pre-service primary teachers' attitudes to teaching mathematics. Mathematics Education Research Journal, 32(2), 34-56.

O'Donnell, J. M. (1985). The origins of behaviorism: American psychology, 1870-1920. New York: New York University Press.

Oprea, J. M., & Stonewater, J. K. (1988). An analysis of in-service teachers' mathematical beliefs: A cognitive development perspective. In M. J. Behr, C. B. Lacampagne, & M. M. Wheeler (Eds.), PME-NA: Proceedings of the tenth annual meeting (pp. 356-363). DeKalb, IL: Northern University.

Owens, J. E. (1987). A study of four preservice secondary mathematics teachers' constructs of mathematics and mathematics teaching. Unpublished doctoral dissertation, University of Georgia, Athens.

Piaget, J. (1954). The construction of reality in the child. New York: Basic

Books.

Prawat, R. S. (1992). Are changes in views about mathematics teaching sufficient? The case of a fifth-grade teacher. Elementary School Journal, 93, 195-211.

Pyenson, L. (1983). Neohumanism and the persistence of pure mathematics in Wilhelmian Germany. Philadelphia: American Philosophical Society.

Raines, B. G. (1971). Personal, situational, and behavioral predisposition factors related to the elementary teachers' attitude toward teaching mathematics (Doctoral Dissertation, University of Virginia, 1970). Dissertation Abstracts International, 31, 4631A.

Rokeach, M. (1960). The open and closed mind. New York: Basic Books.

Romberg, T. A. (1992). Perspectives on scholarship and research methods. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 49-64). New York: Macmillan.

Romberg, T. A., & Wilson, J. W. (1969). The development of tests. (NLSMA Report No. 7). Pasadena, CA: A. C. Vroman.

Scheffler, I. (1965). Conditions of knowledge: An introduction to epistemology and education. Glenview, IL: Scott, Foresman, and Company.

Schram, P., & Wilcox, S. K. (1988, November). Changing preservice teachers' conceptions of mathematics learning. In M. J. Behr, C. B. Lacampagne, & M. M. Wheeler (Eds.), PME-NA: Proceedings of the tenth annual meeting (pp. 349-355). DeKalb, IL: Northern University.

Schubring, G. (1987). On the methodology of analyzing historical textbooks:

Lacroix as textbook author. For the Learning of Mathematics, 7 (3), 41-51.

Shaughnessy, J., Halandyna, T., & Shaughnessy, J. M. (1983). Relations of student, teacher, and learning environmental variables to attitude toward mathematics. School Science and Mathematics, 83, 21- 37.

Shavelson, R. J. (1988). Contributions of educational research to policy and practice: Constructing, challenging, changing cognition. Educational Researcher, 17 (7), 4-11.

Shavelson, R. J., & Stern, P. (1981). Research on teachers' pedagogical thoughts, judgments, decisions, and behavior. Review of Educational Research, 51, 455-498.

Shaw, K. (1989). Contrasts of teacher ideal and actual beliefs about mathematics understanding: Three case studies. Unpublished doctoral dissertation, University of Georgia, Athens.

Shirk, G. B. (1973). An examination of conceptual frameworks of beginning mathematics teachers. Unpublished doctoral dissertation, University of Illinois at Urbana-Champaign.

Sobel, M. A. (1982). One point of view: "I love to teach," a formula for coping with burn-out. Arithmetic Teacher, 29 (5), 2.

Spradley, J. (1980). Participant observation. New York: Holt, Rinehart, and Winston.

Steele, D. (1994, April). Helping preservice teachers confront their conceptions about mathematics and mathematics teaching and learning. Paper presented at the

meeting of the American Educational Research Association, New Orleans, LA.

Swetz, F. (1995). To know and to teach: Mathematical pedagogy from a historical context. Educational Studies in Mathematics, 29, 73-88.

Thompson, A. (1984). The relationship of teachers' conceptions of mathematics teaching to instructional practice. Educational Studies in Mathematics, 15, 105-127.

Thompson, A. (1988). Learning to teach mathematical problem solving: Changes in teachers' conceptions and beliefs. In R. I. Charles & E. Silver (Eds.), The teaching and assessing of mathematical problem solving (pp. 232-243). Reston, VA: National Council of Teachers of Mathematics.

Thompson, A. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In D. A. Grouws (Ed.), Handbook of research on mathematics teaching and learning (pp. 127-146). New York: Macmillan Publishing Company.

