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The Impact of Experience on Elementary School Teacher Affective Relationship with Mathematics

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THE IMPACT OF EXPERIENCE ON ELEMENTARY SCHOOL TEACHER AFFECTIVE RELATIONSHIP WITH MATHEMATICS

by

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ABSTRACT

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This study was designed as an exploratory examination of the impact of teaching experience on elementary school teachers' affective relationships with mathematics. A self-reporting survey was used to examine a wide variety of experience factors, including factors related to quantity of experience, type of experience, and post-certification training opportunities (n = 275). Participants were also asked to identify services that might impact their affective relationships with mathematics. This study resulted in recommendations for seven follow-up studies to gain insight into factors that significantly correlated to teacher attitudes toward math or to their perceived changes in attitudes over time. Recommended practices for school districts and Education Service Agencies were also given.

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CHAPTER I

INTRODUCTION

As Susan drives to work, she cannot help but to worry about the day. Today is the day that Susan plans to introduce her 3^{rd} grade class to multiplication.

Last year, as a first-year teacher, Susan had looked forward to introducing multiplication. Susan had driven to the big city, located the teacher supply store, and spent a great deal of her own money to purchase enough manipulatives for all of her students. Susan had been determined to teach the concept as she had learned to teach it in her Methods of Teaching Math course. Susan's students would discover for themselves the meaning of multiplication and its many uses prior to taking on the task of memorizing the multiplication table – which would then hold a greater value for them.

Susan shook her head as she remembered what a failure her approach had been. Susan had not taken into account that a third grader learning a brand new concept using manipulatives was very different than a college junior learning to use manipulatives to represent a familiar concept. Susan's students enjoyed playing with the manipulatives, but they had no vision of where she was headed conceptually, and she was unsure how to provide that vision. Even worse, Susan realized that she, herself, could not really verbalize the meaning.

To make matters worse, Susan had fallen behind the other third-grade teachers on teaching the times tables. Beginning this year by teaching the "facts" would feel most natural – after all, that is how she remembered learning multiplication. Leading with the multiplication facts was certainly more efficient and would keep Susan from the embarrassment of failing. The test that would be used, however, to determine Susan's school's adequate yearly progress (and her own performance) required students to be able to articulate when and why multiplication is used. Should Susan focus on the facts and spend time teaching "tricks and canned responses" for the state test closer to the test dates? Should Susan focus on the concepts, knowing that her students' abilities to perform calculations may suffer down the road? Is Susan more responsible to herself, to her students, to the teacher her students will have next year, or to the school's test scores? "I used to enjoy math," Susan thought.

On the other side of town, Samantha drove to the same school. Samantha was looking forward to the day. Today was a chance to introduce students to their third mathematical operation – multiplication. Samantha had never enjoyed math as a student. In fact, Samantha nearly considered majoring in Early Childhood Education, rather than Elementary Education, just to avoid one extra mathematics course.

It was only after a few years of teaching that Samantha could finally say that she truly enjoyed math and appreciated its importance. Teaching the subject certainly improved Samantha's understanding of the underlying concepts. Samantha was surprised at how much she did not know about basic math until she gained insights through teaching. Taking a course in the history of elementary mathematics helped Samantha to put into perspective concepts such as positional number systems – which she had always taken for granted.

Although Susan and Samantha are exposed to many of the same challenges, pressures, and opportunities related to their teaching of mathematics, they have experienced these in very different ways. While Susan enjoyed math as a student, the experience of teaching mathematics has caused her to develop a negative attitude toward the subject. Samantha, on the other hand, has benefited from her experience teaching the subject and now has positive attitudes toward mathematics.

Statement of the Problem

A great amount of research has been done on the attitudes of prospective elementary school teachers toward mathematics, including the effect that these attitudes have on the prospective teachers. Research has also been done on the effect that teacher attitude can have on student attitudes and success. However, little is known about the impact that the experience of teaching mathematics has on those attitudes. The purpose of this research is to explore how veteran elementary school teachers in Northern Illinois perceive changes in their attitudes toward the subject over their years of teaching and to provide school districts and Educational Service Agencies with insights into ways that they can assist working teachers to develop and/or maintain positive attitudes toward mathematics.

In research conducted between 1988 and 1990, Rech, Hartzell, and Stephens (1993) found that elementary education majors scored significantly lower than the general college population in both mathematical competency and in attitudes toward mathematics. The average attitude of elementary school teachers toward mathematics was "slightly negative", while the average attitude of the comparison general college population was "slightly positive".

Researchers have found that when teachers have negative attitudes toward mathematics, this negatively impacts the success of their students in mathematics (Alci & Erden, 2006; Ernest, 1989; Karp 1991). It has also been shown that teachers who have positive attitudes toward mathematics have a positive impact on student success in mathematics (Schofield, 1981).

The findings of Alci and Erden (2006), Ernest (1989), Karp (1991), and Schofield (1981) demonstrate the importance of understanding not only the attitudes that teachers bring with them to the profession, but also the changes in attitude that occur after the teacher has begun actively teaching. School districts, Educational Service Agencies, and other professional development providers would also benefit from insight into the factors that contribute to those changes and to determine possible interventions that may facilitate positive attitudes toward mathematics throughout a teacher's career.

Background

Several factors have been shown to impact student attitudes toward mathematics and achievement in mathematics. Among these are peer influences (Wilkins & Ma, 2003), parental influences (Jacobs & Bleeker, 2004; Yee & Eccles, 1988), and societal influences (Wilkins & Ma). Researchers have also shown that a student's teachers have a significant influence on his or her attitudes toward math and achievement in math (Sanders & Rivers, 1996; Schofield, 1981). Researchers have focused on three key attributes that determine a teacher's potential for successful mathematics instruction: Affective Relationship with Math (ARM) (Kolstad, Hughes, & Briggs, 1994; Rech et al., 1993; Southwell, White, Way, & Perry, 2005), Understanding of Mathematics Content (UMC) (Ball, 1990; Campbell, 2002; Hill, Rowan, & Ball, 2005; Morris, 2001), and Pedagogical Skill for Math (PSM) (Ball, 1988b; Smith, 2000; Stodolsky, 1985).

Affective Relationship with Math encompasses a range of personal feelings toward the subject, including attitudes toward math, beliefs about math, confidence in math, and enjoyment of math. Research into ARM began in the 1950s with the work of those such as Dutton (1954), Gough (1954), Dreger and Aiken (1957), and Tulock (1957), who attempted to demonstrate that mathematical achievement was not solely determined by intellective factors, but was influenced by emotional factors, as well. This work continued through the 1960s with attempts to isolate the causes of differing attitudes toward math (Aiken & Dreger), to develop a tool for measuring attitudes toward math (Aiken & Dreger, 1961), and to isolate personality traits that correlate to attitudes toward math (Aiken, 1963).

The relationship between teacher attitudes and student attitudes toward mathematics was examined by Garner (1963) and Peskin (1964), who determined that teacher attitudes do influence student attitudes, but that the strength of that influence relies on other variables, such as teacher understanding of content, student attitude, and student culture. Because student achievement in math and attitudes toward math are affected not only by the teacher's ARM, but also by the teacher's Understanding of Mathematical Content and Pedagogical Skill for Math, researchers began to focus on the interrelation among a teacher's ARM, UMC, and PSM. Studies indicate that a negative ARM impacts one’s ability to learn mathematical concepts. Ma (1999) performed a meta-analysis of 113 such studies. This analysis revealed that there is a negative correlation between negative ARM and UMC.

ARM also influences PSM. In a study in Istanbul, Alci and Erden (2006) examined the mathematical abilities of 337 fourth grade students who were being taught by teachers with positive attitudes toward mathematics, as well as 355 fourth grade students who were being taught by teachers with negative attitudes. Alci and Erden found there to be a strong positive correlation between teacher attitudes and student success. While the study was not designed to isolate the exact route of affect, Alci and Erden believed there to be a combination of two factors leading to student success. Teacher attitudes may have been picked up on by the students, who themselves adopted those attitudes. As demonstrated by Ma (1999), this would impact student achievement. Also, Alci and Erden believed that teachers who had more positive attitudes toward mathematics created more effective learning environments and lessons.

In the past two decades, researchers have attempted to show that a teacher’s attitudes toward math can be improved indirectly as a result of coursework designed to increase UMC (Gibson, Brewer, Magnier, McDonald, & Van Strat, 1999; Smith, 2000) or methods coursework designed to increase PSM (Sloan, Vinson, Haynes, & Gresham, 1997; Smith, 2000; Vinson, 2001). Other researchers, such as Squire, Cathcart, and Worth (1981), have concluded that what is being taught to the teacher may be less important than how it is taught to the teacher in affecting teacher attitudes. Kolstad et al. (1994), whose study indicated that one-third of the kindergarten through fourth-grade teachers studied harbored strongly negative feelings toward math, suggested that instructors place direct emphasis on "...selecting activities that promote interest in and a positive attitude toward mathematics..." (p. 47).

Research Questions

The major research questions for this dissertation were:

1. Using an established assessment tool, what are the attitudes of veteran elementary education teachers in Blue, Green, and Orange Counties, Illinois toward mathematics?
    a. To what extent, if any, is there a relationship between attitudes and quantity of experience, between attitudes and types of experience, and between attitudes and post-certification training experience?
    b. How do veteran teachers' current Affective Relationship with Mathematics compare with their perceptions of their own ARM prior to entering the classroom?
2. What factors do teachers self-identify as the leading post-certification causes of change in their attitudes toward mathematics?
3. What services, if any, do teachers believe that Educational Service Agencies may provide to facilitate positive attitudes toward math among elementary teachers?

Description of Terms

Affective Relationship with Math (ARM). A broad term covering several areas of research on the emotional (non-intellectual) aspects of learning and using math. These include Attitudes Toward Math (ATM), beliefs about math, confidence with math, and enjoyment of math.

Attitudes Toward Mathematics (ATM). The overall level of affinity a teacher has toward mathematics based on the attitudes, beliefs, emotions, and values the teacher associates with mathematics. This term may be prefaced as "Teacher ATM" or "Student ATM" to indicate whose attitudes are under consideration.

Educational Service Agency (ESA). A state, regional, county, or parish agency that is charged with the responsibility for providing professional development programs for public school teachers. In Illinois, this function is filled by Intermediate Service Centers or Regional Offices of Education.

Elementary School Student. A child in kindergarten through fifth grade.

Instructor. A person who teaches teachers, either in a college or a professional development setting.

Math Anxiety. Originally known as Number Anxiety or Mathemaphobia. A negative level of confidence in mathematical ability that may result in fear or apprehension when faced with a mathematical task or learning experience.

Mathematical Common Knowledge. The knowledge of facts, the ability to know what mathematical techniques to apply to a problem, and the ability to perform the calculations to determine an answer that would be expected of the average adult. This is used to contrast a standard knowledge of mathematics with Mathematical Knowledge for Teaching.

Mathematical Knowledge for Teaching. A specialized knowledge of mathematics required for its successful teaching, involving “the ways of representing and formulating the subject that makes it comprehensible to others” (Schulman, in Ball, 1988b, p. 13).

National Assessment of Educational Progress (NAEP). An assessment tool utilized by the National Center for Education Statistics of the U.S. Department of Education to track the nation’s educational progress in core content areas, including mathematics, at Grades 4, 8, and 12.

Pedagogical Skill in Math (PSM). The overall ability that a teacher has to teach effectively mathematical concepts. This includes empathy, the ability to communicate mathematical concepts in an age-appropriate way, ability to utilize various teaching/ learning styles when appropriate, and ability to differentiate instruction.

Prospective Teacher. A person who is enrolled in a teacher education program for the purpose of becoming a certified elementary school teacher.

Student. An elementary school student.

Teacher. Sometimes specified as “active teacher” or “inservice teacher”. A person who is hired as a classroom teacher in an elementary school. In this document, the term refers to those who are already employed in such a position. Prospective teachers will always be referred to as prospective teachers. While the teacher is in the role of a student in a college or professional development setting, such a person will always be referred to as the teacher in this document.

Trends in International Mathematics and Science Study (TIMSS). An assessment developed to allow participant nations, including the United States of America, to compare the mathematics and science knowledge of students, as well as to compare the methods of mathematics and science instruction provided in those countries. Students are sampled at the 4th grade and 8th grade levels.

Understanding of Mathematical Content (UMC). The level of mastery the teacher has attained in regard to knowledge of mathematical facts (knowledge), ability to perform mathematical operations (skill), and understanding of the concepts underlying the facts and operations.

Significance of the Study

By aligning standards from the National Assessment of Educational Progress (NAEP) with the Trends in International Mathematics and Science Study (TIMSS) test, Phillips (2007b) was able to compare the United States of America and each individual state with the mathematics and science performance of countries around the world. The results of this study indicate that less than one-third of eighth-grade students in Illinois meet the “At or Above Proficient” designation on international mathematics standards as defined by the TIMSS. Illinois' mean score on the NAEP places its mathematical performance in the lower half of the "Basic" level, well below "Proficient". While no state reached the "Proficient" level using the international standards, Illinois ranked 33rd of the 50 states.

At first glance, this may not appear to be a major concern. There were more countries scoring below the United States than above it, and the discrepancy between state standards and international standards may be a result of United States students knowing different (not fewer) mathematical concepts. However, when viewed through the context of changing economic and political conditions, the importance of proficiency with international standards becomes more apparent. As stated by Phillips (2007a):

> ...many intractable worldwide problems cannot be addressed in the United States until we reach a critical mass of science and mathematical literacy among the general population. Until the general population becomes aware of the science underlying these problems, they will not be able to establish public policy to address the solutions. In addition to needing more science and mathematics literacy among the general public, the United States needs more students preparing for careers in science, technology, engineering, and mathematics. To meet the demands of the future, a larger proportion of our workforce must have the problem solving and critical thinking skills to compete in a technologically sophisticated and global environment. (p. 3)

Because of the connection that can be made between teacher ARM and a student's decision to pursue mathematics study, any research that provides insight into ways to affect positively teacher relationships with mathematics is worthwhile.

Process to Accomplish

To facilitate answering the questions of this study, the researcher developed a questionnaire to be given to all elementary school teachers in the three counties under consideration. The questionnaire consisted of 60 questions in five sections.

Section 1 – My Math Background. This section was provided to determine the teacher's exposure to mathematics after becoming a classroom teacher (questions 1-10). One of the limitations of available research concerns the selection of samples of teachers who were actively enrolled in courses teaching math content or pedagogy at the time the attitude scale was administered. Because of the recency of the course, and because the attitude scale was administered in the same setting as the course, these studies cannot be used to isolate the role that teaching experience plays in the development of attitudes. The questions in this research allowed the researcher to isolate the experience of teaching as a factor of attitude change.

Section 2 - My Personal Feelings About Math. Section 2 consisted entirely of the Revised Math Attitudes Scale (RMAS). The RMAS is a 20-question instrument developed by Aiken and Dreger (1961) and revised by Aiken (1963). Aiken and Dreger (1961) reported a reliability of $r = .94$ for test-retest, and a test of independence confirmed that attitudes specific to mathematics were being measured ($X^2 = .80$, $df = 1$). The RMAS instrument was selected because of its history of use with similar large-scale studies, such as Higdon (1975) and Rech et al. (1993).

Three questions from the RMAS were altered from their original versions so as to have meaning to those teachers who had not recently taken mathematics coursework.

1. Question 11 (Original) - I am always under a terrible strain in a math class.

   Question 11 (Altered) - I am always under a terrible strain when learning mathematics.

2. Question 12 (Original) - I do not like mathematics, and it scares me to have to take it.

   Question 12 (Altered) - I do not like mathematics, and it scares me to have to learn new math.

3. Question 28 (Original) - I am happier in a math class than in any other class.

   Question 28 (Altered) - I am happier learning about math than any other subject.

Section 3 - Basic Demographics. This study was not designed to explore differences based on demographics such as race, ethnicity, or social class. However, the educational climate at the time one began his or her teaching career may have a significant impact on how one experiences the teaching of mathematics. These questions were included to explore that impact.

Section 4 - Changes in My Personal Feelings About Math. This section was designed to discover the changes that have taken place in a teacher's Affective Relationship with Mathematics, as he or she perceives those changes. Questions 34 through 38 asked participants to rate themselves in five aspects of affect prior to their classroom experience and then to quantify their perceived change in those areas. Questions 39 through 40 provided an opportunity for participants to consider those people or experiences that most contributed to both positive and negative changes in their attitudes. Questions 41 through 46 followed by asking participants to consider six possible contributing factors of change in math attitudes and to label each as causing a positive or negative change.

Section 5 – Services. This series of questions was designed to explore possible services or resources that teachers believe would positively impact (or would have positively impacted earlier in their careers) their attitudes.

Surveys were printed as a four-page standard letter-sized pamphlet (Appendix A). The principals of 142 schools were sent letters (Appendix B) requesting permission to distribute the surveys to their elementary school buildings, a permission form (Appendix C) to complete, and a copy of the survey instrument (Appendix A). Permission was granted by 41 principals covering 42 elementary schools. Packets were then sent to the principals of those schools. The packet included a letter from the researcher (see Appendix D) giving instructions on the how the survey was to be distributed, and enough copies of the survey instrument for all of the teachers in that building.

With each survey was a brief letter from the researcher (see Appendix E) explaining the purpose of the survey and a self-addressed, stamped envelope. Participants were asked to complete the survey and to place it in the mail.

Because participation was voluntary, the following steps were taken to encourage participation:

1. Surveys were printed in color to make them more noticeable and appealing.
2. The return envelope was brightly colored to aid participants in remembering to place it in the mail.
3. Instructions specifically stated that a greater participation rate would increase the study's impact in the region.

4. Potential participants were given a math-related bookmark (a monkey ruler) and a postcard (Appendix F) that they could mail in to receive a set of bookmarks for their students.

Survey responses were collected over a three-month period. Statistics were compiled in relation to the original research questions.

Research Question 1 - Using an established assessment tool, what are the attitudes of veteran elementary education teachers in Northern Illinois toward mathematics? To answer this question, results were compiled for the Revised Math Attitudes Scale portion of the survey (questions 11 - 30). As described by Rech et al. (1993), the Aiken scale utilizes a Likert scoring procedure to result in a score for each participant from 0 to 80, with a score of 40 indicating a neutral attitude toward mathematics. The higher the score, the more positive the attitude toward mathematics; the lower the score, the more negative the attitude toward mathematics. Of the 20 questions, 10 were reverse coded. Each participant was assigned a score using this method. The minimum, maximum, and median scores were determined, as were the deciles.