Tuckman, B. W. (1994). Conducting educational research. Fort Worth, TX: Harcourt Brace.

Underhill, R. G. (1988). Mathematics teachers' beliefs: Review and reflections. Focus on Learning Problems in Mathematics, 10 (3), 43-58.

VanVoorhis, J. L., & Anglin, J. M. (1994). Teachers share their mathematics backgrounds: Telling it like it was. School Science and Mathematics, 94, 407-412.

Vygotsky, L. S. (1962). Thought and language. Cambridge, MA: Massachusetts Institute of Technology Press.

Weimer, W. B. (1979). Notes on the methodology of scientific research. Hillsdale, NJ: Lawrence Erlbaum.

Westbury, I., Ethington, C., Sosniak, L, & Baker, D. (Eds.) (1994). In search of more effective mathematics education. Norwood, NJ: Ablex Publishing Corporation.

Wolcott, H. (1987). Ethnographic research in education. In R. M. Jaeger (Ed.), Complementary methods for research in education (pp. 187-206). Washington, DC: American Educational Research Association.

Wolgast, E. H. (1977). Paradoxes of knowledge. Ithaca, NY: Cornell University Press.

Wyer, R. S. (1974). Cognitive organization and change: An information processing approach. Potomac, MD: Lawrence Erlbaum Associates.

APPENDICES

APPENDICES

Appendix A: Georgia Southern University Institutional Review Board Approval

Office of Research Services & Sponsored Programs
Georgia Southern University

Institutional Review Board (IRB)
Memorandum

Phone: 681-5465 P.O. Box 8005 Fax: 681-0719
ovrsight@GaSoU.edu -- or -- ngarrets@GaSoU.edu

To: William Otis Lacefield, III
Department of Curriculum, Foundations, and Research

From: Neil Garretson, Coordinator
Research Oversight Committees (IACUC/IBC/IRB)

Date: December 17, 1998

Subject: Application for Approval to Utilize Human Subjects in Research

---

On behalf of Dr. Howard M. Kaplan, Chair of the Institutional Review Board (IRB), I am writing to inform you that we have completed the review of your *Application for Approval to Utilize Human Subjects* in your proposed research, "Study of Elementary Teachers' Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods Used in the Elementary Classroom." It is the determination of the Chair, on behalf of the Institutional Review Board, that your proposed research adequately protects the rights of human subjects. Your research is approved on the basis that it falls within the *Federal Policy for the Protection of Human Subjects* (45 CFR §46101(b)(2)), which exempts:

> (2) Research involving the use of ...survey procedures, interview procedures (as long as)
> (i) information obtained (either) is recorded in such a manner that human subjects ~~can~~ (cannot) be identified, directly or through identifiers linked to the subjects, ~~and~~ (or)
> (ii) any disclosure of the human subjects' responses outside the research could (not) reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation.

However, this approval is conditional upon the following revisions and/or additions being completed prior the collection of any data:

1. Due to the fact that your research design and informed consent letter ensures the anonymity of the respondents, please provide additional details regarding your sampling procedures. More specifically, please detail exactly what methods are being employed to ensure the anonymity of the respondents. Please be aware that by ensuring the respondents anonymity you are guaranteeing a much greater level of protection than confidentiality.
2. You will need to submit a letter of permission/support from the superintendent of the Bibb County school system, or his/her authorized representative, that indicates that he/she has reviewed your proposed research and has give you his/her permission to conduct this research on their employees.

If you have any questions, comments, or concerns about these conditions of approval, please do not hesitate to contact the IRB Coordinator. Please send a copy of all revised and/or additional materials to the IRB Coordinator at the Office of Research Services and Sponsored Programs (PO Box 8005).

This IRB approval is in effect for one year from the date of this letter. If at the end of that time, there have been no changes to the exempted research protocol, you may request an extension of the approval period for an additional year. Please notify the IRB Coordinator immediately if a change or modification of the approved methodology is necessary. Upon completion of your data collection, please notify the IRB Coordinator so that your file may be closed.

Cc: Dr. Jane A. Page, Faculty Advisor

Date: Thu, 11 Mar 1999 09:53:53 -0500
From: "Research Oversight Committees (IACUC/IBC/IRB)" <ovrsight@GaSoU.edu>
To: Lacefield_WO@Mercer.EDU
Cc: janepage@gsvms2.cc.GaSoU.edu
Subject: Status of Conditional IRB Approval

[The following text is in the "iso-8859-1" character set]
[Your display is set for the "DEC-MCS" character set]
[Some characters may be displayed incorrectly]

To: William Lacefield
Department of Curriculum, Foundations, and Research

Cc: Dr. Jane A. Page, Faculty Advisor
Department of Curriculum, Foundations, and Research

From: Neil Garretson, Coordinator
Research Oversight Committees

Date: March 11, 1999

Subject: Status of Conditional IRB Approval

The Institutional Review Board (IRB) Committee has received your revised and/or additional application materials for the approved research titled, "Study of Elementary Teachers' Attitudes Toward Mathematics Instruction and Mathematics Teaching Methods Used in the Elementary Classroom." You have satisfactorily met the conditions of your Institutional Review Board (IRB) approval, as detailed in the December 17, 1998 approval letter.

Please remember that this approval is in effect for one year (12/17/98 - 12/17/99) and if at the end of that time there have been no substantive changes to the approved methodology, you may request a one year extension of the approval period.

Good luck with your research efforts, and if you have any questions, comments, or concerns about the status of your approval, please do not hesitate to contact me.

==========
Research Oversight Coordinator
Research Oversight Committees (IACUC/IBC/IRB)
Georgia Southern University

PO Box 8005
PH: 912-681-5465
FX: 912-681-0719

ovrsight@GaSoU.edu
http://www2.gasou.edu/research/
==========

Appendix B: Request Letter

1049 Greentree Parkway
Macon, GA 31220
December 18, 1998

Mr. Harry Trawick
Deputy Superintendent
Bibb County Board of Education
484 Mulberry Street
Macon, GA 31201

Dear Mr. Trawick:

My name is William Lacefield and I am currently pursuing the Doctor of Education degree in Curriculum Studies at Georgia Southern University. For my dissertation research, I will be exploring the relationships between elementary teachers' attitudes regarding mathematics instruction and the teaching methods elementary teachers use in the elementary classroom. To collect information related to my research questions, I would like to use two Likert scale survey instruments. Teachers (grades K-4) from six Bibb County schools will be asked to complete these survey instruments anonymously.

I have randomly selected six schools for inclusion in this study. With this letter, I am requesting permission to distribute the survey instruments at the following Bibb County elementary schools: Redding Elementary School, Burdell Elementary School, Burghard Elementary School, Tinsley Elementary School, Riley Elementary School, and McKibben Lane Elementary School.

Prior to final distribution of the survey instruments, I would like to conduct a pilot study in order to refine the instruments as deemed helpful and necessary. For the pilot study, I would like to ask the teachers of Alexander II Math/Science Magnet School to assist me in this endeavor. Because of Alexander II's focus on mathematics and science, I feel that the school's teachers may be able to provide some useful input related to my survey instruments. Enclosed please find a copy of my dissertation proposal and copies of the survey instruments to be used.

I appreciate your consideration of my request. I would be happy to provide any additional information needed. My telephone numbers are 752-2046 (office) and 471-7626 (home).

Thank you very much.

Sincerely,

William O. Lacefield, III

Appendix C: Approval Letter

Bibb County Public Schools

484 MULBERRY STREET • POST OFFICE BOX 6157
MACON, GEORGIA 31208 • 912/765-8711

January 4, 1999

Mr. William O. Lacefield, III
1049 Greentree Parkway
Macon, GA 31220

Dear Mr. Lacefield:

I have reviewed your request to utilize Bibb County teachers at seven elementary schools in support of dissertation research. Both of the Likert Scale Surveys which you submitted for approval appear to be appropriate. Since you indicate that responses will be anonymous, there are only two remaining concerns. First of all, it must be clearly stated to the teachers that their participation is strictly voluntary. Secondly, their participation cannot infringe upon instructional time. If these requirements are met, you may proceed with the study. You will need to contact the principals of the schools involved to make them aware of your desire to utilize teachers at their schools.

Good luck with your study.