Question 1, Subquestion A - To what extent, if any, is there a relationship between attitudes and years of experience, between attitudes and type of experience, and between attitudes and recency of mathematics training? In order to gain a more accurate understanding of the role of experience in determining attitude, appropriate correlation statistics were calculated to determine the relationship between RMAS score and each of the following:

1. Age (SQ 33)

2. Number of years of teaching experience (SQ 1)
3. Number of years teaching at the current grade level (SQ 2)
4. Number of years of experience teaching mathematics (SQ 3)
5. Category of currently teaching math at a single grade level or more than one grade level (SQ 4)
6. Category of having taught math at a single grade level versus more than one grade level (SQ 5)
7. Among those currently teaching at a single grade level, the grade level currently taught (SQ 4)
8. The lowest grade of math currently taught (SQ 4)
9. The lowest grade of math taught in one's career (SQ 5)
10. The highest grade of math currently taught (SQ 4)
11. The highest grade of math taught in one's career (SQ 5)
12. The range of grades in which one currently teaches (SQ 4)
13. The range of grades in which one has taught during his career (SQ 5)
14. The number of unique grades of math one currently teaches (SQ 4)
15. The number of unique grades of math one has taught during his career (SQ 5)
16. Category of having or not having taught math in a departmentalized classroom (SQ 6)
17. Category of having or not having taught math in a co-teaching situation (SQ 6)
18. Category of having or not having taught math in a resource capacity (SQ 6)

19. Sex (SQ 31)
20. Path to a teaching career (SQ 32)
21. Category of having or not having taken a college course in math or the methods of teaching math since entering the classroom (SQ 7)
22. Among those who have taken a college course in math or the methods of teaching math since entering the classroom, the length of time since the last course was taken (SQ 8)
23. Category of having or not having taken a full-day workshop on mathematics since entering the classroom (SQ 9)
24. Among those who have taken a full-day workshop on mathematics since entering the classroom, the length of time since the last course was taken.

Statistical methods utilized included multiple regression analysis, independent samples *t*-test, one-way ANOVA, and Pearson *r*.

Question 1, Subquestion B - How do these results compare with veteran teachers' perceptions of their own attitudes toward mathematics prior to entering the classroom? For this subquestion, survey questions 34 through 38 were utilized to assess teachers' perceived changes in five components of ARM. For each component, teachers were asked to indicate their level of favorability at the present time and as they perceive that it would have been before they began teaching. A paired-samples *t*-test was used to determine if the perceived change was significant. Descriptive statistics for those at various starting levels were calculated. For each of the five attitudinal components, a multiple regression analysis was then run on each of 20 experience factors drawn from the survey.

Question 2 - What factors do teachers self-identify as the leading post-college causes of change in their attitudes toward mathematics? For this question, survey questions 39 and 40 were collaboratively coded for themes by three educators (the researcher, one experienced teacher and administrator, and one prospective teacher). Codes were then tabulated and ranked in a table. For survey questions 41 through 46, percentages were calculated for each response. Then, a series of multiple regression analyses were run to determine the relationship between responses and 20 experience factors.

Question 3 - What services, if any, do teachers believe that Educational Service Agencies may provide to facilitate positive attitudes toward math among elementary teachers? Responses to questions 47 through 57 were tallied, and percentages were determined. For questions 58 and 59, three educators (the researcher, one experienced teacher and administrator, and one prospective teacher) collaboratively coded responses. Results were compiled and described.

In an effort to determine which, if any, services were sought more by those with negative attitudes toward mathematics, a series of multiple regressions were run on each of the survey questions 40 through 57, looking at the relationship between the level of need for the service based on total RMAS score.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

The purpose of this chapter was to examine existing research that might provide insight into the role that teacher Affective Relationships with Mathematics (ARM) play in elementary education, the impact of experience on teacher ARM, and concomitant interventions that might positively impact teacher ARM. The chapter began by establishing the need for improvements in mathematics education at the elementary level. With the need for improvements established, the role of the teacher as the primary agent of student learning was explored. Teacher mathematical knowledge was examined as one of two teacher traits commonly associated with student success. Affective Relationship with Mathematics was the other teacher trait commonly associated with student success. The history of study into the affective components of beliefs, attitudes, and emotions as related to mathematics was summarized, including the various tools that have been employed in their assessments. Studies relating the ARM of students, their parents, and their teachers to student success were examined. This was followed by a review of studies that explore the ARM held by prospective teachers, and culminating with studies that explore the ARM held by in-service teachers. Lastly, factors that may contribute to change in teacher ARM and possible interventions to improve ARM were perused.

Is There Truly a Need to Improve Mathematics Education?

The call for reform in mathematics education appears to come from several directions. The United States Department of Education (National Mathematics Advisory Panel, 2008), national mathematics organizations (National Council of Teachers of Mathematics, 2000), and average citizens in rural Illinois (Lucas & Fugit, 2007) have indicated that the current mathematics education received by public school students is inadequate.

The Trends in International Mathematics and Science Study (TIMSS) provides one of the rare opportunities to objectively compare the success of mathematics education in the United States with that of other countries around the world (Mullis, Martin, & Foy, 2005). While reports of TIMSS data usually focus on the scores in content knowledge (Mullis et al., 2005; Phillips, 2007a, 2007b), Wilkins (2000) used the full range of TIMSS data to look at the full quantitative literacy of those who are leaving the public school system (in the United States, these are 12th grade students.) Wilkins finds that the United States scores 19th out of the 21 countries participating in this level of testing in the area of mathematical content knowledge and 17th in the area of mathematical reasoning. It is important to note that the content knowledge assessed in the quantitative literacy model does not include advanced mathematics, but instead focuses on:

> an everyday functional knowledge of mathematical content that forms a foundation for application and investigation...the level of mathematics knowledge required to decide the best priced item from among two in a grocery store, understand the closeness of a political race based on a

> random sample of voters, or interpret the results of a graph presented in a newspaper. (Wilkins, pp. 406-407)

Despite the poor performance of United States students in the areas of content knowledge and mathematical reasoning, these students hold remarkably high views of the importance of mathematics and of their own abilities in mathematics. On the belief that mathematics is important in everyone's life (social utility), 88% of these students agreed. This percentage was a tie for the most of any country. The United States also scored first for percentage of students who believe that they have done well in mathematics and second for percentage of students who believe that mathematics is an easy subject (Wilkins, 2000).

This discrepancy between actual performance and the perceived importance of mathematics, the perceived success in mathematics, and the perceived easiness of the subject may have multiple explanations. The first explanation is the large percentage of United States students who believe that memorizing formulas and algorithms equates to knowing mathematics. A student whose mathematics courses have focused on these skills may have been successful with this aspect, while not being able to apply that knowledge (Wilkins, 2000). Another possible explanation involves the tracking systems used by schools in the United States that allow students to fill their mathematics requirement by taking multiple courses covering the same mathematical content in slightly different contexts (e.g., General Math, Life Math, Career Math) (Wilkins).

Wilkins (2000) concluded that, while students in the United States seem to understand the importance of math and to feel positively about their ability to perform mathematical tasks, they “are not likely to reason well enough mathematically to figure out what to do in a quantitative situation, even when the content requires only simple arithmetic” (p. 415). In essence, we are producing graduates who are not quantitatively literate.

A perusal of the raw TIMSS data for 4th grade and 8th grade students appears, at first glimpse, to be less bleak. The tests for these two groups focus on five content domains: Number, Algebra (Patterns and Relationships), Measurement, Geometry, and Data, as well as three cognitive domains: knowing facts, procedures, and concepts; applying knowledge and understanding; and reasoning (Mullis et al., 2005). For both grade levels, the United States scored above average overall and within each of the three cognitive domains (Mullis et al.). In addition, scores were in line with other European and English-speaking countries (Phillips, 2007a).

Looking beyond countries that are similar to the United States, results placed the United States well above the Middle East and Africa, but far below the country’s “Asian economic competitors” (Phillips, 2007a). While the ranking itself appears to place the United States in line with like countries, Phillips argues that comparisons of achievement scores to other countries distract attention away from a more important question - does the United States have a critical mass of the general population with enough mathematical knowledge and thinking skills to solve complex world-wide problems?

In an effort to answer this question, Phillips (2007b) took advantage of the fact that the TIMSS tests were designed to be linkable to the United States’ National Assessment of Educational Progress (NAEP). The NAEP utilizes performance standards defined by the United States (as opposed to those defined by the international committee that designed the TIMSS) to categorize students as falling into one of four categories: Below Basic, Basic, Proficient, and Advanced (Phillips).

Utilizing this approach, and looking for that "critical mass" of the population who are "proficient" in mathematics, the difference between the United States and its Asian economic competitors becomes more pronounced. Using the TIMSS 2003 data, only 26% of 8th grade students in the United States would be categorized as Proficient or above. This percentage ranges from 57% to 73% in the participating Asian countries (Phillips 2007b). These results are particularly problematic given that the United States has a government based on a democratic system, in that three fourths of those responsible for voting do not have the necessary understanding of mathematics to understand fully the complex issues facing the country and the world (Phillips, 2007a).

Illinois performs better than the nation in producing students who can be classified as Proficient in mathematics. NAEP results for the state show that 31% of Illinois 8th graders are proficient (National Center for Educational Statistics, 2008; Phillips, 2007a). While higher than the national average, Illinois still falls far short of the proficient majority enjoyed by Asian economic competitors. In fact, not one of the 50 states reached the 57% proficiency level of the weakest-performing Asian country (Phillips).

A multitude of factors have been shown to correlate to student success in mathematics. Familial factors that may affect a student's success include socio-economic status, home atmosphere, parent perceptions about mathematics, and parent perceptions about a child's ability to perform mathematics (Marzano, 2000; Yee & Eccles, 1988). Student-level factors that may affect a student's success in mathematics may include aptitude, prior knowledge, and interest (Marzano). School-level factors include the quality of administrative leadership, the school climate, the curriculum design, expectations set and conveyed to students, and the process by which performance is monitored (Marzano).

While the exact percentage of a student's success or failure that is attributable to teacher-level factors, versus familial, student, or school factors, is debated by researchers, it is clear that teachers do play a significant role in the process. Wright, Horn, and Sanders (1997) went so far as to say that, "...more can be done to improve education by improving the effectiveness of teachers than by any other single factor" (p. 63).

The Tennessee Value-Added Assessment System, a statewide database tracking student achievement data, student variables, teacher variables, and classroom variables, has provided researchers with the ability to study these variables over time. Using data from this system, Wright et al. (1997) found that the most important factor in student academic gain was teacher effectiveness. The teacher effectiveness factor contributed more to predicting student gain than class size, class heterogeneity, student achievement levels, or any other factor.

Sanders and Rivers (1996) also used data from this system to explore the cumulative effects of teacher effectiveness over a period of three years. Sanders and Rivers began by placing the teachers in two school districts into quintiles based on their effectiveness scores. Sanders and Rivers then looked at students whose end-of-second-grade scores were similar and tracked those students through third, fourth, and fifth grades. This analysis revealed that, on the end-of-fifth-grade exam, students who experienced ineffective teachers three years in a row scored more than 50 percentile points below peers who experienced effective teachers for three consecutive years, despite having begun at the same level. Analysis of the data also revealed that, even though an effective fifth grade teacher could have a positive impact on a student who experienced an ineffective teacher in an earlier grade, the residual effect of the ineffective teacher was still observable (Sanders & Rivers).

Given that ineffective teachers can have such a significant and long-lasting impact on their students, Darling-Hammond sought to determine if there were correlations between state policies regarding teacher certification and hiring and student achievement. Using NAEP scores and state policies, Darling-Hammond determined that, "the most consistent highly significant predictor of student achievement in reading and mathematics...is the proportion of well-qualified teachers in a state: those with full certification and a major in the field they teach" (p. 29). In fact, "the effects of well-prepared teachers on student achievement can be stronger than the influence of student background factors, such as poverty, language background, and minority status" (p. 39). Darling-Hammond qualified this result by positing that teacher certification may, in fact, be a proxy for two other teacher factors - content knowledge and pedagogical knowledge - as those areas are usually addressed in teacher certification programs.

While conservative estimates place the amount of impact that teacher-level variables have on student achievement at approximately 13% (Marzano, 2000), Rowan, Correnti, and Miller (2002) claimed that when the rate of change or student growth, rather than student achievement, are made the focus of investigation, this percentage increases to 52 - 72% percent. Rowan et al. concluded that, "when the analysis shifts from concern with students' achievement status to concern with students' growth in achievement, home and social background, as well as school composition and location, become relatively insignificant predictors of academic development" (p. 13).

While the studies above look at the overall impact that teachers have on students, several studies have also focused on the impact that teachers have on students' achievement and attitudes in mathematics (Alci & Erden, 2006; Garner, 1963; Jackson & Leffingwell, 1999; Peskin, 1964; Schofield, 1981). Noting the prevalent belief in Australia that teachers directly pass both their attitudes and achievement to their students, Schofield examined the attitude and achievement of 48 first-year teachers of fourth, fifth, and sixth grade and their students. The results indicated that "there is a degree of incompatibility in maximizing both cognitive and affective outcomes in children, at least at the grades 4-6 level in the area of mathematics" (p. 470). When teachers with high achievement scores were separated from teachers with medium and low achievement scores, the students of the teachers in the first group had higher achievement scores, but lower attitude scores, than their peers. In other words, the teacher's achievement scores were positively correlated to student achievement, but negatively correlated to student attitudes. When teachers with high attitude scores were separated from teachers with medium and low attitude scores, the students in the first group had higher achievement scores, but lower attitude scores, than their peers. This would indicate that teacher attitudes toward mathematics are positively correlated to student achievement, but negatively correlated to student attitudes (Schofield).

In a study performed in Istanbul, Alci and Erden (2006) supported the assertion that teachers who have positive attitudes toward mathematics have students who score significantly higher than those who have poor attitudes toward mathematics. This correlation was particularly strong with female students. However, given Schofield's (1981) results indicating that teacher attitude and student achievement are not linked by student attitude, Alci and Erden speculate that teachers with strong positive attitudes toward mathematics organize more effective learning environments than their peers. Alci and Erden call for more research on the intermediate factors. That is, what classroom practices and instructional techniques do teachers with higher attitudes tend toward that promote student achievement? (Alci & Erden).

An answer to the above question may come in the form of the beliefs that teachers with positive attitudes toward math tend to hold about mathematics. In a study of 62 third grade and 51 sixth grade teachers, Van de Walle (1973) found that the teachers' attitudes toward math worked in combination with the teachers' beliefs about mathematics to impact their students. Teachers who had positive attitudes toward mathematics and who believed the nature of mathematics to be "informal" (not the static application of memorized rules and formulas) had students who scored significantly higher in attitude, computation, and comprehension (Van de Walle). Staub and Stern (2002) also found that such teachers had students who scored significantly higher in word problems at the second and third grade levels.

Stodolsky (1985) explored the difference between the teaching of subjects that are generally considered informal (using Van de Walle's [1973] terminology) and those that are presented as rule-based by examining the instructional techniques utilized in fifth grade mathematics versus those that are utilized by the same teachers in social studies. Stodolsky found that mathematics classes primarily consisted of a teacher's instruction on the skills to be learned, followed by individual student practice. Textbooks served as problem sets and provided little, if any, opportunity for students to learn new concepts from them. This was in stark contrast to the approach that the same teachers took to social studies, where students were encouraged to become independent seekers of information and to learn from one another. Social studies textbooks were also found to be self-contained instructional devices that could provide students with additional paths to content. The teacher-as-sole-provider approach to teaching mathematics, Stodolsky concluded, leaves the student entirely dependent upon the teacher for new knowledge. If those teachers with the lowest level of content knowledge are the most likely to utilize a teacher-as-sole-provider approach (Karp, 1991), and if teachers who have deficient knowledge of mathematical content are unaware of those deficiencies (Swars, Hart, Smith, Smith, & Tolar, 2007), a situation may be created where student learning will suffer (Schoenfeld, 1988). It is for this reason that Hill et al. (2005) recommended focused efforts to provide professional development for those elementary teachers whose content knowledge in mathematics is below the 30th percentile of teachers.

The need to improve quantitative literacy in the United States is well documented (Mullis et al., 2005; Phillips, 2007a, 2007b; Wilkins, 2000). While the specific size of the impact that teachers have on student learning is debated, it is clear that teacher-level factors play a significant role in student learning (Marzano, 2000; Rowan et al., 2002; Sanders & Rivers, 1996; Wright et al., 1997). Unlike many student-level factors, teacher-level factors can be manipulated through state policy (Darling-Hammond, 1999). Two areas of teacher improvement that have been found to increase student achievement are teacher knowledge (Hill et al., 2005; Schofield, 1981) and teacher attitudes (Alci & Erden, 2006; Schofield; Van de Walle, 1973). The following two sections will address each of those areas.

Teacher Mathematical Knowledge

Teacher knowledge has been shown to have a significant impact on student achievement (Hill et al., 2005; Schofield, 1981). However, researchers have found that misconceptions regarding the need to train elementary school teachers in mathematics content pervades (Ball, 1990; Conference Board of the Mathematical Sciences, 2001; Morris, 2001). Ball pointed out the common assumption that future teachers learn what they need to know about mathematics through their own K-12 learning. Given that only one quarter of 8th grade students are seen as proficient in the content that the United States standards say they should have mastered (Phillips, 2007a), and given that it is from this group of under-prepared graduates that future elementary teachers emerge, teacher educators must assume that elementary teacher candidates do not have mastery over the content they will be teaching (Ball, Hill, & Bass, 2005; Morris).

Will prospective elementary teachers seek to improve their own mathematical content knowledge before entering the field? They may not know there is a need. There appears to be a serious disconnect between confidence in one's ability in elementary mathematics and one's actual knowledge of the content. That is, prospective elementary school teachers do not know how much they do not know (Ball, 1990; Morris, 2001; Swars et al., 2007). This mismatch between high confidence and low content understanding can even be found among prospective elementary teachers who completed a major or a minor course of study in mathematics (Ball, 1988a, 1990). This unwarranted confidence is a problem, as "...confidence, coupled with thin and rule-based understanding, can pose a threat to student learning as teachers confidently proclaim wrong ideas or portray mathematics in misleading ways" (Ball, 1990).

Will prospective elementary teachers seek to improve their own mathematical content knowledge if shown the areas in which their knowledge is deficient? Morris (2001) found that, even when prospective elementary teachers were shown their weaknesses and provided with opportunities and resources to address those weaknesses, they had no propensity to do so. According to Morris, "for the majority of pre-service teachers who failed [the pre-test], it appears that avoidance or disbelief were the common traits...They were unaware of the implications this lack of knowledge could have on their, and their pupils' futures" (p. 45).

Even if teacher candidates are able to perform the basic operations that their students will be asked to perform, this is only the beginning of the understanding necessary to teach the content in question (Ball, 1990; Ball et al., 2005; Conference Board of the Mathematical Sciences, 2001). As stated by Ball et al., "How well teachers know mathematics is central to their capacity to use instructional materials wisely, to assess student progress, and to make sound judgements about presentation, emphasis, and sequencing" (p. 29).

In its extensive report, the Conference Board of the Mathematical Sciences (CBMS, 2001) of the American Mathematical Society detailed dozens of common teaching scenarios in which simply being able to "do" the mathematics being taught could result in teachers providing students with inadequate, inaccurate, or misleading instruction. Clearly, if the teacher does not understand the concepts behind procedures being taught, then concomitantly, the student has no choice but to memorize the procedure. When the student is placed in this situation, "memorization must pass for understanding, and mathematics becomes an endless, senseless parade of disparate facts, definitions, and procedures" (CBMS, p. 55). Inaccurate or misleading instruction on conceptual knowledge may be as detrimental as a lack of instruction on conceptual knowledge, as "it is during these early years that young students lay down those habits of reasoning upon which later achievement in mathematics will crucially depend" (CBMS, p. 55).

Hill, Schilling, and Ball (2004) have begun the work of developing a comprehensive tool to measure not only a prospective teacher's ability to "do" mathematics (which Hill et al. refer to as mathematical common knowledge), but also the prospective teacher's understanding of the specialized knowledge needed to teach the subject successfully (which Hill et al. refer to as mathematical knowledge for teaching). It is hoped that this tool will provide researchers with a more clear understanding of how the different sets of knowledge impact teachers and students, as well as how teacher educators can best work to see that teachers have both sets of mathematical knowledge (Ball et al., 2005).

Mathematical common knowledge can be thought of as the knowledge of facts, the ability to know what mathematical techniques to apply to a problem, and the ability to perform the calculations to determine an answer. Mathematical knowledge for teaching, on the other hand, involves “the ways of representing and formulating the subject that makes it comprehensible to others” (Shulman, in Ball, 1988b). Specifically, mathematical knowledge for teaching includes the ability to:

- determine the best order in which to introduce concepts
- explain each step of procedures and algorithms
- explain the concepts behind the procedures
- define vocabulary
- use mathematical language fluently and accurately
- identify sources of student errors and confusion
- recognize alternative approaches to the same concept or procedure proposed by students and determine if such approaches will or will not lead the student to conceptual difficulties down the road
- create valid and educationally beneficial examples
- create or identify various models and representations for a given concept
- find a balance between the often-competing goals of age-appropriate understandability and mathematical soundness (Ball, 1990; Ball et al., 2005; CBMS, 2001; Reynolds, 1995).

Even one who has a deep understanding of a mathematical concept may have difficulties with these professional skills. Ball (1993) provided a detailed analysis of the difficulties a teacher may experience in determining the best representation to use for introducing the concept of negative numbers and demonstrating various operations on negative numbers. A thorough knowledge of mathematics, Ball concludes, is not only needed for determining the representation to use, but also to adapt midstream when a representation is not working.

The assumption that mathematical knowledge for teaching is obtained by students in their pre-college mathematics exposure is a faulty one (Ball, 1990). It is up to colleges, then, to provide this understanding (Ball et al.; Reynolds, 1995). Many researchers in this area agree that this coursework must be specifically designed for prospective teachers, and that simply requiring additional coursework in advanced mathematics will not solve the problem (Ball et al.; CBMS, 2001). That being said, there is disagreement over whether these courses should be taught by career mathematicians (CBMS, 2001) or educators (Ball et al.).

What should be the nature of such a course? The Conference Board of the Mathematical Sciences (2001) recommended that teachers be provided with nine semester hours of coursework addressing the development of mathematical knowledge for teaching. Because depth of mathematical understanding is the goal, CBMS recommended that faculty from the Mathematics department, not the Education department, should teach this course. CBMS added that mathematicians (and especially mathematics professors) must consider the education of prospective teachers as one of their highest priorities, and that they should play a more central role in the development of mathematics standards (CBMS).

The clear separation of courses directed at developing knowledge for teaching mathematics from those directed at developing teaching methodology is supported by studies that indicate that pre-service teachers who are not mathematically competent have difficulty learning the skills that are taught in methods courses and that are observed in field experiences. In a mathematics methods course, Battista (1986) found that "...preservice teachers' mathematical knowledge was indeed significantly related to their learning of mathematical pedagogy as measured by methods course exams..." (pp. 17-18). In response to the tendency of pre-service teachers in her class to choose to teach lower grades in order to avoid being responsible for knowing mathematical content, Ball (1988b) noted that "their feelings and opinions about math may thus affect their approach to learning to teach it..." (p. 21).

Ambrose (2004), however, argued that it may be more beneficial to expose pre-service teachers to field experiences in elementary mathematics classrooms prior to providing them with courses on mathematical knowledge for teaching. Such an approach allows teacher education programs to overcome pre-service teachers' unjustified overconfidence in their abilities to teach mathematics (as noted in Ball, 1990; Morris, 2001; Swars et al., 2007) and to experience for themselves the deep level of understanding that one must have to teach concepts they consider "simple" (Ambrose). Ambrose believes that the experience of not being able to create examples, representations, or alternate explanations while in the presence of a real elementary student will be emotion-packed for the pre-service teacher and prompt him or her to open to the idea that the course on mathematics content for teaching is needed.

An early field experience may also help pre-service teachers to overcome what Campbell (2002) called the "Incapability Thesis." The Incapability Thesis is the idea that elementary school children are not capable of understanding the conceptual foundations of the mathematics they are learning (Campbell). Educational theories that support a focus on mastery of skills (traditionalist) or on real-world applications (progressivist) promote the Incapability Thesis and leave the development of conceptual understanding to occur by chance (Campbell). Because most pre-service teachers have primarily experienced such styles of mathematics learning (Stigler & Hiebert, 1997), they will likely retain the Incapability Thesis unless an experience prompts them to reject it (Campbell). Most pre-service teachers do not have an opportunity to observe the conceptual potential of young children until after they have completed their last mathematics course (Ambrose, 2004). Providing this experience before the course in mathematics knowledge for teaching would provide the pre-service teacher with even more incentive to take the course seriously.

As those who teach mathematics are also students of mathematics, some researchers have lamented the discrepancy between what teacher educators teach prospective teachers about the best way to teach mathematics and the way in which teacher educators are taught mathematics (Ball, 1988b; McLaren, 2005). Ball provided pre-service teachers with a mathematics unit that was taught entirely through constructivist approaches. Ball described the eye-opening experience for her students as they learned how to implement a structure of learning that many believed they should implement but did not have the tools to implement.

McLaren (2005) sought to determine if the way in which a pre-service teacher learns a mathematical concept affects his or her understanding of and ability to communicate about the topic. To test this, McLaren randomly split a group of pre-service teachers for a unit on place value. One group was taught using explicit (traditional) instruction, while the other group was taught using a problem-based, constructivist approach. McLaren found no significant difference between the two groups, either in understanding of the concept or in ability to communicate that understanding. McLaren warned that teacher educators and teachers must not view any one type of learning as a magic bullet that can be utilized for every lesson to the benefit of every student. Group work, for example, tends to benefit those who do well in social settings, and constructivist techniques tend to benefit those with persistent personalities (McLaren).

Pre-service teachers are heavily influenced by their own experience as students in K-12 mathematics education (Brady & Bowd, 2005). Beliefs about the nature of mathematics and mathematics education are relatively stable and difficult to change in the relatively short period of time in which prospective teachers are enrolled in teacher education programs (Ambrose, 2004). It is for this reason that Ball (1988b) and Sullivan (2003) recommend that one of the most important parts of preparing an elementary teacher to teach mathematics involves aiding prospective teachers in reflecting on their own educational experiences and analyzing them, and what they imply about the nature of mathematics or mathematics education, in an honest and critical manner.

If a teacher's approach to learning and teaching mathematics is so heavily influenced by his or her own experiences in the classroom, one might expect to see a very different approach to mathematical knowledge for teaching in countries whose classrooms are unlike those in the United States. Stigler and Hiebert (1997) sought to explore this area utilizing the video component of the 1995 TIMSS. In this component, researchers selected 8th grade teachers at random from among three countries that were seen as economically competitive - Germany, Japan, and the United States. These teachers were videotaped in their classrooms and surveyed (Stigler & Hiebert).

The differences between Japan (one of the top scorers in TIMSS assessments) and the United States were "...not just a matter of degree: U.S. students apparently experience a different kind of mathematics than their Japanese peers" (Stigler & Hiebert, 1997, para. 30). The most common method of instruction in the United States involves two phases. In the acquisition phase, the teacher introduces a concept or procedure and provides one or more demonstrations of the concept or procedure being applied to problems. In the application phase, students practice the procedure on problems similar to the ones demonstrated. It is the role of the teacher to provide the knowledge needed, then to guide student practice (Stigler & Hiebert).

The typical Japanese lesson is quite different. After a review of the key points from the previous day's lesson, students are given a problem that can only be solved by utilizing previously learned material and the one new concept or technique to be introduced in the current lesson. Rather than simply being told the information, students are expected to struggle with the problem so that they may develop the concept or procedure on their own. After students share what they discovered or attempted, the teacher clarifies and summarizes. In this model, the teacher must carefully develop problems that will guide student thought, discovery, and creativity toward the intended objective (Stigler & Hiebert, 1997).

As teachers in Japanese schools are a product of a very different approach to learning mathematics, one might expect to see a different approach to learning mathematics for teaching, as well. Stigler and Hiebert (1997) described a process of collaborative growth and learning in which groups of teachers of the same grade level gather on a regular basis into “lesson study groups”. These groups isolate the least effective lessons currently in use, jointly develop revised lesson plans, and observe one another as these lessons are tested. The goal is a gradual and incremental improvement in instruction. When the lessons for a particular unit are perfected, these are shared with the teachers of other schools. In such a learning community, all teachers and students benefit from advancements in mathematical knowledge for teaching (1997).

In summary, mathematical knowledge for teaching is an important factor in the success of any teacher (Hill et al., 2005; Schofield, 1981). Assisting prospective teachers to gain this set of knowledge must be intentional (Ball et al., 2005; Morris, 2001) and given a high priority (CBMS, 2001). Whether mathematical knowledge for teaching is taught before (Ball, 1988b; Battista, 1986) or after (Ambrose, 2004) coursework focused on pedagogy or field experiences, it includes a very profession-specific set of skills that must be addressed (Ball, 1990; Ball et al.; CBMS, 2001; Reynolds, 1995). In the process of learning mathematical knowledge for teaching, it is important for teachers to reflect on their own experiences as mathematics students critically to expose underlying assumptions and beliefs about the nature of mathematics and mathematics education (Ball, 1988b; Sullivan, 2003). In the next section, how these beliefs affect teacher attitudes toward mathematics will be explored.

Teachers' Affective Relationships with Mathematics

Defining Affective Relationship with Mathematics

Mathematical common knowledge and knowledge of mathematics for teaching can be classified as falling into the cognitive domain of a teacher's relationship with mathematics. Achievement tests, which focus primarily on a student's mathematical common knowledge, are primarily designed to assess within the cognitive domain.

In the 1950s, researchers in mathematics education began to focus more attention to the affective domain, studying both students', as well as teachers', affective relationships with mathematics (ARM) (Dreger & Aiken, 1957; Dutton, 1954; Poffenberger & Norton, 1956; Tulock, 1957). Words such as "anxiety", "attitudes", and "beliefs" were utilized for the next few decades with little effort to define them formally (DiMartino & Zan, 2001; Dwyer, 1993; Hannula, 2002; Ruffell, Mason, & Allen, 1998) or to specify an overall structure to the affective domain related to mathematics (McLeod, 1992; Zan, Brown, Evans, & Hannula, 2006).

McLeod (1992) addressed this issue by structuring the affective domain into a spectrum consisting of three components: beliefs, attitudes, and emotions. In this system, beliefs hold the position on the spectrum nearest to the cognitive domain and are characterized by their high level of stability and low level of intensity. On the opposite end of the spectrum are emotions, which occur in the moment and, therefore, have a low level of stability and a high level of intensity. Between these lie attitudes, which are nearly as stable as beliefs, but which have a higher level of intensity (McLeod).

Within the area of beliefs, McLeod (1992) classified four sets of beliefs related to mathematics education. These include beliefs about mathematics (its nature, its structure, its difficulty, etc.), beliefs about self and mathematics (confidence in ability to do well in math, causal attributions of success or failure in math, etc.), beliefs about the teaching and learning of mathematics, and beliefs about the social context of the mathematics classroom (McLeod). Pehkonen and Pietilä (2003) referred to beliefs as a form of subjective knowledge that is based on personal experience and understanding, and which, unlike objective knowledge, is subject to change.

Goldin (2002) pointed out some of the complexities involved in beliefs. Belief systems may be structured or unstructured. Beliefs held by an individual may be consistent or contradictory. Belief may also frame how an emotion is experienced. For example, frustration over a complex mathematics problem may be fun for a student who believes that he or she can ultimately find the solution but disheartening for a student who believes that he or she is not capable of finding the solution (Goldin).

Emotions are the component of ARM that is the least stable and the most intense (McLeod, 1992). Emotions are short-term responses to mathematical situations. These responses can be fleeting (such as joy, frustration, or anger) or may extend over a short period of time (moods) (Hannula, 2005). Emotions are deeply tied to goals. In the mathematics classroom, goals that may arouse emotions include mastery goals, performance goals, ego-defensive goals, and social goals (Hannula). While emotions are mental in origin, physiological and/or behavioral responses may accompany the emotion (McLeod; Zan, Brown, Evans, & Hannula, 2006).

While many emotions are consistently labeled as positive or negative (such as joy or anger), other emotions may be experienced as positive or negative depending on the context in which it is experienced or on the beliefs of the person experiencing the emotion (such as frustration) (Goldin, 2002).

Of the three aspects of ARM specified by McLeod (1992), researchers have had the most difficulty settling on a definition for attitudes toward mathematics (ATM) (DiMartino & Zan, 2001; Hannula, 2002; Ruffell et al., 1998; Zan & DiMartino, 2007). McLeod defined attitudes as “affective responses that involve positive or negative feelings of moderate intensity and reasonable stability” (p. 581). McLeod’s examples included liking, disliking, enjoying, or being bored by a certain mathematical topic or activity.

DiMartino and Zan (2001, 2007) have identified three strands of definitions of attitude that are utilized (though most often implicitly) by researchers. The first strand follows directly from McLeod’s (1992) structure and identifies attitude as an affective disposition toward mathematics or toward a mathematical topic or activity (Zan & DiMartino, 2007). In this strand, attitudes are distinct from beliefs and emotions, though attitudes are highly interactive with beliefs and emotions (McLeod). Attitudes can be generated as a result of repeatedly experiencing the same emotion with the same mathematical stimulus (McLeod; Zan et al., 2006). For example, if one experiences joy on several occasions while learning geometry, he or she may develop the attitude that geometry is enjoyable. This attitude would predispose (but does not guarantee) one to approach future situations involving geometry with the expectation of enjoying the experiences. Because beliefs may frame emotions, they may also play a role in the formation of attitudes (Goldin, 2002). For example, if one experiences frustration on several occasions while learning algebra, his or her beliefs about self and about the nature of mathematics may lead toward an attitude that algebra is challenging and fun, or toward an attitude that algebra is difficult and not enjoyable.

In the second strand identified by Zan and DiMartino (2007), attitudes are not distinct from emotions and beliefs. Instead, ATM is defined as the pattern of emotions and beliefs that one associates with mathematics (or a mathematical topic or activity) (Zan & DiMartino). The third strand is similar to the second, but it includes behavior as a third component. In other words, ATM is defined as the pattern of emotions and beliefs that one associates with mathematics, and the behavior that one exhibits in mathematical situations (DiMartino & Zan, 2001; Zan & DiMartino).

Proponents of the second and third strand argue that attitudes as a stand-alone construct hold no practical value to teachers. For teachers, a student's attitude is only practically viewable as the emotions he or she expresses, the beliefs that the teacher can help to mold, and the behavior that the student exhibits (Polo & Zan, 2005). However, this definition may lead to situations where the word is utilized in a way that is contradictory with its expected usage. For example, a student who greatly enjoys mathematics, but who has beliefs about the nature of mathematics that are considered negative, would be classified as having a negative ATM under this strand (Polo & Zan).

DiMartino and Zan (2001) clarify that the first strand is generally seen as the true definition, with the other strands seen as clarifying how attitudes will be treated within a particular study. In fact, some researchers have called for the word to take on “working definitions” that differ and are expressly defined within each study, depending on the context and goals of the study (Kulm, in Zan & DiMartino, 2007; Daskalogianni & Simpson, in Zan & DiMartino, 2007; Zan & DiMartino, 2007).

When viewed as one of the components of ARM (separate from beliefs and emotions), attitudes toward mathematics can be decomposed into various factors. Tapia and Marsh (2002, 2004) performed a factor analysis on an attitude assessment. Self-confidence, value, enjoyment, and motivation were confirmed as independent factors. Anxiety, which was intended to be a separate factor on the assessment, was found to have a high inter-factor correlation with self-confidence and was deemed not to be an independent factor.

Mathematics anxiety has received a considerable amount of attention from researchers over the last 50 years (Hembree, 1990; Ma, 1999). Dreger and Aiken (1957) demonstrated that number anxiety is a different construct than general anxiety, that it is not significantly related to IQ, and that it is significantly related to achievement. Meta-analyses of research on math anxiety support the link between math anxiety and achievement (Hembree; Ma), though Ma reminded educators that the relationship between math anxiety and achievement is complex, and that anxiety interacts with other aspects of affect that may increase or decrease its influence on achievement.

Several researchers have proposed expanding McLeod's model to include components of affect in addition to beliefs, attitudes, and emotions. DeBellis and Goldin (in Hannula, 2005) recommended the addition of values (including ethics, morals, and deep, personal truths) as a fourth component. Hannula and Zan et al (2006) proposed the addition of motivation as a fifth component with considerable implications for instruction. Various, sometimes competing, motivations affect a student's thoughts and actions. Neale (1969) looked to motivational and personality factors as trumping attitudinal factors in determining student achievement, citing research demonstrating that it is common for students with negative attitudes and beliefs toward mathematics to perform well in mathematics. Neale stated that:

> Modern mathematics programs, so far, have not changed the basic facts of life for children in school. Children must be there, like it or not; things must be learned, like it or not; children are evaluated, like it or not; and they have a boss, like it or not. (p. 639)

The motivation (or lack of motivation) to earn a good grade, whether motivated to please parents, teachers, or self, along with self-control to do what is required regardless of enjoyment, were found to be more strongly correlated than any attitudinal factor studied (Neale).

Some researchers have called for abandoning the positive/negative dichotomy associated with attitudinal research in favor of qualitative research that describes each subject's attitudes in narrative form (DiMartino & Zan, 2001; Hannula, 2002; Zan & DiMartino, 2007). Others question the very existence of beliefs and attitudes as constructs that exist within the subjects of research, suggestion that these may be constructs developed in the mind of the researcher, biased toward his or her sensitivities, imposed upon the subject after the action attributed to said beliefs or attitudes (Ruffell et al., 1998).

Measuring Affective Relationship with Mathematics (ARM)

Despite calls for the research into ARM to take a more qualitative approach (McLeod, 1994), researchers continue to attempt to quantify affective factors. Several tools have been developed over the last half century to aid researchers in quantifying the constructs of ARM (Dwyer, 1993).

Zan and DiMartino (2007) noted that an emotion should be deemed positive when it leads the person experiencing that emotion to a sense of pleasure. Research attempting to measure emotions toward mathematics, however, has been sparse (Zan et al., 2006). Such measurement is likely restricted to the measurement of physiological responses, observation of expressive displays of emotion, and in-the-moment interviewing, as survey tools inherently measure the disposition toward emotions (attitudes) rather than emotions (Hannula, 2002).

Dutton (1954) was among the first to develop a survey instrument to measure attitudes toward arithmetic. Dutton asked over 600 prospective teachers to write statements regarding their feelings toward arithmetic, both positive and negative. Utilizing the method prescribed by Thurstone and Chave (in Dutton), 22 statements were selected and scaled. Factors addressed in the final questions include avoidance, enjoyment, confidence/fear, value, motivation (Dutton). The Dutton Scale has been revised twice and is still used by some researchers (Dwyer, 1993; Kolstad et al. 1994).