Sincerely,

Harry W. Trawick
Deputy Superintendent Education Operations

HWT:ja

cc: Dr. Gene Buinger
Mrs. Vickie Scott

Appendix D: Letter of Informed Consent

Dear Elementary School Mathematics Teacher:

My name is William O. Lacefield. I am a doctoral student at Georgia Southern University. I am interested in gathering information about elementary teachers' attitudes toward mathematics instruction and information about the teaching methods used in the elementary mathematics classroom. I feel that there may be relationships between teachers' beliefs about mathematics teaching and the types of teaching methods they choose to use. There is, however, very little research which has addressed such relationships. The present study is an attempt to determine if relationships exist between elementary teachers' self-reported attitudes toward mathematics instruction and the methods elementary teachers elect to plan and implement in the elementary classroom.

This letter is to request your assistance in gathering data to analyze this situation. There is, of course, no penalty should you decide not to participate or to later withdraw from the study. If you agree to participate, please complete the attached questionnaires and place them in the envelope provided. Completion and return of the questionnaires will indicate permission to use the information you provide in the study. You may mail the envelope to me at Mercer University, School of Education, 1400 Coleman Avenue, Macon, GA 31207. Please be assured that your responses will be completely anonymous. All of the questionnaires and return envelopes are identical. Neither I nor anyone else will be able to distinguish your response from those of the other participants. The study will be most useful if you respond to every item in the questionnaires. However, you may choose not to answer one or more of the items, without penalty. Copies of the study's results will be made available to your school principal.

If you have any questions about this research project, please call me, William O. Lacefield, at (912) 752-2046. If you have any questions or concerns about your rights as a research participant in this study, they should be directed to the Institutional Review Board (IRB) Coordinator at the Office of Research Services and Sponsored Programs at Georgia Southern University. The telephone number is (912) 681-5465.

Let me thank you in advance for your assistance in studying this question. The results should provide useful information about elementary teachers' attitudes toward mathematics instruction and the teaching methods used in the elementary mathematics classroom.

Respectfully,

William O. Lacefield, III
Doctoral Student in Curriculum Studies
Georgia Southern University

Appendix E: Survey Instrument I

Elementary Teachers' Attitudes Toward Mathematics Instruction

Mathematics Teaching Attitudes Likert Scale Survey

The following are statements on teaching mathematics, about which your opinion is sought. For each statement, please circle the response that most closely indicates your extent of agreement or disagreement with the statement.

1. Generally I feel secure about the idea of teaching mathematics.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

2. Of all the subjects, mathematics is the one I worry about most in teaching.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

3. It would make me happy to be recognized by other teachers as an excellent teacher of mathematics.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

4. I would get a sinking feeling if I came across a hard problem while teaching mathematics.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

5. I would be proud to be the outstanding teacher of mathematics among my peers.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

6. The thought of teaching mathematics makes me feel restless, irritable, and impatient.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

7. I would like the students to recognize me as a good teacher of mathematics.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

8. I am confident about the methods of teaching mathematics.

   Strongly Agree Agree Undecided Disagree Strongly Disagree

9. Teaching mathematics makes me feel nervous.

Strongly Agree Agree Undecided Disagree Strongly Disagree

10. Being an outstanding teacher of mathematics would make me feel unpleasantly conspicuous.

Strongly Agree Agree Undecided Disagree Strongly Disagree

11. I have a lot of self confidence when it comes to teaching mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

12. The thought of teaching mathematics makes me feel nervous.

Strongly Agree Agree Undecided Disagree Strongly Disagree

13. My peers would think I was strange if I were an outstanding teacher of mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

14. I feel at ease when I am teaching mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

15. I would not want to let on that I was good at teaching mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

16. I enjoy the challenge of teaching a new and difficult concept in mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

17. I am not the type of person who could teach mathematics very well.

Strongly Agree Agree Undecided Disagree Strongly Disagree

18. Time passes quickly when I am teaching mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

19. Teaching mathematics is enjoyable and stimulating to me.

Strongly Agree Agree Undecided Disagree Strongly Disagree

20. Mathematics is the subject I am least confident about teaching.

Strongly Agree Agree Undecided Disagree Strongly Disagree

21. Teaching mathematics does not scare me at all.

Strongly Agree Agree Undecided Disagree Strongly Disagree

22. I like teaching mathematics.

Strongly Agree Agree Undecided Disagree Strongly Disagree

This Likert scale survey is based on a survey developed by Steven Nisbet found in:

Nisbet, S. (1991). A new instrument to measure pre-service primary teachers' attitudes to teaching mathematics. Mathematics Education Research Journal, 3 (2), 34-56.