Aiken and Dreger (1961) sought to develop a scale to measure attitudes toward mathematics utilizing a Likert-type scale. Starting with paragraphs written by 310 college students about their attitudes toward mathematics, Aiken and Dreger (1961) developed a 20-item Likert-type scale instrument called the Mathematics Attitude Scale. This instrument was revised by Aiken (1972) and is referred to as the Revised Mathematics Attitude Scale (RMAS). The RMAS consists of 10 positively-worded and 10 negatively-worded items covering factors such as enjoyment, security, and interest (Aiken, 1972). The RMAS is still in use by researchers (Dwyer, 1993; Rech et al., 1993). Aiken (1974) later developed a tool consisting of two 20-item surveys on a Likert-type scale. The E Scale was designed to measure enjoyment of mathematics, and the V Scale was designed to measure the value of mathematics.

Fennema and Sherman (1976) developed an instrument consisting of nine components: (a) Mathematics Anxiety Scale, (b) Attitude Toward Success in Mathematics Scale, (c) Effectance Motivation in Mathematics Scale, (d) Usefulness of Mathematics Scale, (e) Confidence in Learning Mathematics Scale, (f) Mathematics as a Male Domain Scale, (g) Mother's Attitude Scale, (h) Father's Attitude Scale, and (i) Teacher's Attitude Scale. While this instrument was initially designed for use in research on gender differences in mathematics education, it has been utilized in a variety of settings

(McLeod, 1994). Several researchers, however, have questioned the validity, reliability, and factor structure of this scale (Tapia & Marsh, 2004).

Seeing the need for a tool designed specifically to measure "anxiety associated with the single area of the manipulation of numbers and the use of mathematical concepts," Richardson and Suinn (1972) developed the Mathematics Anxiety Ratings Scale (MARS). The MARS consists of 98 items in which the subjects are given academic or real-life situations (such as "adding two three-digit numbers while someone looks over your shoulder" [Richardson & Suinn, p. 552]) and asked to rate the level of anxiety they would expect to feel in those situations. The MARS is the most commonly used self-reporting assessment in research concerning mathematics anxiety (Zan et al., 2006).

Tapia and Marsh (2004) developed the Attitudes Toward Mathematics Inventory (ATMI) to assess the aspects of attitude that researchers had recently addressed as being important. These factors included confidence, anxiety, value, enjoyment, motivation, and parent/teacher expectations. Factor analysis in high school and college populations revealed only four independent factors: confidence/anxiety, value, enjoyment, and motivation (Tapia & Marsh, 2002, 2004). The ATMI has also been utilized in a format revised for assessing attitudes of teachers (Smith, 2000).

Beliefs are said to be positive if they are shared by experts in mathematics (Zan & DiMartino, 2007). Pachnowski (1997) set out to devise a scale to measure beliefs about mathematics. Using prospective teachers' responses to "What is mathematics?" essays, Pachnowski identified key nouns and adjectives defining the nature of mathematics. Some of these were placed with their "opposites" in a Likert-type format. For example, “Math is an art,” and “Math is a science,” were placed at opposite ends of a spectrum. Study participants were also asked to choose and rank from these and additional words which top five that described what mathematics is and the top five that described what mathematics is not (Pachnowski, 1997).

Perry, Vistro-Yu, Howard, Wong, and Fong (in Perry, Way, Southwell, White, & Pattison, 2005) developed a belief scale for teachers where respondents were asked to agree or disagree with 18 various statements, such as, “Mathematics learning is enhanced by challenge within a supportive environment” (Perry et al., 2005).

Several researchers have pointed out the problems with utilizing self-report tools, such as those described above, to measure attitudes and beliefs. First, it is only possible to measure espoused beliefs (and not subconscious beliefs) with such devices (Ruffell et al., 1998). Second, respondents may intentionally or unintentionally provide the answers that they believe make them look better (Sierles, 2003). DiMartino and Zan (2001) warn researchers to avoid using a tool that measures beliefs as a way to assign positive or negative attitudes. A belief that may lead one person to positive emotions or behaviors may lead another to negative emotions or behaviors (DiMartino & Zan). In addition to survey tools, researchers have looked to symbolic drawings (Rule & Harrell, 2006), concept maps, and journals (Tuft, 2005) as ways to measure ARM.

The Impact of ARM on Student Learning

Those who support the idea that educators should be concerned with student ARM may do so because they believe that a positive ARM has a positive impact on student achievement (Aiken, 1972; Lehmann, 1987; Woodard, 2004), or because they believe that having a positive ARM is itself an important goal of the mathematics classroom (Hannula, 2005; NCTM, 2000).

Many educators and researchers believe that student ARM and achievement are highly related. Aiken (1972) concluded that "...the correlation between attitudes and achievement is frequently higher for mathematics than for school subjects with more verbal content" (p. 231). Lehmann (1987) stated that, "To change another person's attitudes is notoriously difficult. Nonetheless, the attempt to do so should not be abandoned, nor should it be considered outside the scope of any instructor's task...[as it]...may come between ability and achievement" (p. 10).

In a meta-analysis of 113 primary studies that sought to explore the relationship between ATM and achievement, Ma and Kishor (1997) found mixed results both supporting and rejecting a relationship between attitudes and achievement in mathematics. When the study subjects were combined, Ma and Kishor found an overall positive, but weak, relationship between the two parameters. Attitudes showed a slight impact on achievement, but achievement showed almost no impact on attitudes. Ma and Kishor believe, however, that these effect sizes are actually more pronounced than they appear in these studies. Ma and Kishor point to poor attitude scales and a lack of attention to mediating variables as leading to an under-estimation of the size of the relationship. In a different meta-analysis of 26 studies focusing specifically on the relationship between the mathematics anxiety factor of ATM and achievement, Ma (1999) found a significant negative correlation (high anxiety correlated with lower achievement).

Ma and Xu (2004) attempted to determine the causal ordering between ATM and achievement. They found that achievement had causal predominance over attitude, especially for average and below-average mathematics students. However, Ma & Xu noted that the relationship was reciprocal, and that,

> ...there are also some opportunities for mathematics educators to use attitude toward mathematics to promote achievement in mathematics, particularly in senior high school grades. This effort may well be worthwhile in that attitude and achievement are in a positive (mutually beneficial) reciprocal interaction among these students. Therefore, an initial effort to improve attitude (in late junior or early senior high school grades) can have a far-reaching impact into the circle of attitude and achievement. (p. 277)

While the relationship between ARM and achievement in mathematics may not be clear, many mathematics educators believe that building positive ARM in students is an important goal, regardless of its impact or lack of impact on achievement (Hannula, 2005). If one goal of mathematics education is to help students to establish a positive ARM, these goals must be directly addressed, as they will not naturally occur as a result of achievement-oriented goals (Neale, 1969.)

Parents Impact Attitudes Toward Mathematics

In interviews with college freshmen, Poffenberger and Norton (1956) found that parents had a substantial impact on student attitudes toward mathematics. Parent influence appeared to take three forms. The first form involves expectations. Students whose parents expected less from them in the area of mathematics than in other content areas tended to perform poorly in mathematics coursework. Encouragement was the second form of influence. Even if parents, themselves, held negative attitudes toward mathematics, their children could still be positively affected if the parents had a positive attitude toward the child's mathematical learning. The third form of influence involves direct transmission of attitude through family interaction. For example, a parent's comments about liking or disliking mathematics, or a parent's positive or negative comments about performing mathematical tasks at home or at work (Poffenberter & Norton).

Eccles and Jacobs (1986) followed 164 students through their seventh, eighth, and ninth grade years. Students, their parents, and their teachers were surveyed in each year. A path analysis revealed that the value a student places on mathematics is partially directed by both parents' views of the value of mathematics and by the mother's perception of how difficult math is for the child (Eccles & Jacobs).

Eccles and Jacobs (1986) stated that, "...parents' gender-stereotyped beliefs are a key cause of sex differences in students' attitudes toward mathematics" (p. 375). Parents have been shown to perceive their sons as having less difficulty in mathematics and more interest in the subject than their daughters, even after actual ability is factored out (Eccles & Jacobs). These beliefs are often expressed indirectly through actions such as offering unsolicited assistance with mathematics homework (which may indicate a lack of faith in a daughter's abilities) or the purchasing of mathematics-related gifts (Jacobs & Bleeker, 2004).

Teachers Impact Attitudes Toward Mathematics

In their interviews, Poffenberger and Norton (1956) found that individual teachers could have dramatic impact on their students' attitudes toward mathematics. Anecdotal evidence appeared to indicate that one poor mathematics teacher may have the power to turn a student off of mathematics, while one good teacher may have the power to bring a student with poor ATM back to the subject (Poffenberger & Norton). The latter conclusion was soon supported by Tulock (1957) who detailed her success in helping students with severe mathematics anxiety to develop positive attitudes toward the subject.

Poffenberger and Norton (1956) described the traits of a teacher who has the ability to lead students to a positive ATM. Such a teacher, they say, should have "a good knowledge of the subject matter, strong interest in the subject, the desire to have students understand the material, and good control of the class without being strict" (p. 116). Tulock (1957) detailed 15 techniques that such a teacher can use to affect positively those with negative attitudes. These techniques include creating opportunities for the student to experience success, showing a genuine interest in the student's success, and avoiding behaviors that belittle the student or his or her efforts (Tulock).

Banks (in Aiken, 1972) described the contrasting effect of a teacher who has a negative ARM:

> ...by far the most significant contributing factor [to an unhealthy attitude toward arithmetic] is the attitude of the teacher. The teacher who feels insecure, who dreads and dislikes the subject, for whom arithmetic is largely rote manipulation, devoid of undestanding, cannot avoid

> transmitting her feelings to the children...On the other hand, the teacher who has confidence, understanding, interest and enthusiasm for arithmetic has gone a long way toward insuring success. (p. 232)

As research into the effect of teachers on student attitude has progressed, researchers have continued to conclude that "teachers' attitudes and effectiveness in mathematics are viewed as being prime determiners of students' attitudes and performance in the subject," (Aiken, 1972, p. 232). Eccles and Jacobs (1986) found in their path analysis that teachers carried an equal weight with parents in influencing student self-concept in mathematics. Other studies indicate that teachers have a stronger impact than parents. Wilkins and Ma (2003) concluded that "the perceived encouragement from teachers consistently predicted positive status and slower decline in student attitude toward mathematics and was the only significant predictor of change in attitude during the middle school years" (p. 60).

Effects of ARM on Teaching

Schofield (1981) had concluded that teacher ARM positively impacted student achievement through changes in the structure and quality of teaching, rather than through student attitudes. Trice and Ogden (1987) sought to determine differences in pedagogical practice among teachers with high levels of mathematics anxiety and those with lower levels of mathematics anxiety. In this study, 40 first-year elementary school teachers were asked to take a battery of surveys, which included a Revised MARS and tools that were not mathematics related. These teachers were asked to provide their lesson plans over a three-week period and were observed in their classrooms during this time, never being told that the focus of the study was on mathematics (Trice & Ogden).

After analyzing the results, Trice and Ogden (1987) found that those teachers in the upper quartile of mathematics anxiety scheduled an average of 11.5 less minutes per day for mathematics instruction than other teachers, averaging under 50 minutes of instruction. Of this shortened allotted time segment, these same teachers were observed utilizing only 63% in mathematics-related instruction or activities (Trice & Ogden).

In an effort to determine differences in teaching styles between those with positive ATM and those with negative ATM, Karp (1991) selected and observed two teachers with highly positive ATM (one from fourth grade, and one from sixth grade), and two teachers with highly negative ATM (one from fourth grade, and one from sixth grade). While all four teachers had similar backgrounds and similar students, those with positive attitudes appeared to use differing instructional techniques. As stated by Karp, "...teachers with negative attitudes toward mathematics employed methods that fostered dependency whereas teachers with positive attitudes were found to encourage student initiative and independence" (p. 266).

More specifically, teachers with negative ATM focused their lessons on rules and algorithms to be memorized and used to produce the correct answer. Concepts were not developed. Student contributions during instruction and demonstration were limited to simple computation within more complex concepts, if requested at all. During student practice periods, students generally worked on worksheets that gave no instructional assistance, but simply required students to solve problems and ask the teacher for assistance if a step was forgotten. In these situations, teachers were often seen performing the step for the student, rather than asking the student to think through the process. Karp (1991) describes these methods as leading students toward learned helplessness.

In contrast, teachers with positive ATM:

> ...nurtured independent learning skills through teaching heuristics and strategies, presenting active demonstrations, and by using representations and materials rather than a lockstep procedure presented as an abstract rule. They modeled persistent behaviors themselves and provided opportunities in which students could persist in their efforts until they met success or reached the goal of the lesson, thus giving the students proof their efforts have a positive impact on learning outcomes. (Karp, p. 269).

Teaching methods, Karp (1991) concluded, may vary greatly based on the ATM of the teacher. These variations affect student understanding of mathematics content and student independence in learning mathematics content (Karp).

Elementary Teachers' Affective Relationships with Mathematics

The influence that teachers have over student achievement and student attitudes in mathematics appears to be influenced by both teachers' understanding of mathematical content (common knowledge and knowledge for teaching) and teachers' Affective Relationships with Mathematics (Poffenberger & Norton, 1956; Schofield, 1981). This, along with anecdotal evidence that elementary school teachers have poor attitudes toward mathematics, has led several researchers to seek information about the attitudes which elementary school teachers hold (Higdon, 1975; Rech et al., 1993).

Utilizing the model proposed by McLeod (1992), ARM is composed of beliefs, emotions, and attitudes. Attitudes may further be broken down into components, such as self-confidence/anxiety, enjoyment, and value (Tapia & Marsh, 2004), or scored as a whole. The following studies provide insight into the beliefs and attitudes of elementary school teachers.

In a study of 289 prospective elementary teachers, Dutton (1954) found that 20% identified themselves as having overall negative feelings toward mathematics. Meanwhile, 39% of respondents felt unsure of their ability to perform arithmetic operations, 38% expressed a dislike for word problems, and 29% expressed fear of doing word problems (Dutton).

Kelly and Tomhave (1985) compared the mathematics anxiety of prospective elementary teachers with freshmen who had taken no college preparatory mathematics and seniors who had taken no mathematics courses in college. The latter two groups may be considered “math avoiders”, and math avoiders usually have a higher rate of mathematics anxiety than the general population (Kelly & Tomhave). Kelly and Tomhave found that the prospective elementary school teachers studied had higher levels of mathematics anxiety than either of the two avoider groups. In fact, of the 43 elementary education majors in the study, 37 also fell into one of the avoider groups (Kelly & Tomhave).

Wood and Floden (1990) surveyed 319 college elementary education majors regarding their beliefs about mathematics. Of these, only 62% believed that, if they gave their full effort, they would be capable of learning advanced mathematics (Wood &

Floden). Also, only 66% expressed a belief that to be good in mathematics requires hard work (Wood & Floden). Wood and Floden speculated that these responses indicate an underlying belief that mathematical ability is innate, on contrast to the espoused belief that any student can learn mathematics. This speculation was backed up by Frank (1990), whose survey of 131 prospective elementary teachers found that 63% agreed with the statement that “some people have a math mind and some don’t” (p. 11). The presence of this belief in so many teachers takes on great importance when viewed through Eccles’ and Jacobs’ (1986) findings linking a teacher’s beliefs about a student’s ability and that student’s own self-concept.

In a meta-analysis of studies in which the MARS tool was utilized to assess mathematics anxiety in college students and in which the majors of the students were identified, Hembree (1990) determined that elementary education majors exhibited a higher level of anxiety (m = 219.2) than any other major. Students majoring in the humanities had the next highest mean score of 198.5. In a meta-analysis of studies where the MARS was administered within a specific mathematics class, Hembree (1990) found that the MARS scores in Mathematics for Elementary Teachers courses (m = 243) were higher than those in any other course, including Developmental Mathematics (which had the next highest mean at 236.3). In another study, Cady and Reardan (2007) found 34% of 47 students in a methods course at the University of Tennessee had high levels of mathematics anxiety.

Rech et al. (1993) gave Aiken’s Revised Math Attitudes Scale (RMAS) to 171 prospective elementary teachers and compared the results to a normative group of 1054 college students who were given the RMAS in another study. The elementary education majors had a mean score of 36.63, on a scale ranging from zero (extremely negative ATM) to 80 (extremely positive ATM). The general population had a mean score of 45.39. Assuming that a score of 40 indicates a neutral attitude toward mathematics, a general college population would be expected to have a slightly positive mean attitude toward mathematics, while the elementary education population showed a slightly negative mean attitude toward mathematics (Rech et al.).

While there are numerous studies that assess the ARM of prospective teachers, there are few that assess the ARM of in-service teachers. In one such study, Higdon (1975) gave Aiken's RMAS to 724 prospective and 284 in-service elementary school teachers in the Houston area. Prospective and in-service teacher groups in the study both had mean scores indicating a slightly positive ATM, with in-service teachers (m = 50.19) indicating significantly higher attitudes than prospective teachers (m = 46.55). Among the in-service teachers surveyed, years of experience did not significantly correlate to ATM. Among both groups, those who taught or were expecting to teach in grades four to six had significantly higher attitudes than those who taught or expected to teach in grades kindergarten through 3.

Kolstad et al. (1994) gave the Dutton Attitude Scale to 84 teachers of grades kindergarten through four enrolled in a methods course. Thirty-four percent of these teachers had a negative or strongly negative attitude toward arithmetic, 23% had neutral attitudes, and 43% had positive or strongly positive attitudes (Kolstad et al.).

ARM and the Experienced Teacher

The First-Year Teacher and ARM - A Discrepancy of Beliefs

Student achievement in mathematics has been shown to be positively correlated to teacher ARM (Alci & Erden, 2006; Schofield, 1981; Van de Walle, 1973). While teacher preparation programs may seek to address teacher ARM, researchers continue to note that, at least in the area of mathematics, the training that takes place in teacher education programs has a much smaller impact on practice than does the new teachers' experiences prior to and after these programs (Cady, Meier, & Lubinski, 2006; Cooney, 1985; Ernest, 1989; Sullivan & Leder, 1992).

Cady et al. (2006) demonstrated how even extensive pre-service mathematics training may lose its influence once participants enter the work force. In the first year of this study, Cady et al. worked with experienced teachers to develop an understanding of and to implement Cognitively Guided Instruction (CGI). In the second year of the study, pre-service teachers were taught about CGI and spent time in the classrooms of the inservice teachers to become comfortable with CGI in a real-world setting. Despite espousing beliefs about the nature of mathematics and about the teaching and learning of mathematics that were supportive of CGI, the pre-service teachers enacted a traditional transmission-style teaching once in their own classrooms (Cady et al.).

Ernest (1989) credited this often-observed discrepancy between espoused and enacted beliefs with the "constraints and opportunities provided by the social context of teaching" (para 9). Sullivan and Leder (1992) split these constraints and opportunities into school-level influences and classroom-level influences. One major school-level influence involves security. New teachers wish to be accepted by their peers, and they see conforming to their peers' teaching methods as one way to ensure acceptance (Sullivan & Leder). New teachers are also concerned with ensuring that their classrooms appear to be under control at all times - a goal that is most easily met with transmission-style instruction and task-oriented assignments (Sullivan & Leder). While the new teacher may carry the belief that teaching through problem-solving and concept development is best, he or she may feel a pressure to utilize the traditional style of teaching that parents, the principal, and co-workers expect (Ernest, 1989).

Another school-level influence that may lead to a discrepancy between espoused and enacted beliefs is the usage of standardized and high-stakes testing (Ernest, 1989). In a nation-wide survey of teachers, Abrams, Pedulla, and Madaus (2003) found that 76% of teachers in states with high-stakes testing and 63% of teachers in states with low-stakes testing indicated that they felt enough pressure to produce results on standardized tests to teach in ways that contradict what they believed to be sound educational practices. In describing the effects that standardized tests have on teachers, Smith (1991) described as "alienation" and "dissonance" the conflict that teachers face when forced to act against their professional judgement to improve performance on external tests, especially when the test is perceive to have little educational value.

Standardized curriculum, textbook choices, and materials available constitute a third school-level factor (Ernest, 1989). In their study of seven first-year teachers, Sullivan and Leder (1992) found that all seven new teachers indicated the textbook and available materials as one of the greatest influence on their instructional choices. Together, these school-level constraints:

> ...lead the teacher to internalise a powerful set of constraints affecting the enactment of the models of teaching and learning mathematics. The socialisation effect of the context [of the school] is so powerful that despite having differing beliefs about mathematics and its teaching, teachers in the same school are often observed to adopt similar classroom practices. (Ernest, para 12)

Classroom-level influences may include student expectations. Sullivan and Leder (1992) found that, while new teachers did not list student reaction as influencing their teaching methods, interviews indicated that student reaction was the most significant factor influencing teachers to alter or maintain instructional methods. For students who have experienced mathematics primarily within the transmission model, problem-solving or constructivist models of instruction may be discomforting (Cooney, 1985). Students may not know what is expected of them (Sullivan & Leder) or may believe that the teacher is wasting their time (Cooney). Unsure of what is expected of them, students may seek to complete what is required with minimal thought and work. This result may encourage a teacher to return to a more traditional approach, where he or she can see that tasks are complete.

After the First Year

While the first year of teaching sees new teachers teaching against their espoused beliefs about the nature of mathematics teaching and learning, does experience alter the beliefs carried by these teachers? Cady et al. (2006) noted that after the first or second year of teaching, most teachers were able to put security issues aside. However, only those with an "internal locus of control" utilized their new confidence to address the discrepancies between their espoused and enacted beliefs about how mathematics was taught in their classrooms (Cady et al., 2006). While this study looked for the enactment of beliefs five years after those beliefs were espoused, it did not attempt to identify if changes in those beliefs occurred during those five years.

Little research has focused on the relationship between experience and ARM. Rowan et al. (2002) found that teacher experience had a positive impact on student growth in mathematical achievement, but no intermediate variable (ATM, classroom management, content knowledge, etc.) was identified. In fact, states may vary greatly in regard to the correlation between experience and student achievement. Idaho showed a significant (r = - 0.7) negative correlation between the two factors, leading to speculations about how experience might negatively impact teacher ATM (Howell, 2006).

In Higdon's (1975) study, in-service teachers indicated a more positive ATM than prospective teachers. However, the length of experience of the in-service teachers did not seem to correlate to ATM (Higdon), and prospective teachers were not re-surveyed after gaining experience to determine if their attitudes improved. While little may be known about the change in ATM that takes place, it is clear that a non-trivial portion of active teachers retain or gain negative ATM (Kolstad et al., 1994).

Creating Change in In-Service Teacher ATM

Despite the lack of current quantitative data regarding the ATM of in-service teachers in Illinois, the high incidence of negative ATM in pre-service and in-service elementary teachers nationwide (Dutton, 1954; Higdon, 1975; Kelly & Tomhave, 1985; Kolstad et al., 1994; Rech et al., 1993), along with evidence that teacher ATM impacts the quality of their instruction (Karp, 1991; Schofield, 1981; Trice & Ogden, 1987), suggest that educational service agencies responsible for professional development and services need to develop one or more methods of supporting a positive ATM among elementary school teachers.

Changing Beliefs in Methods Courses

One approach utilized by researchers (primarily with pre-service teachers) is to utilize one or more Methods of Teaching Mathematics course(s) to promote directly or indirectly positive beliefs about mathematics. Several researchers have focused on changing particular beliefs about the nature of mathematics or how mathematics is learned by teaching mathematical concepts through constructivist or problem-solving means (Benbow, 1993; Emenaker, 1996; Steele, 1994; Szydlik, Szydlik, & Benson, 2003). These studies reflect the belief that through teaching them in a certain way, teachers can change their beliefs and are subsequently prompted to change their own teaching (Steele), or that teaching in such a way will give participants the experience needed to support beliefs they may already have (Benbow). Results of such studies have been mixed, with some claiming to have successfully impacted the target beliefs (Steele; Szydlik et al.), some claiming partial success by impacting a portion of the target beliefs

(Benbow; Emenaker), and one proposing that changes only occurred among A-level and B-level students (Emenaker). None of these studies provided longitudinal evidence that beliefs remained after pre-service teachers entered the workforce.

Changing Attitudes in Methods Courses

Others have attempted to utilize methods courses to alter ATM (Squire et al., 1981; Tuft, 2005). Tuft sought to help the participants in one course to alter their perspectives from those of students of mathematics to those of a future teachers of mathematics, while utilizing a constructivist style. Tuft found that prospective teachers experienced an improvement in attitude toward mathematics and in attitudes toward teaching mathematics, specifically citing gains in confidence and excitement about teaching the subject.

Squire et al. (1981) split the sections of a Math Curriculum and Instruction course so that some of the students experienced the class in a lecture format, while others experienced the class in a lab/seminar format. The ATM of participants was measured at the beginning and ending of the class. Those participants who began the course with a low ATM tended to leave the class with a higher ATM if they received the class in lecture format, but with even lower ATM if they received the lab/seminar format. Those who entered the class with middle-level ATM tended to experience the opposite results, with ATM levels dropping among those who received the lecture format and increasing among those who experienced the lab/seminar format. Squire et al. recommend that those offering such courses consider the option of providing a separate section designed for those with low ATM, providing more instructor direction than in other sections.

In addition to impacting beliefs and general ATM, such courses can also be used to reduce levels of math anxiety. Harper and Daane (1998), Sloan et al. (1997), and Vinson (2001) all reported overall decreases in mathematics anxiety after pre-service teachers complete a mathematics methods course. However, Harper and Daane (1998) caution that some participants who have not had experience with manipulatives or with problem-solving may experience an increase in math anxiety if these are stressed within the course.

After reviewing 33 studies where researchers attempted to alter beliefs or attitudes through the use of more constructivist instructional methods, Muis (2004) concluded that such techniques are promising. However, Muis pointed out that it is unknown if any of the noted changes hold in these studies once the participants leave the course. The timing of such coursework is also important. Cady et al. (2006) recommended that such courses be provided to active teachers in their second or third year of teaching, after they have had an opportunity to become comfortable and confident in the school and in their classrooms.

Reflection

While the above approaches propose implicitly altering teacher beliefs and ATM through experiences that challenge their existing beliefs and ATM, several researchers have pointed out a need to have prospective and in-service teachers explicitly reflect on their beliefs and attitudes (Cady et al., 2006; Ernest, 1989). This process involves asking teachers to reflect on prior experiences that may have led to those beliefs and attitudes (Carroll, 1998), to reflect on their own instruction in light of their beliefs (Carroll;

Cooney, 1985; Ernest), and to gain a meta-cognitive perspective of their attitudes and emotions (Cohen & Leung, 2004).

Math Mentor / Peer Collaboration

Carroll (1998) concluded that in-service teachers can get the most out of self-reflection when they do so in conjunction with a more knowledgeable math mentor. Other researchers have looked to math mentoring or math coaching as a way to increase teacher satisfaction and retention (Gschwend & Moir, 2007; NCTM, 2000). Others have promoted peer collaboration as a way to improve teacher satisfaction and instruction (Cordingley, Bell, Rundell, & Evans, 2003; Miles & Darling-Hammond, 1997).

Conclusion

The research included in this chapter indicates that improvement is needed in mathematics education in the United States and that teacher-level factors offer the most practical and direct route to this improvement. Teacher knowledge of mathematics and Affective Relationship with Mathematics have surfaced as the teacher-level variables most often explored in the research. However, little research has examined the ARM of in-service teachers. Even less is known concerning the role of experience as a teacher in changing a teacher's beliefs, attitudes, and emotions related to mathematics. Possible interventions were also explored. In the next chapter, a methodology will be developed for studying the role of experience in evolving teacher attitudes toward mathematics.

CHAPTER III

METHODOLOGY

Introduction

An important aspect of the doctoral program in which this dissertation was written was the requirement that dissertations provide valuable information that had immediate implications within the researcher's sphere of influence. The researcher in this study had the ability to influence professional development offerings and services in Blue County, Green County, and Orange County in Northern Illinois.

In Chapter 2, a need was established for more information about the affective relationship that veteran elementary school teachers have with mathematics and about the aspects of experience that alter this relationship. To stay within the realm of the researcher's sphere of influence, the study was restricted to seeking the answers to these questions as they applied to the teachers of Blue, Green, and Orange counties.

Specifically, the following research questions were addressed:

1. Using an established assessment tool, what are the attitudes of veteran elementary education teachers in Blue, Green, and Orange Counties, Illinois toward mathematics?
    a. To what extent, if any, is there a relationship between attitudes and quantity of experience, between attitudes and types of experience, and between attitudes and post-certification training experience?

b. How do veteran teachers' current affective relationships with mathematics compare with their perceptions of their own affective relationships with mathematics prior to entering the classroom?

2. What factors do teachers self-identify as the leading post-certification causes of change in their attitudes toward mathematics?
3. What services, if any, do teachers believe that Educational Service Agencies may provide to facilitate positive ARM among elementary teachers?

Research Design

The research questions concern teacher attitudes, self-identified factors, and beliefs. According to Robson (2002), surveys provide a "…relatively simple and straightforward approach to the study of attitudes, values, beliefs, and motives" (p. 233). Self-administered questionnaire surveys are preferable to interview surveys when the researcher seeks to obtain data from a large number of participants and when full participant anonymity is necessary to promote honest responses (Robson).

To answer the research questions successfully, a large sample of teachers with varying experiences was required. Anonymity was vital, given that one might equate admitting to negative attitudes toward a school subject with an inability to teach that subject effectively, leading participants to rate attitudes as higher than they actually were. Anonymity was also important for protecting participants from a perceived danger in reporting negative beliefs about the support and services provided by their administration and regional agencies. For these reasons, a questionnaire-type survey was determined to be the most effective and efficient means by which to seek the answers to the research questions.

Survey Instrument Part 1 – My Math Experience

The first section of the survey was titled My Math Experience and consisted of 10 questions (Survey Question 1 through Survey Question 10) designed to provide the information necessary to answer Research Question 1a.

Survey Questions 1 and 3 asked participants for the number of years they had taught and the number of years they had taught mathematics. These questions were used to explore the correlations between amount of experience and current attitudes. Survey Question 2 asked participants for the number of years they had taught at their current grade level. This question allowed for an examination of the impact that experience with specific subject matter may have had on attitudes toward that subject.

Survey Questions 4 and 5 asked participants to list all grades in which they were currently teaching or had taught mathematics. Several pieces of interval data were derived from each of these questions, including: lowest grade level, highest grade level, range between highest and lowest grade level, and number of unique grade levels.

Survey Question 6 asked participants about the contexts in which they had had the opportunity to teach mathematics. The purpose of this question was to determine if teachers who have the opportunity to teach mathematics in a setting other than the self-contained classroom are positively or negatively impacted by those experiences.

Survey Questions 7 through 10 asked participants about training that they have received in mathematics or mathematics education after beginning their teaching careers.

The purpose of these questions was to determine if continuing education opportunities provided for practicing teachers have an impact on their attitudes, as well as to gain insight as to the effectiveness of such opportunities based on their length (workshops versus courses) and recency (based on the number of years since the most recent training.)

Survey Instrument Part 2 – My Personal Feelings About Math (As They are Today)

Survey Questions 11 through 30 are taken from Aiken's Revised Math Attitudes Scale (Aiken, 1963). As described in Chapter 1, three of these questions (SQ 11, SQ12, and SQ 28) were slightly modified to have meaning for teachers whether or not they had recently taken mathematics coursework. For each participant, these 20 questions produce a score ranging from zero (strong negative attitudes toward mathematics) to 80 (strong positive attitudes toward mathematics).

Survey Instrument Part 3 – Basic Demographics

Question 31 asked for the sex of the participant. This question was included to explore the difference in RMAS scores between male and female teachers, to determine if sex is related to perceived changes in attitudinal components, as well as to determine if various factors (Questions 41 through 46) affected the attitudes of male teachers differently than female teachers. It was also important to have this information available so that, if there were significant differences between males and females on attitudes, or if there were significant differences between males and females on the factors affecting those attitudes, and if male teachers were disproportionately represented in certain subgroups (e.g., the upper elementary grades versus the lower elementary grades), the researcher would have the option to exclude them from appropriate analyses.

Survey Question 32 asked participants to classify themselves as having earned their teaching certifications immediately after their schooling, later in life after raising a family, or later in life after pursuing another career. By determining if differences in ATM exist among these categories, teacher education institutions and hiring districts may be provided with guidance on how to direct their limited resources. This question was also used to determine if the teachers in these various classifications were differently impacted by various factors that might affect attitudes (Survey Questions 41 through 46).

Survey Question 33 asked participants for their current ages. This question was used to determine the relationship, if any, between age and RMAS score. This question was also used to determine if age played a role in determining how various factors influence one's ATM (with Survey Questions 41 through 46).

Survey Instrument Part 4 – Changes in My Personal Feelings About Math

Survey Questions 34 through 38 asked participants to consider five key components of ARM and their perceived changes over time in each of these components. Specifically, they were asked to rate their enjoyment of math, their confidence with math, their understanding of elementary school math, their belief that math is intrinsically valuable, and their belief that math is extrinsically valuable both as they believe it was prior to entering the classroom and as it is now. These questions were used to explore the changes over time due to experience, as well as to explore any links between initial levels in these areas and the impact that various influencing stimuli (Survey Questions 41 through 46) have on teachers. For example, is a teacher who has low confidence with math more likely to be negatively impacted by instructional feedback from the principal than a teacher who begins his or her teaching career with high confidence?

Survey Questions 39 and 40 asked participants to identify the factor that has most affected their attitudes toward mathematics for the better or for the worse. Survey Questions 41 through 46 asked participants specifically about previously identified factors to determine if these had positive or negative affects on their overall ATM.

Survey Instrument Part 5 – Services

Survey Questions 47 through 59 were utilized to give immediate actionable information to the providers of continuing education in the three counties surveyed, including the schools, the districts, the local Education Service Agency, and the local colleges. The first two questions (SQ 47 and SQ 48) asked participants if these groups provided professional development opportunities that were helpful to them. The results of these questions may indicate a combination of the level of success of these providers in providing needed offerings and the level of success of these providers in making teachers aware of offerings that do exist.

Survey Questions 49 through 57 ask participants to indicate the extent to which they believe they would benefit from various professional development offerings. In addition to looking at these results on the whole (for actionable information), the researcher also searched for relationships between the level of desire for each of these interventions and the respondents' attitudes toward mathematics (for academically valuable information.)

Survey Questions 58 and 59 allowed respondents the opportunity to provide open-ended responses regarding the types of services that they would have liked to have received in their first two years of teaching and that they would like to receive now.

Population

All 142 elementary schools located within the three counties were invited to participate in this study. This included 24 from Blue County, 13 from Green County, and 105 from Orange County. Of these, 42 schools (29.6%) agreed to participate. Participating schools included 10 from Blue County (41.7% of those asked), seven from Green County (53.8% of those asked), and 25 from Orange County (23.8% of those asked).

Of the 42 schools participating, 36 are classified by the National Center of Educational Statistics (2008) with the location code "Urban Fringe of a Large City", five are considered to be "Rural", and one is considered to be in a "Mid-Size City". Demographic and salary information for these schools were generated from the Illinois Interactive Report Card (2009).

The seven participating schools within Green County include the five rural schools, as well as two others. Combined, these schools serve 2366 students, 17.0% of which are considered low-income students. Racially, there is little diversity, with 89.4% of students classified as White/Non-Hispanic. Only 0.1% of students in these schools are said to have Limited English Proficiency. Average class sizes range from five to 31 students. During Fiscal Year 2007, the districts represented by these schools reported instructional expenditures per pupil of between $3,166 and $5,374. It is important to note that some of these districts are K-12 districts, while others are elementary districts. Elementary districts and K-12 districts may differ in teacher pay, budget constraints, administrative priorities, or other important factors.

Teachers in Green County are also racially homogeneous, with 92.5% to 100% of teachers in the districts represented listed as White/Non-Hispanic. The teachers in these districts average 12.9 years of experience and have an average salary of $45,022.

The 10 participating schools within Blue County serve 5095 students, 14.8% of which are considered low-income students. Racially, the Blue County schools have much more diversity than the Green County schools, with 58.8% of students classified as White/Non-Hispanic, 21.1% Hispanic, 6.5% Black/Non-Hispanic, 5.9% Asian, and 7.7% Multiracial or Other. A total of 7.1% of students in these schools are said to have Limited English Proficiency. Average class sizes range from 16 to 26.3 students. During Fiscal Year 2007, the districts represented by these schools reported instructional expenditures per pupil of between $4,082 and $4,262. Blue County districts represented are K-12 districts.

Teachers in Blue County are also racially homogeneous, with 94.7% to 98.5% of teachers in the districts represented listed as White/Non-Hispanic. The teachers in these districts average 8.2 years of experience and have an average salary of $51,319.

The 25 participating schools within Orange County serve 10816 students, 15.8% of which are considered low-income students. In these schools, 72.7% of students are classified as White/Non-Hispanic, 12.9% are classified as Hispanic, 8.8% are classified as Black/Non-Hispanic, and 5.6% are otherwise classified. A total of 3.6% of students in these schools are said to have Limited English Proficiency. Average class sizes range from 11 to 31.3 students. During Fiscal Year 2007, the districts represented by these schools reported instructional expenditures per pupil of between $3,420 and $7,150. It is important to note that some of these districts are K-12 districts, while others are elementary districts.

Teachers in Orange County are slightly more racially diverse than in the other counties, with 81.3% to 100% of teachers in the districts represented listed as White/Non-Hispanic. The teachers in these districts average 9.8 years of experience and have an average salary of $44,144.

Data Collection

On March 16, 2009, the researcher mailed a packet to the building principal in each of the 142 elementary schools identified. Each packet contained:

- a cover letter explaining the purpose of the survey (Appendix B)
- a permission form (Appendix C)
- a self-addressed, stamped envelope in which to return the permission letter
- a sample of the packet that their teachers would be receiving (Appendices A, E, and F)

Over the next month (March 23, 2009 - April 14, 2009), permission forms were returned to the researcher in the self-addressed, stamp envelope that had been provided. As each permission form was received, an envelope was returned to the principal or his or her designee with distribution instructions (Appendix D) and enough teacher packets for every certified teacher in the building responsible for teaching mathematics. Teacher packets contained:

- a cover letter explaining the study (Appendix E)
- a monkey ruler/bookmark attached to the cover letter
- a copy of the survey (Appendix A)
- a brightly colored self-addressed, stamped envelope that matched the bookmark
- a self-addressed, stamped postcard the teacher could return separately to receive a set of bookmarks for his or her students (Appendix F)

Surveys were accepted through June 15, 2009, which was the last scheduled school date for any of the schools participating. In all, 275 surveys were received. Of those received, 235 surveys had all quantitative questions answered, and 40 contained at least one quantitative question that was unanswered. The two questions that were left blank by more than three participants were question 33 (“My current age is:”), which was left blank by six participants and question 56 (“I could teach math more effectively if my district provided a standard set of lesson plans to follow.”), which was left blank by eight participants. There were 10 participants who left one or more questions blank within the Revised Math Attitudes Scale (RMAS), making it impossible to determine their RMAS score.