Appendix F: Survey Instrument II

Mathematics Teaching Methods Used in Elementary Classrooms

Mathematics Teaching Methods Likert Scale Survey

For each teaching method listed, please circle the word that most closely indicates how often you plan and implement that teaching method in your mathematics classroom.

Following are definitions of terms used:

"Daily" = Once or more per school day
"Frequently" = More than once per week
"Occasionally" = About once per week
"Seldom" = Less than once per week
"Never" = not at all

Teacher-Focused Lecture	Daily	Frequently	Occasionally	Seldom	Never
Teacher-Focused Demonstration on Chalk Board/Dry Erase Board	Daily	Frequently	Occasionally	Seldom	Never
Teacher-Focused Demonstration on Overhead Projector	Daily	Frequently	Occasionally	Seldom	Never
Teacher-Led Question-and-Answer Session with Students	Daily	Frequently	Occasionally	Seldom	Never
Student-Focused Demonstration on Chalk Board/Dry Erase Board	Daily	Frequently	Occasionally	Seldom	Never
Student-Focused Demonstration on Overhead Projector	Daily	Frequently	Occasionally	Seldom	Never
Skills Practice with Flash Cards	Daily	Frequently	Occasionally	Seldom	Never
Skills Practice through Oral Recitation	Daily	Frequently	Occasionally	Seldom	Never
Student Completion of Professionally-Produced Worksheets/Workbook Pages	Daily	Frequently	Occasionally	Seldom	Never
Student Completion of Teacher-Produced Worksheets	Daily	Frequently	Occasionally	Seldom	Never

Student Completion of Mathematics Problems copied from Chalkboard/ Dry Erase Board	Daily	Frequently	Occasionally	Seldom	Never
Student Completion of Mathematics Problems copied from Overhead Projector	Daily	Frequently	Occasionally	Seldom	Never
Teacher Demonstration Using Professionally-Produced Mathematics Manipulatives	Daily	Frequently	Occasionally	Seldom	Never
Teacher Demonstration Using Teacher-Made Mathematics Manipulatives	Daily	Frequently	Occasionally	Seldom	Never
Teacher Demonstration Using Everyday Items (keys, rocks, etc.) as Mathematics Manipulatives	Daily	Frequently	Occasionally	Seldom	Never
Whole-Class Use of Professionally-Produced Mathematics Manipulatives (Every student has manipulatives to use.)	Daily	Frequently	Occasionally	Seldom	Never
Whole-Class Use of Teacher-Made Mathematics Manipulatives (Every student has manipulatives to use.)	Daily	Frequently	Occasionally	Seldom	Never
Whole-Class Use of Everyday Items (keys, rocks, etc.) as Mathematics Manipulatives (Every student has manipulatives to use.)	Daily	Frequently	Occasionally	Seldom	Never
Cooperative Learning Activities in Which Students Complete Paper/Pencil Activities	Daily	Frequently	Occasionally	Seldom	Never
Cooperative Learning Activities in Which Students Orally Discuss Mathematics Concepts	Daily	Frequently	Occasionally	Seldom	Never
Cooperative Learning Activities in Which Groups Use Professionally-Produced Manipulatives	Daily	Frequently	Occasionally	Seldom	Never

Cooperative Learning Activities in Which Groups Use Teacher-Produced Manipulatives	Daily	Frequently	Occasionally	Seldom	Never
Cooperative Learning Activities in Which Groups Use Everyday Items (keys, rocks, etc.) As Mathematics Manipulatives	Daily	Frequently	Occasionally	Seldom	Never
Creative Activities in which Individual Students Create Physical Examples of Mathematical Concepts	Daily	Frequently	Occasionally	Seldom	Never
Creative Group Activities in which Students Create Physical Examples of Mathematical Concepts	Daily	Frequently	Occasionally	Seldom	Never
Activities that Use Children's Literature to Teach Mathematics	Daily	Frequently	Occasionally	Seldom	Never
Activities that Integrate Writing and Mathematics	Daily	Frequently	Occasionally	Seldom	Never
Computer Activities Using Professionally Produced Software	Daily	Frequently	Occasionally	Seldom	Never
Computer Activities in Which Students Create Their Own Problems	Daily	Frequently	Occasionally	Seldom	Never
Calculator Activities in Which Students Solve Given Problems	Daily	Frequently	Occasionally	Seldom	Never
Calculator Activities in Which Students Create Their Own Problems	Daily	Frequently	Occasionally	Seldom	Never