Because no single survey contained more than two blank questions, it was determined that all of the 40 incomplete surveys would be included in the analysis. Individual surveys were excluded from individual tests when the test relied on a question that was left blank.

Survey results were entered into a FileMaker Pro database designed specifically for this survey. This intermediate step was taken between the paper survey and the SPSS software to enable data entry to follow the same format as the questionnaire, with checkboxes and radio buttons used on many questions. This data file was also used to calculate derivative data, such as the total RMAS score and the range of grade levels taught. Data from the FileMaker Pro file were then exported into SPSS for analysis.

Analytical Methods

Research questions were answered by using data to answer a series of subquestions through statistical methods to explore possible relationships. Research Question 1 asked about the current attitudes toward mathematics of elementary school teachers in Blue, Green, and Orange Counties. To quantify these attitudes, a score was calculated for each survey participant using the Revised Mathematics Attitudes Scale (Aiken, 1972). The minimum, maximum, median, mean, standard deviation, and skewness of scores were determined, as were the deciles.

Research Question 1a asked to what extent, if any, there is a relationship between attitudes and quantity of experience, between attitudes and types of experience, and between attitudes and post-certification training experience. To answer this question, a number of "Analysis Questions" were developed and are listed below.

The Relationship Between Attitudes and Quantity of Experience

The four factors surveyed that indicate quantity of experience included age (SQ 33), number of years of teaching experience (SQ 1), number of years teaching at the current grade level (SQ 2), and number of years of experience teaching mathematics (SQ

3). Because of the highly correlative nature of these four factors, a step-wise regression was run to determine if any of these variables, alone or in combination, correlated to RMAS score.

- Analysis Question 1a.1 - Are any of the four quantity of experience variables, alone or in combination, predictors of RMAS score? In order to determine this, a step-wise regression was run.

The Relationship Between Attitudes and Types of Experience

- Analysis Question 1a.2 - What, if any, is the difference between RMAS scores of those who currently teach math at a single grade level and those who currently teach math at multiple grade levels (SQ 4)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.3 - What, if any, is the difference between RMAS scores of those who have, in their careers, taught math only at one grade level and those who have had experience teaching math at more than one grade level (SQ 5)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.4 - Among those who are currently teaching math at a single grade level, what, if any, is the difference in RMAS scores among those who teach at various grade levels? Statistical method - one-way ANOVA.
- Analysis Question 1a.5 - What, if any, is the relationship between the lowest grade of math currently taught (SQ 4) and RMAS score? Statistical method - Pearson *r*.

- Analysis Question 1a.6 - What, if any, is the relationship between the lowest grade of mathematics taught during one's career (SQ 5) and the RMAS score? Statistical method - Pearson *r*.
- Analysis Question 1a.7 - What, if any, is the relationship between the highest grade of math currently taught (SQ 4) and RMAS score? Statistical method - Pearson *r*.
- Analysis Question 1a.8 - What, if any, is the relationship between the highest grade of mathematics taught during one's career (SQ 5) and the RMAS score? Statistical method - Pearson *r*.
- Analysis Question 1a.9 - What, if any, is the relationship between the range of grades in which one is currently teaching mathematics (SQ4) and the RMAS score? Statistical method - Pearson *r*.
- Analysis Question 1a.10 - What, if any, is the relationship between the range of grades of mathematics taught during one's career (SQ 5) and the RMAS score? Statistical method - Pearson *r*.
- Analysis Question 1a.11 - What, if any, is the relationship between the number of unique grades of mathematics currently taught (SQ4) and the RMAS? Statistical method - Pearson *r*.
- Analysis Question 1a.12 - What, if any, is the relationship between the number of unique grades taught during one's career (SQ 5) and the RMAS score? Statistical method - Pearson *r*.

- Analysis Question 1a.13 - What, if any, is the difference between RMAS scores of those who have only taught in a self-contained context and those who have had experience teaching mathematics in a departmentalized classroom (SQ 6)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.14 - What, if any, is the difference between the RMAS scores of those who have only taught in a self-contained context and those who have had experience co-teaching mathematics (SQ 6)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.15 - What, if any, is the difference between RMAS scores of those who have only taught in a self-contained context and those who have had experience teaching in a resource capacity (SQ 6)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.16 - Is there a significant difference in RMAS scores between male teachers and female teachers? Statistical method - independent samples *t*-test.
- Analysis Question 1a.17 - Is there a difference between the RMAS scores of those who earned their teaching certificates immediately after their schooling, those who pursued another career prior to pursuing their teaching certificates, and those who raised a family prior to earning their teaching certificates? Statistical method - one-way ANOVA.

The Relationship Between Attitudes and Training Experience

- Analysis Question 1a.18 - What, if any, is the difference between RMAS scores of those who have taken college coursework in mathematics or the methods of teaching mathematics since entering the classroom and those who have not (SQ 7)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.19 - Among those who have taken a college course in mathematics or the methods of teaching mathematics since entering the classroom (SQ 7), what, if any, is the correlation between the RMAS scores and the length of time since the last course was taken (SQ 8)? Statistical method - Pearson *r*.
- Analysis Question 1a.20 - What, if any, is the difference between RMAS scores of those who have taken a full-day workshop focused on mathematics since entering the classroom and those who have not (SQ 9)? Statistical method - independent samples *t*-test.
- Analysis Question 1a.21 - Among those who have taken a full-day workshop on mathematics since entering the classroom (SQ 9), what, if any, is the correlation between the RMAS scores and the length of time since the last workshop was taken (SQ 10)? Statistical method - Pearson *r*.

Research Question 1b asks for a comparison between teachers' current ARM and their perceptions of their ARM prior to entering the classroom. The researcher was concerned that asking participants to complete an entire RMAS as they believe that they would have completed it prior to entering the classroom would be unreasonable for most participants. Instead, survey questions 34 through 38 were used to seek participants' perceived changes over time in five key components of ARM - enjoyment, confidence, understanding, intrinsic value, and extrinsic value.

To examine research question 1b, the researcher explored each component of ARM thoroughly. A paired-samples *t*-test was used to determine if the perceived change was significant. Descriptive statistics regarding the change experienced by those with different starting levels were then discussed. Multiple regression analysis was then run on each of 20 experience factors drawn from the survey, using the experience factor as the independent variable, the "now" level of the component of ARM being explored as the dependent variable, and holding the "before teaching" level of the component constant. The results of the 20 regressions were then displayed in a table, with significant relationships indicated.

Research Question 2 asked what factors teachers self-identify as the leading post-college causes of change in their attitudes toward mathematics. Survey Questions 39 and 40 directly asked participants to identify factors that most positively and negatively influenced changes in their attitudes toward mathematics. The researcher and two assistants collaboratively coded responses. Frequencies were then calculated.

Survey questions 41 to 46 asked the participants to rate the influence that six particular stimuli have had on their attitudes toward mathematics. Percentages were calculated to determine the overall impact of these stimuli on teacher attitudes. Then, a series of multiple regression analyses were run to determine if relationships existed between the reaction to the stimuli and the 20 experience factors previously identified.

Research Question 3 asked what services teachers believed should be provided by their school, their district, or their regional professional development center. Survey Questions 47 to 48 asked questions about the level of professional development already provided by the region or school. Questions 49 to 57 asked to what extent the participants felt that they would benefit from particular services being offered or expanded. Percentages were calculated for questions 47 through 57.

In an effort to determine which, if any, services were sought more by those with negative attitudes toward mathematics, a series of multiple regressions were run on each of survey questions 49 through 57, looking at the relationship between the level of need for the service based on total RMAS score.

Survey Questions 58 and 59 were open-ended questions designed to elicit from teachers what services they would have liked to have received in their first two years of teaching (SQ 58) and would like to see at the present (SQ 59). Responses to these questions were coded in a similar fashion to Survey Questions 39 and 40 by the same individuals who coded those questions. Quantities of each response were reported.

Survey Question 60 allowed participants to make general comments regarding the survey. The comments made were generally "good luck with your survey" type comments and are not examined in the study.

Limitations

This study involved several limitations. First and foremost, this study contained the limitations that are inherent in self-reported survey data. The researcher attempted to reduce intentional misrepresentation by assuring the anonymity of the survey by not asking the participant to identify his or her school or district and by providing each participant with a self-addressed, stamped envelope in which to return the survey directly to the researcher. However, some participants may have felt the need to overstate their attitudes.

In addition to intentional misrepresentation, self-reported survey data also suffers from unconscious misrepresentation. A participant may answer a question based upon how he would like to be, rather than how he is.

Another limitation involves the voluntary nature of the survey. Each survey had to survive two levels of volunteerism - the principal, then the teacher. Despite the fact that schools were not indicated on the survey, it is possible that a principal may be more or less likely to assent to the survey given the attitudes of his or her teachers toward mathematics or the teaching of mathematics. Principals whose teachers are doing well in teaching mathematics may be prompted to participate in the study or, conversely, may fail to see the benefit of participating in the study. Similarly, principals whose teachers are not doing well in teaching mathematics may be prompted to participate because they see a future benefit or less likely to participate due to a fear of negative results.

Teacher participation was also voluntary, leading to yet another possible skewing of the results. One might suspect that those who volunteered to take the time to complete the survey would be more likely to be the most confident in their mathematical abilities, the least confident in their mathematical abilities, or the most conscientious teachers. It was hoped that the incentive of the bookmarks would somewhat offset this potential problem by making participation meaningful to the average teacher.

A third level of volunteerism that had not been anticipated by the researcher became apparent during the study. After most of the 42 principal permission forms were returned, there was an obvious lack of participation by two of the largest districts in Orange County. Upon further investigation, it was discovered that these districts had policies in place blocking the distribution of surveys to their teachers. Unfortunately, one of these districts was the district classified as a mid-sized city and represents the most urban area in the three counties, as well as the most diverse teaching force.

The timing of the survey may also have impacted results. In Illinois, students in grades 3 through 5 took the Illinois Standards Achievement Test, the standardized test used to determine if a school is meeting Adequate Yearly Progress, during the period of March 2 through March 13. Teacher attitudes toward mathematics immediately following a period of test preparation may be different than they would be during the rest of the year.

The cross-sectional nature of the study limited its usefulness in determining true change over time. Instead, the study focused on the teachers' perceived change over time. A teacher's ability to perceive his or her attitudes prior to teaching objectively or to perceive the causes of change objectively may be limited by his or her metacognitive abilities. The time limitations of this doctoral program did not make a longitudinal study feasible.

The cross-sectional nature of the study also requires caution when reviewing conclusions related to age or years of experience. Age itself may more accurately be a proxy variable for other variables that relate to the period of time in which participants grew up. For example, the group of teachers who were in elementary school during the period in which "New Math" was taught may have attitudes toward mathematics that are far different than those who are younger or older than they are. Other factors for which age may serve as a proxy include: respect for authority, value of education, societal views of the role of women and their ability to do mathematics, social acceptability of liking/ disliking mathematics, and the use of calculators in elementary school.

Lastly, the relative lack of participation by male teachers ($n = 10$) diminished the statistical power of tests run using the sex variable.

CHAPTER IV

FINDINGS AND CONCLUSIONS

Introduction

In Chapter 1, a need was established for studying the attitudes toward mathematics (ATM) of active elementary school teachers. Previous research indicated that those entering the field of elementary education may have a higher prevalence of negative ATM than the general public (Dutton, 1954; Hembree, 1990; Kelly & Tomhave, 1985; Rech et al., 1993) and that a teacher's ATM may affect student ATM (Aiken, 1972; Eccles & Jacobs, 1986; Wilkins & Ma, 2003) and student success in math (Alci & Erden, 2006; Schofield, 1981; Van de Walle, 1973). These findings, along with a lack of research into the impact that experience has on teacher ATM, suggested a need for exploratory research into the ATM of experienced teachers.

Specifically, the following research questions were addressed:

1. Using an established assessment tool, what are the attitudes of veteran elementary education teachers in Blue, Green, and Orange Counties, Illinois toward mathematics?
    a. To what extent, if any, is there a relationship between attitudes and quantity of experience, between attitudes and types of experience, and between attitudes and post-certification mathematics training?

b. How do veteran teachers' current Affective Relationship with Mathematics compare with their perceptions of their own ARM prior to entering the classroom?

2. What factors do teachers self-identify as the leading post-certification causes of change in their ARM?
3. What services, if any, do teachers believe that Educational Service Agencies may provide to facilitate positive ARM among elementary teachers?

In this chapter, the findings of the survey are given in the Findings section. In the Conclusions section, the results are parsed for interpretation and meaning. This is followed by the Implications and Recommendations section, which provides recommendations for practitioners and researchers in the field.

Findings

Research Question 1 first asked in general about the current attitudes of elementary school teachers in Blue, Green, and Orange counties toward mathematics. Of the 275 teachers who participated in the study, 10 did not fully complete the Revised Math Attitudes Scale (RMAS) portion of the survey and were, therefore, unable to be assigned an RMAS score. The RMAS had a very high internal reliability in this study, with a Chronbach Alpha of 0.977. Among the 265 who were assigned scores, scores ranged from a minimum of eight (extremely negative attitudes) to a maximum of 80 (extremely positive attitudes). The median score was 58, well above the score of 40 which would indicate neutral attitudes. The mean RMAS score was 56.64 (SD = 17.59).

A skewness statistic of -0.709, with an *ses* of 0.150 indicates that the distribution is negatively skewed, with a kurtosis statistic of -0.136 (see Figure 1).

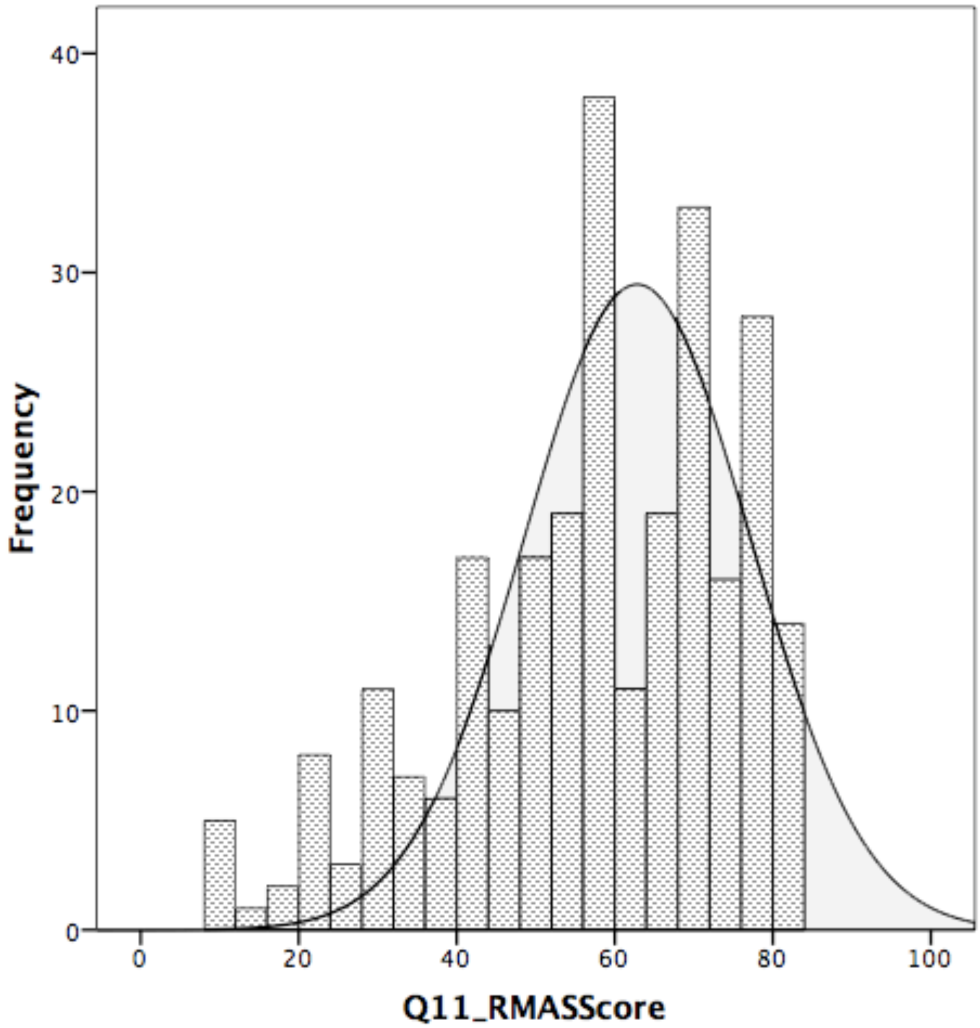


Figure 1. The distribution of RMAS scores (*n* = 265) shown with a normal curve.

Table 1 indicates the deciles for the RMAS scores among the 265 participants with RMAS scores. This table indicates that less than 20% of participants scored in the range of negative attitudes toward mathematics.

Table 1

Deciles of RMAS Scores Among All Participants with RMAS Scores (n = 265)

Decile	10	20	30	40	50	60	70	80	90
Score	30.0	42.0	50.0	55.4	58.0	64.0	68.0	73.0	78.0

Research Question 1a asked to what extent, if any, there was a relationship between teachers' current attitudes toward mathematics and their experience. Specifically, Research Question 1a asked about the relationship between between attitudes and quantity of experience, between attitudes and type of experience, and between attitudes and post-certification training.

Between ATM and Quantity of Experience

To explore the relationship between ATM and the quantity of one's experience, a step-wise regression analysis was performed on the four quantity of experience variables (number of years teaching, number of years teaching at the current grade level, number of years teaching math, and age). The analysis determined that the number of years a teacher has taught at the current grade level is the best indicator of teacher ATM a with positive relationship, $\beta = 0.210$, $t = 3.428$, $p < .001$.

Between ATM and Type of Experience

To explore the relationship between ATM and the type of experience a teacher has had, a series of possible relationships were explored.

What, if any, is the difference in RMAS score between those who are currently teaching mathematics at a single grade level and those who are currently teaching mathematics at multiple grade levels (AQ 1a.2)? To answer this question, an independent samples *t*-test was run to compare the RMAS scores of those who currently teach math at a single grade level (n = 241, M = 57.64, SD = 16.49) with those who currently teach mathematics at multiple grade levels (n = 23, M = 46.61, SD = 25.03) for the dependent variable of RMAS score. Levene's Test indicated that equal variances could not be assumed. The RMAS scores of the two groups were significantly different, r = -.38, t(23.858) = 2.071, $p < .05$.

What, if any, is the difference in RMAS score between those who have, in their careers, taught math only at one grade level and those who have had experience teaching math at more than one grade level (AQ 1a.3)? To answer this question, an independent samples *t*-test was run to compare the RMAS scores of those who have only taught math at one grade level (n = 101, M = 57.70, SD = 15.818) and those who have taught math at more than one grade level (n = 164, M = 55.99, SD = 18.619). Levene's Test indicated that equal variances could not be assumed. The RMAS scores of these two groups were not significantly different, t (237.411) = 0.800.

Among those who currently teach math at a single grade level, what, if any, is the difference in RMAS scores among those who teach at various grade levels (AQ 1a.4)? To answer this question, a one-way ANOVA was performed to compare the RMAS scores among those who teach kindergarten (n = 27, M = 54.44, SD = 19.017), first grade (n = 42, M = 57.00, SD = 14.855), second grade (n = 44, M = 56.73, SD = 14.045), third grade (n = 41, M = 54.22, SD = 20.776), fourth grade (n = 43, M = 61.16, SD = 15.334), and fifth grade ($n = 41$, $M = 60.46$, $SD = 15.012$). No significant difference was found among the groups, $F(5, 232) = 1.226$.

What, if any, is the relationship between the lowest grade of math currently taught (SQ 4) and RMAS score (AQ 1a.5)? To answer this question, a Pearson *r* correlation was run. A positive relationship was found between lowest grade of math currently taught and RMAS score, $r(262) = .149$, $p < .05$.

What, if any, is the relationship between the lowest grade of math taught in one's career (SQ 5) and RMAS score (AQ 1a.6)? To answer this question, a Pearson *r* correlation was run. A positive relationship was found between the lowest grade level taught in one's career and RMAS score, $r(263) = .150$, $p < .05$.

What, if any, is the relationship between the highest grade of math currently taught (SQ 4) and RMAS score (AQ 1a.7)? To answer this question, a Pearson *r* correlation was run. No significant relationship was found.

What, if any, is the relationship between the highest grade of math taught in one's career (SQ 5) and RMAS score (AQ 1a.8)? To answer this question, a Pearson *r* correlation was run. No significant relationship was found.

What, if any, is the relationship between the range of grades in which one is currently teaching (SQ 4) and the RMAS score AQ 1a.9)? To answer this question, a Pearson *r* correlation was run. A significant, negative relationship was found, $r(262) = -.234$, $p < .001$.

What, if any, is the relationship between the range of grades in which one has taught during his or her career (SQ 5) and RMAS score (AQ 1a.10)? To answer this question, a Pearson *r* correlation was run. No significant relationship was found.

What, if any, is the relationship between the number of unique grades in which one currently teaches (SQ 4) and his or her RMAS score (AQ 1a.11)? To answer this question, a Pearson *r* correlation was run. A significant, negative relationship was found, r (262) = -.245, $p < .001$.

What, if any, is the relationship between the number of unique grades in which one has taught during his or her career (SQ 5) and RMAS score (AQ 1a.12)? To answer this question, a Pearson *r* correlation was run. No significant relationship was found.

Is there a significant difference in RMAS score between those who have only taught math in a self-contained classroom and those who have experience teaching in a departmentalized classroom (AQ 1a.13)? To answer this question, an independent-samples *t*-test was run to compare the means of those who have taught math only in a self-contained classroom (n = 175, M = 54.43, SD = 17.618) and those who have had experience teaching in a departmentalized math classroom (n = 39, M = 65.49, SD = 16.321). A significant difference was found between the two groups, t (212) = -3.591, $p < .001$.

Is there a significant difference in RMAS score between those who have only taught math in a self-contained classroom and those who have experience co-teaching math (AQ 1a.14)? To answer this question, an independent-samples *t*-test was run to compare the means of those who have taught math only in a self-contained classroom (*n*

= 175, *M* = 54.43, *SD* = 17.618) and those who have had experience co-teaching math (*n* = 39, *M* = 62.79, *SD* = 12.064.) Levine's Test indicated that equality of variance could not be assumed. A significant difference was found between the two groups, *t* (78.821) = -3.566, *p* < .01.

Is there a significant difference in RMAS score between those who have only taught math in a self-contained classroom and those who have experience teaching math in a resource capacity (AQ 1a.15)? To answer this question, an independent-samples *t*-test was run to compare the means of those who have taught math only in a self-contained classroom (*n* = 175, *M* = 54.43, *SD* = 17.618) and those who have had experience teaching math in a resource capacity (*n* = 33, *M* = 56.58, *SD* = 19.794). No significant difference was found between the two groups, *t* (206) = -0.629.

Is there a significant difference in RMAS scores between male teachers and female teachers (AQ 1a.16)? To answer this question, an independent samples *t*-test was run to compare the means of male teachers (*n* = 9, *M* = 66.44, *SD* = 10.702) and female teachers (*n* = 255, *M* = 56.23, *SD* = 17.701). No significant difference was found between the two groups, *t* (262) = 1.719.

Is there a difference between the RMAS scores of those who earned their teaching certificates immediately after their schooling, those who pursued another career prior to pursuing their teaching certificates, and those who raised a family prior to earning their teaching certificates (AQ 1a.17)? To answer this question, a one-way ANOVA was performed to compare the RMAS scores of those who earned their teaching certificates immediately after their schooling (*n* = 211, *M* = 56.11, *SD* = 17.635), those who raised a family prior to earning their teaching credentials (n = 20, M = 61.90, SD = 16.167), and those who pursued another career prior to pursuing their teaching certificates (n = 33, M = 56.61, SD = 18.347). No significant difference was found among the groups, F (2, 261) = .985.

Between ATM and Training Experience

To explore the relationship between ATM and the type of training experience that teachers received after entering the field, a series of possible correlations were explored.

What, if any, is the difference between RMAS scores of those who have taken college coursework in mathematics or the methods of teaching mathematics since entering the classroom and those who have not (SQ 7) (AQ 1a.18)? To answer this question, an independent-samples t-test was run to compare the scores of those who have not participated in college coursework in mathematics (n = 176, M = 54.98, SD = 17.426) and those who have (n = 89, M = 59.92, SD = 17.558). A significant difference was found between the groups, t (263) = -2.173, $p < .05$.

Among those who have taken one or more courses in mathematics or the methods of teaching math since entering the classroom (SQ 7), what, if any, is the correlation between the RMAS scores and the length of time since the last course was taken (SQ 8) (AQ 1a.19)? To answer this question, a Pearson r correlation was performed for those who had taken such coursework (n = 88). No significant relationship was found between RMAS score and the length of time since the last college course was taken.

What, if any, is the difference between RMAS score of those who have attended a full-day workshop focused on mathematics since entering the classroom and those who have not (SQ 9) (AQ 1a.20)? To answer this question, an independent-samples *t*-test was run to compare the scores of those who have not participated in a full-day workshop on math (n = 129, M = 53.77, SD = 18.550) and those who have participated in such a workshop (n = 136, M = 59.37, SD = 16.236). A significant difference was found, t (263) = -2.619, $p < .01$.

Among those who have attended one or more full-day workshops related to mathematics since entering the classroom (SQ 9), what, if any, is the relationship between the RMAS scores and the length of time since the last workshop was attended (SQ 10) (AQ 1a.21)? To answer this question, a Pearson *r* correlation was performed for those who had attended such a workshop (n = 138). No significant relationship was found between RMAS score and the length of time since the last workshop was taken.

Perceptions of Change in Attitude Components

Research Question 1b asked for a comparison between teachers' current ARM and their perceptions of their ARM prior to entering the classroom. Survey Questions 34 through 38 asked participants to rate their levels of five components of ARM - enjoyment, confidence, understanding, intrinsic value, and extrinsic value - as they perceived them to be prior to entering the classroom and as they would rate them in the present. These ratings were on a scale from 1 (Very Low) to 7 (Very High) with the value of 4 being labeled as Neutral.

Enjoyment of math. The 275 teachers who rated their enjoyment of mathematics (SQ 34) entered the teaching field with enjoyment levels ranging from 1 to 7, as shown in Table 2. The average rating for enjoyment prior to teaching was 4.36, indicating a neutral level of enjoyment. The average rating for enjoyment at the present time was 5.45, indicating that the average veteran teacher somewhat enjoys mathematics. To determine if this difference was significant, a paired-samples t-test was run to compare the teachers' perceived level of enjoyment of math prior to teaching ($M = 4.36$, $SD = 1.946$) with their current level of enjoyment of math ($M = 5.45$, $SD = 1.304$). The increase in enjoyment was significant, $t(274) = 10.899$, $p < .001$.

Table 2

Change in Enjoyment of Mathematics

	Enjoyment Level Prior to Entering the Classroom							
	1	2	3	4	5	6	7	Total
Count	37	19	27	55	42	52	43	275
Percent	13.5	6.9	9.8	20.0	15.3	18.9	15.6	100.0
Avg Change	3.432	2.368	1.852	1.382	0.643	-0.365	-0.163	1.087
Median Change	3	2	2	1	1	0	0	1

Of the 83 teachers who indicated a negative level of enjoyment prior to entering the classroom (a value of 3 or less), 68 have experienced an increase in level of enjoyment sufficient to bring them to a neutral or positive level of enjoyment, while 15 still have negative levels of enjoyment. Five who had held neutral or positive levels of enjoyment prior to teaching have since shifted to a negative level.

To further explore the impact of experience on teachers' enjoyment of math, multiple regression analysis was run on 20 experience factors drawn from the survey. In each case, the experience factor was utilized as the independent variable, and the level of enjoyment "now" was the dependent variable. The level of enjoyment prior to teaching was held constant. Results are shown in Table 3.

Table 3

Experience Factors as Predictors of Level of Enjoyment Now, Holding Enjoyment Before Teaching Constant

Experience Factors	*B*	*t*	*p*	Sig
SQ33 - Age	0.047	0.916	0.361	
SQ01 - Number of Years Teaching Exper	0.040	0.788	0.432	
SQ02 - Number of Years at Current GL	0.095	1.867	0.063	
SQ03 - Number of Years Taught Math	0.076	1.487	0.138	
SQ04 - Minimum Grade Level Current	0.124	2.444	0.015	< .05
SQ05 - Minimum Grade Level Historic	0.103	2.034	0.043	< .05
SQ04 - Maximum Grade Level Current	0.024	0.469	0.639	
SQ05 - Maximum Grade Level Historic	0.044	0.857	0.392	
SQ04 - Range of Grade Levels Current	-0.209	-4.210	0.000	< .001
SQ05 - Range of Grade Levels Historic	-0.036	-0.706	0.481	
SQ04 - Count of Grade Levels Current	-0.212	-4.280	0.000	< .001
SQ05 - Count of Grade Levels Historic	-0.067	-1.309	0.192	
SQ06 - Self-Contained v. Departmental	0.134	2.442	0.015	< .05
SQ06 - Self-Contained v. Co-teaching	0.080	1.394	0.165	
SQ06 - Self-Contained v. Resource	0.002	0.041	0.967	
SQ31 - Sex	0.003	0.062	0.950	
SQ07 - Has Taken College Coursework	0.055	1.081	0.280	
SQ08 - Years Since Last College Course	-0.100	-1.053	0.295	
SQ09 - Has Taken Math Workshop	0.118	2.323	0.021	< .05
SQ10 - Years Since Last Math Workshop	-0.071	-0.948	0.345	

As can be seen in Table 3, several correlations were indicated. Enjoyment of mathematics was positively correlated with having experience working in a departmentalized classroom, with having taken a full-day math workshop, with the lowest grade level currently being taught, and with the lowest grade level taught in one's career. Enjoyment of mathematics was negatively correlated with the number of unique grades currently being taught by the teacher and the range of grades currently being taught by the teacher.

Confidence with math. The 275 teachers who rated their confidence in mathematics (SQ 35) entered the teaching field with confidence levels ranging from 1 to 7, as shown in Table 4. The average rating for confidence prior to teaching was 4.422, indicating a neutral level of confidence. The average rating at the present time was 5.59, indicating that the average veteran teacher feels somewhat confident in math. To determine if this difference was significant, a paired-samples *t*-test was run to compare the teachers' perceived level of confidence in math prior to teaching ($M = 4.42$, $SD = 1.886$) with their current level of confidence in math ($M = 5.59$, $SD = 1.227$). The increase in confidence was significant, $t\ (274) = 12.042$, $p < .001$.

Of the 85 teachers who indicated a negative level of confidence prior to entering the classroom (a value of 3 or less), 70 have experienced an increase in level of confidence sufficient to bring them to a neutral or positive level of confidence, while 15 still have negative levels of confidence. Four who had held neutral or positive levels of enjoyment prior to teaching have since shifted to a negative level.

Table 4

Change in Level of Confidence

	Confidence Level Prior to Entering the Classroom							
	1	2	3	4	5	6	7	Total
Count	27	29	29	42	52	56	40	275
Percent	9.8	10.5	10.5	15.3	18.9	20.4	14.5	100.0
Average Change	3.296	2.793	2.103	1.595	0.808	-0.179	-0.250	1.164
Median Change	4	3	2	2	1	0	0	1

To explore further the impact of experience on teachers' confidence in math, multiple regression analysis was run on 20 experience factors drawn from the survey. In each case, the experience factor was utilized as the independent variable, and the level of confidence "now" was the dependent variable. The level of confidence prior to teaching was held constant. Results are shown in Table 5.

As can be seen in Table 5, four correlations were indicated. Confidence in mathematics was positively correlated with having taken a full-day math workshop and with the minimum grade level currently being taught. Confidence in mathematics was negatively correlated with the number of unique grades currently being taught by the teacher and the range of grades currently being taught by the teacher.

Table 5

Experience Factors as Predictors of Level of Confidence Now, Holding Confidence Before Teaching Constant

Experience Factors	*B*	*t*	*p*	Sig
SQ33 - Age	0.054	1.043	0.298	
SQ01 - Number of Years Teaching Exper	0.052	1.019	0.309	
SQ02 - Number of Years at Current GL	0.068	1.333	0.184	
SQ03 - Number of Years Taught Math	0.070	1.374	0.170	
SQ04 - Minimum Grade Level Current	0.178	3.568	0.000	< .001
SQ05 - Minimum Grade Level Historic	0.094	1.839	0.067	
SQ04 - Maximum Grade Level Current	0.062	1.222	0.223	
SQ05 - Maximum Grade Level Historic	0.054	1.047	0.296	
SQ04 - Range of Grade Levels Current	-0.242	4.916	0.000	< .001
SQ05 - Range of Grade Levels Historic	-0.019	-0.378	0.705	
SQ04 - Count of Grade Levels Current	-0.247	-5.031	0.000	< .001
SQ05 - Count of Grade Levels Historic	-0.063	-1.243	0.215	
SQ06 - Self-Contained v. Departmental	0.095	1.696	0.091	
SQ06 - Self-Contained v. Co-teaching	0.088	1.575	0.177	
SQ06 - Self-Contained v. Resource	-0.005	-0.082	0.935	
SQ31 - Sex	0.054	1.043	0.298	
SQ07 - Has Taken College Coursework	0.039	0.752	0.453	
SQ08 - Years Since Last College Course	-0.051	-0.526	0.600	
SQ09 - Has Taken Math Workshop	0.166	3.322	0.001	< .01
SQ10 - Years Since Last Math Workshop	0.044	0.598	0.551	

Understanding of elementary math. The 275 teachers who rated their understanding of elementary mathematics (SQ 36) entered the teaching field with understanding levels ranging from 1 to 7, as shown in Table 6. The average rating for understanding prior to teaching was 5.069, indicating a somewhat positive understanding. The average rating at the present time was 6.15, indicating that the average veteran teacher feels positive about his or her understanding of elementary content. To determine if this difference was significant, a paired-samples *t*-test was run to compare the teachers' perceived level of understanding of math prior to teaching ($M = 5.07$, $SD = 1.580$) with their current level of understanding of math ($M = 6.15$, $SD = 0.978$). The increase in enjoyment was significant, $t\ (274) = 13.275$, $p < .001$.

Table 6

Change in Level of Understanding of Elementary Math

	Level of Understanding of Elementary Math Prior to Entering the Classroom							
	1	2	3	4	5	6	7	Total
Count	6	18	22	38	73	57	61	275
Percent	2.2	6.5	8.0	13.8	26.5	20.7	22.2	100.0
Average Change	4.333	3.444	1.864	1.868	1.164	0.298	-0.098	1.076
Median Change	4	4	2	2	1	0	0	1

Of the 46 teachers who indicated a negative level of understanding prior to entering the classroom (a value of 3 or less), 39 have experienced an increase in level of confidence sufficient to bring them to a neutral or positive level of understanding, while 7 still have negative levels of understanding. Two who had held neutral or positive levels of understanding prior to teaching have since shifted to a negative level.

To further explore the impact of experience on teachers' level of understanding of elementary math, multiple regression analysis was run on 20 experience factors drawn from the survey. In each case, the experience factor was utilized as the independent variable, and the level of understanding of elementary math "now" was the dependent variable. The level of understanding of elementary math prior to teaching was held constant. Results are shown in Table 7.

As can be seen in Table 7, four correlations were indicated. Level of understanding of elementary mathematics was positively correlated with the lowest grade level currently being taught and with the lowest grade level taught in one's career. Understanding of elementary mathematics was negatively correlated with the number of unique grades currently being taught by the teacher and the range of grades currently being taught by the teacher.

Belief that Math is Intrinsically Valuable. The 273 teachers who rated their belief that math is intrinsically valuable (SQ 37) entered the teaching field with levels of belief in math's intrinsic value ranging from 1 to 7, as shown in Table 8. The average level of this belief prior to teaching was 4.597, indicating a neutral belief in math's intrinsic value. The average rating at the present time was 5.56, indicating that the average veteran teacher feels that math is somewhat intrinsically valuable. To determine if this difference was significant, a paired-samples *t*-test was run to compare the teachers' perceived level

Table 7

Experience Factors as Predictors of Level of Understanding of Elementary Math Now, Holding Understanding of Elementary Math Before Teaching Constant

Experience Factors	*B*	*t*	*p*	Sig
SQ33 - Age	0.009	0.180	0.857	
SQ01 - Number of Years Teaching Exper	-0.002	-0.046	0.964	
SQ02 - Number of Years at Current GL	0.009	0.168	0.867	
SQ03 - Number of Years Taught Math	0.039	0.741	0.460	
SQ04 - Minimum Grade Level Current	0.176	3.508	0.001	< .01
SQ05 - Minimum Grade Level Historic	0.128	2.508	0.013	< .05
SQ04 - Maximum Grade Level Current	0.053	1.034	0.302	
SQ05 - Maximum Grade Level Historic	0.077	1.493	0.137	
SQ04 - Range of Grade Levels Current	-0.258	-5.251	0.000	< .001
SQ05 - Range of Grade Levels Historic	-0.024	-0.464	0.643	
SQ04 - Count of Grade Levels Current	-0.244	-4.940	0.000	< .001
SQ05 - Count of Grade Levels Historic	-0.057	-1.120	0.264	
SQ06 - Self-Contained v. Departmental	0.062	1.077	0.283	
SQ06 - Self-Contained v. Co-teaching	0.069	1.173	0.242	
SQ06 - Self-Contained v. Resource	-0.042	-0.740	0.460	
SQ31 - Sex	-0.049	-0.945	0.345	
SQ07 - Has Taken College Coursework	0.056	1.091	0.276	
SQ08 - Years Since Last College Course	0.004	0.045	0.964	
SQ09 - Has Taken Math Workshop	0.087	1.698	0.091	
SQ10 - Years Since Last Math Workshop	-0.006	-0.081	0.935	

Table 8

Change in Level of Belief that Math is Intrinsically Valuable

	Intrinsic Value Level Prior to Entering the Classroom							
	1	2	3	4	5	6	7	Total
Count	17	19	24	76	43	49	45	273
Percent	6.2	7.0	8.8	27.8	15.8	17.9	16.5	100.0
Average Change	2.647	1.842	2.208	0.908	1.093	0.306	0.000	0.967
Median Change	3	2	2	1	1	0	0	0

of belief that math is intrinsically valuable prior to teaching (*M* = 4.60, *SD* = 1.715) with their current level of belief that math is intrinsically valuable (*M* = 5.56, *SD* = 1.452). The increase in level of belief in intrinsic value was significant, $t\ (272) = 12.413$, $p < .001$.

Of the 60 teachers who indicated a negative level of belief in math's intrinsic value prior to entering the classroom (a value of 3 or less), 41 have experienced an increase in this belief sufficient to bring them to place a neutral or positive intrinsic value on math, while 19 still have negative levels of this belief. Two who had held neutral or positive levels of belief in math's intrinsic value prior to teaching have since shifted to a negative level.

To explore further the impact of experience on teachers' level of belief that math has intrinsic value, multiple regression analysis was run on 20 experience factors drawn from the survey. In each case, the experience factor was utilized as the independent variable, and the level of belief that math has intrinsic value "now" was the dependent variable. The level of belief that math has intrinsic value prior to teaching was held constant. Results are shown in Table 9.

As can be seen in Table 9, several correlations were indicated. Level of belief that math is intrinsically valuable was positively correlated with age, with the number of years the teacher has taught, with the number of years the teacher has taught at the current grade level, with the number of years the teacher has taught math, and with having taken a full-day math workshop. Level of belief that math is intrinsically valuable was negatively correlated with the number of unique grades currently being taught by the teacher and the range of grades currently being taught by the teacher.

Belief that Math is Extrinsically Valuable. The 274 teachers who rated their belief that math is extrinsically valuable (SQ 37) entered the teaching field with levels of belief in math's extrinsic value ranging from 1 to 7, as shown in Table 10. The average level of this belief prior to teaching was 5.310, indicating a somewhat positive belief in math's extrinsic value. The average rating at the present time was 6.24, indicating that the average veteran teacher feels that math is extrinsically valuable. To determine if this difference was significant, a paired-samples t-test was run to compare the teachers' perceived level of belief that math is extrinsically valuable prior to teaching (M = 5.31, SD = 1.527) with their current level of belief that math is extrinsically valuable (M = 6.24, SD = 1.058). The increase in belief that math is extrinsically valuable was significant, t (273) = 12.107, $p < .001$.

Table 9

Experience Factors as Predictors of Level of Belief that Math Has Intrinsic Value Now, Holding Level of Belief that Math Has Intrinsic Value Before Teaching Constant

Experience Factors	*B*	*t*	*p*	Sig
SQ33 - Age	0.118	2.632	0.009	< .01
SQ01 - Number of Years Teaching Exper	0.116	2.621	0.009	< .01
SQ02 - Number of Years at Current GL	0.098	2.198	0.029	< .05
SQ03 - Number of Years Taught Math	0.107	2.411	0.017	< .05
SQ04 - Minimum Grade Level Current	0.058	1.304	0.193	
SQ05 - Minimum Grade Level Historic	0.005	0.104	0.917	
SQ04 - Maximum Grade Level Current	0.009	0.201	0.841	
SQ05 - Maximum Grade Level Historic	0.033	0.741	0.459	
SQ04 - Range of Grade Levels Current	-0.105	-2.377	0.018	< .05
SQ05 - Range of Grade Levels Historic	0.027	0.613	0.540	
SQ04 - Count of Grade Levels Current	-0.116	-2.627	0.009	< .01
SQ05 - Count of Grade Levels Historic	0.023	0.511	0.610	
SQ06 - Self-Contained v. Departmental	0.015	0.306	0.760	
SQ06 - Self-Contained v. Co-teaching	0.050	1.003	0.317	
SQ06 - Self-Contained v. Resource	-0.007	-0.131	0.896	
SQ31 - Sex	0.040	0.889	0.375	
SQ07 - Has Taken College Coursework	0.067	1.487	0.138	
SQ08 - Years Since Last College Course	0.062	0.788	0.433	
SQ09 - Has Taken Math Workshop	0.110	2.484	0.014	< .05
SQ10 - Years Since Last Math Workshop	-0.006	-0.085	0.932	

Of the 28 teachers who indicated a negative level of belief in math's extrinsic value prior to entering the classroom (a value of 3 or less), 24 have experienced an increase in this belief sufficient to bring them to place a neutral or positive extrinsic value

Table 10

Change in Level of Belief that Math is Extrinsically Valuable

	Extrinsic Value Level Prior to Entering the Classroom							
	1	2	3	4	5	6	7	Total
Count	9	8	11	45	62	66	73	274
Percent	3.3	2.9	4.0	16.4	22.6	24.1	26.6	100.0
Average Change	3.000	2.625	3.273	1.667	1.290	0.273	-0.041	0.927
Median Change	3	2.5	4	2	1	0	0	0

on math, while four still have negative levels of this belief. None who had held neutral or positive levels of levels of belief in math's extrinsic value prior to teaching have since shifted to a negative level.

To explore further the impact of experience on teachers' level of belief that math has extrinsic value, multiple regression analysis was run on 20 experience factors drawn from the survey. In each case, the experience factor was utilized as the independent variable, and the level of belief that math has extrinsic value "now" was the dependent variable. The level of belief that math has extrinsic value prior to teaching was held constant. Results are shown in Table 11.

As can be seen in Table 11, three correlations were indicated. Level of belief that math is extrinsically valuable was positively correlated with age and with the lowest grade level currently being taught. Level of belief that math is extrinsically valuable was

Table 11

Experience Factors as Predictors of Level of Belief that Math Has Extrinsic Value Now, Holding Level of Belief that Math Has Extrinsic Value Before Teaching Constant

Experience Factors	*B*	*t*	*p*	Sig
SQ33 - Age	0.106	2.147	0.033	< .05
SQ01 - Number of Years Teaching Exper	0.075	1.519	0.130	
SQ02 - Number of Years at Current GL	0.061	1.224	0.222	
SQ03 - Number of Years Taught Math	0.077	1.536	0.126	
SQ04 - Minimum Grade Level Current	0.121	2.436	0.015	< .05
SQ05 - Minimum Grade Level Historic	0.043	0.855	0.393	
SQ04 - Maximum Grade Level Current	0.075	1.504	0.134	
SQ05 - Maximum Grade Level Historic	0.060	1.207	0.228	
SQ04 - Range of Grade Levels Current	-0.090	-1.821	0.070	
SQ05 - Range of Grade Levels Historic	0.024	0.483	0.629	
SQ04 - Count of Grade Levels Current	-0.107	-2.155	0.032	< .05
SQ05 - Count of Grade Levels Historic	0.023	0.459	0.646	
SQ06 - Self-Contained v. Departmental	0.052	0.915	0.361	
SQ06 - Self-Contained v. Co-teaching	0.086	1.530	0.128	
SQ06 - Self-Contained v. Resource	-0.017	-0.310	0.757	
SQ31 - Sex	0.094	1.895	0.059	
SQ07 - Has Taken College Coursework	0.055	1.086	0.278	
SQ08 - Years Since Last College Course	0.081	0.947	0.346	
SQ09 - Has Taken Math Workshop	0.070	1.403	0.162	
SQ10 - Years Since Last Math Workshop	-0.128	-1.837	0.068	

negatively correlated with the number of unique grades currently being taught by the teacher.

Causes of Changes in Attitudes Toward Mathematics

Research Question 2 asked what factors veteran teachers self-identify as being the leading post-college causes of change in their attitudes toward mathematics. Survey Questions 39 through 46 were used to attempt to answer this question. Survey Questions 41 through 46 asked participants to classify the effect that six identified influencers have had on their attitudes toward mathematics.

Participants generally agreed that the experience of teaching math had a positive impact on their attitudes, with 36.1% indicating that its impact was very positive, 51.8% indicating that its impact was positive, 9.5% indicating that it did not impact their attitudes, and only 2.6% indicating that it had a negative impact.

Professional development workshops about math or the teaching of math were also influential. Of the 142 participants who indicated in SQ 9 that they had taken full-day workshops in mathematics, 20.4% indicated that its impact was very positive, 59.9% indicated that its impact was positive, 15.5% indicated that its impact was neutral, and 4.2% indicated that it had a negative impact.

The focus on increasing standardized test scores received mixed reviews, with 5.9% indicating that it had a very positive impact on their attitudes, 32.6% indicating that it had a positive impact on their attitudes, 29.3% indicating that it had a neutral impact, 24.5% indicating that it had a negative impact, and 7.7% indicating that it had a very negative impact.

Interaction with principals and interaction with parents had similar impacts on teachers. Interaction with principals was rated by 6.5% of participants as having a very positive impact on attitudes, 41.1% as having a positive impact, 44.7% as having a neutral or no impact, 5.8% as having a negative impact, and 1.8% as having a very negative impact on their attitudes. Interaction with parents was rated by 6.5% of participants as having a very positive impact on their attitudes, 42.9% as having a positive impact, 42.9% as having a neutral impact, 6.5% as having a negative impact, and 1.1% as having a very negative impact.

Life experience needing and using mathematics was seen by most participants as having a positive impact on their attitudes, with 18.5% indicating that it had a very positive impact, 64.7% indicating that it had a positive impact, 13.1% indicating a neutral impact, 3.3% indicating a negative impact, and 0.4% indicating a very negative impact.

In order to determine if the way that a teacher is impacted by these six attitude influencers is related to the teachers' attitudes toward math prior to entering the classroom or to any experience factors, regression analyses were performed using the six attitude influencers as dependent variables. Independent variables used were the five "before teaching" values of SQ 34 through SQ 38, as well as the 20 experience factors identified earlier.

As indicated by Table 12, the influence of the experience of teaching math on teacher attitudes (SQ 41) was not significantly correlated to any of the explored factors.

As indicated by Table 13, the influence of professional development workshops about math or the teaching of math on teacher attitudes (SQ 42) was positively correlated with having taken college coursework since entering the classroom ($\beta = .119$, $t = 2.405$, $p < .05$) and negatively correlated with being male ($\beta = -0.195$, $t = -2.347$, $p < .05$).

Table 12

Predictors of How Positively or Negatively the Experience of Teaching Math to Students Impacts Teacher ATM

Experience Factors	*β*	*t*	*p*	Sig
SQ 34 - Enjoyment of Math (Before)	0.051	0.843	0.4	
SQ 35 - Confidence with Math (Before)	0.034	0.563	0.57	
SQ 36 - Understanding of Math (Before)	0.060	0.998	0.32	
SQ 37 - Intrinsic Value of Math (Before)	0.075	1.236	0.22	
SQ 38 - Extrinsic Value of Math (Before)	0.047	0.777	0.44	
SQ33 - Age	0.045	0.730	0.47	
SQ01 - Number of Years Teaching Exper	0.052	0.855	0.39	
SQ02 - Number of Years at Current GL	0.104	1.731	0.09	
SQ03 - Number of Years Taught Math	0.106	1.745	0.08	
SQ04 - Minimum Grade Level Current	0.101	1.671	0.1	
SQ05 - Minimum Grade Level Historic	0.075	1.238	0.22	
SQ04 - Maximum Grade Level Current	0.069	1.143	0.25	
SQ05 - Maximum Grade Level Historic	0.034	0.561	0.58	
SQ04 - Range of Grade Levels Current	-0.062	-1.03	0.31	
SQ05 - Range of Grade Levels Historic	-0.024	-0.39	0.7	
SQ04 - Count of Grade Levels Current	-0.072	-1.2	0.23	
SQ05 - Count of Grade Levels Historic	0.038	0.628	0.53	
SQ06 - Self-Contained v. Departmental	0.048	0.711	0.48	
SQ06 - Self-Contained v. Co-teaching	0.054	0.799	0.43	
SQ06 - Self-Contained v. Resource	0.022	0.323	0.75	
SQ31 - Sex	0.059	0.970	0.33	
SQ07 - Has Taken College Coursework	0.099	1.645	0.1	
SQ08 - Years Since Last College Course	-0.112	-1.06	0.29	
SQ09 - Has Taken Math Workshop	0.109	1.801	0.07	
SQ10 - Years Since Last Math Workshop	-0.043	-0.51	0.61	

Table 13

Predictors of How Positively or Negatively Professional Development Workshops Impact Teacher ATM

Experience Factors	*β*	*t*	*p*	Sig
SQ 34 - Enjoyment of Math (Before)	0.078	0.926	0.356	
SQ 35 - Confidence with Math (Before)	0.045	0.538	0.591	
SQ 36 - Understanding of Math (Before)	0.143	1.710	0.089	
SQ 37 - Intrinsic Value of Math (Before)	0.036	0.421	0.674	
SQ 38 - Extrinsic Value of Math (Before)	0.027	0.318	0.751	
SQ33 - Age	-0.004	-0.042	0.966	
SQ01 - Number of Years Teaching Exper	0.065	0.774	0.440	
SQ02 - Number of Years at Current GL	0.031	0.363	0.718	
SQ03 - Number of Years Taught Math	0.072	0.856	0.393	
SQ04 - Minimum Grade Level Current	0.073	0.869	0.386	
SQ05 - Minimum Grade Level Historic	0.015	0.177	0.859	
SQ04 - Maximum Grade Level Current	0.086	1.019	0.310	
SQ05 - Maximum Grade Level Historic	0.005	0.065	0.949	
SQ04 - Range of Grade Levels Current	0.051	0.605	0.546	
SQ05 - Range of Grade Levels Historic	-0.006	-0.075	0.940	
SQ04 - Count of Grade Levels Current	0.033	0.385	0.701	
SQ05 - Count of Grade Levels Historic	0.065	0.767	0.444	
SQ06 - Self-Contained v. Departmental	-0.066	-0.782	0.436	
SQ06 - Self-Contained v. Co-teaching	0.142	1.695	0.092	
SQ06 - Self-Contained v. Resource	0.016	0.193	0.847	
SQ31 - Sex	-0.195	-2.347	0.020	< .05
SQ07 - Has Taken College Coursework	0.199	2.405	0.017	< .05
SQ08 - Years Since Last College Course	0.132	1.022	0.311	
SQ09 - Has Taken Math Workshop	Void	Void	Void	Void
SQ10 - Years Since Last Math Workshop	0.014	0.167	0.868	

As indicated by Table 14, the influence of the focus on standardized testing on teacher attitudes (SQ 43) was weakly negatively correlated with the range of grades one has taught in his or her career (β = -.153, t = -2.554, $p < .05$), the number of unique grade levels in which one has taught (β = -.172, t = -2.874, $p < .01$), having taught in a resource capacity (β = -.149, t = -2.204, $p < .05$), and the number of years since having taken a college math course (β = -.218, t = -2.121, $p < .05$).

As indicated by Table 15, the influence of feedback from instructional leaders on teacher attitudes (SQ 44) was weakly positively correlated with the lowest grade level one has taught (β = .132, t = 2.201, p < .05). It was weakly negatively correlated with age (β = -.252, t = -4.264, $p < .001$), number of years of teaching experience (β = -.238, t = -4.054, $p < .001$), number of years teaching at the current grade level (β = -.230, t = -3.904, $p < .001$), number of years teaching mathematics (β = -.203, t = -3.419, $p < .01$), range of grade levels currently teaching (β = -.165, t = -2.751, $p < .01$), range of grade levels ever taught (β = -.201, t = -3.389, $p < .01$), count of unique grade levels currently teaching (β = -.166, t = 2.778, $p < .01$), count of grades ever taught (β = -.178, t = -2.983, $p < .01$), and having taught in a resource capacity (β = -.172, t = -1.054, $p < .05$).

As indicated by Table 16, the influence of interaction with parents on teacher attitudes (SQ 45) was negatively correlated with range of grades currently teaching (β = -. 127, t = -2.119, $p < .05$) and the number of unique grade levels currently teaching (β = -. 133, t = -2.217, $p < .05$).

Table 14

Predictors of How Positively or Negatively the Focus on Standardized Test Scores Impacts Teacher ATM

Experience Factors	*β*	*t*	*p*	Sig
SQ 34 - Enjoyment of Math (Before)	-0.002	-0.033	0.973	
SQ 35 - Confidence with Math (Before)	0.015	0.247	0.805	
SQ 36 - Understanding of Math (Before)	0.044	0.732	0.465	
SQ 37 - Intrinsic Value of Math (Before)	0.005	0.088	0.930	
SQ 38 - Extrinsic Value of Math (Before)	0.071	1.173	0.242	
SQ33 - Age	-0.113	-1.848	0.066	
SQ01 - Number of Years Teaching Exper	-0.072	-1.183	0.238	
SQ02 - Number of Years at Current GL	-0.083	-1.367	0.173	
SQ03 - Number of Years Taught Math	-0.062	-1.020	0.309	
SQ04 - Minimum Grade Level Current	-0.049	-0.799	0.425	
SQ05 - Minimum Grade Level Historic	0.070	1.149	0.251	
SQ04 - Maximum Grade Level Current	-0.075	-1.230	0.220	
SQ05 - Maximum Grade Level Historic	-0.109	-1.806	0.072	
SQ04 - Range of Grade Levels Current	-0.060	-0.987	0.325	
SQ05 - Range of Grade Levels Historic	-0.153	-2.554	0.011	< .05
SQ04 - Count of Grade Levels Current	-0.085	-1.403	0.162	
SQ05 - Count of Grade Levels Historic	-0.172	-2.874	0.004	< .01
SQ06 - Self-Contained v. Departmental	-0.010	-0.152	0.879	
SQ06 - Self-Contained v. Co-teaching	-0.121	-1.804	0.073	
SQ06 - Self-Contained v. Resource	-0.149	-2.204	0.029	< .05
SQ31 - Sex	-0.070	-1.157	0.248	
SQ07 - Has Taken College Coursework	0.014	0.231	0.818	
SQ08 - Years Since Last College Course	-0.218	-2.121	0.037	< .05
SQ09 - Has Taken Math Workshop	-0.091	-1.511	0.132	
SQ10 - Years Since Last Math Workshop	-0.086	-1.020	0.310	

Table 15

Predictors of How Positively or Negatively the Feedback of Instructional Leaders Impacts Teacher ATM

Experience Factors	β	t	p	Sig
SQ 34 - Enjoyment of Math (Before)	0.081	1.347	0.179	
SQ 35 - Confidence with Math (Before)	0.090	1.489	0.138	
SQ 36 - Understanding of Math (Before)	0.037	0.614	0.540	
SQ 37 - Intrinsic Value of Math (Before)	-0.014	-0.229	0.819	
SQ 38 - Extrinsic Value of Math (Before)	-0.019	-0.313	0.755	
SQ33 - Age	-0.252	-4.264	0.000	< .001
SQ01 - Number of Years Teaching Exper	-0.238	-4.054	0.000	< .001
SQ02 - Number of Years at Current GL	-0.230	-3.904	0.000	< .001
SQ03 - Number of Years Taught Math	-0.203	-3.419	0.001	< .01
SQ04 - Minimum Grade Level Current	0.045	0.749	0.455	
SQ05 - Minimum Grade Level Historic	0.132	2.201	0.029	< .05
SQ04 - Maximum Grade Level Current	-0.032	-0.521	0.603	
SQ05 - Maximum Grade Level Historic	-0.110	-1.825	0.069	
SQ04 - Range of Grade Levels Current	-0.165	-2.751	0.006	< .01
SQ05 - Range of Grade Levels Historic	-0.201	-3.389	0.001	< .01
SQ04 - Count of Grade Levels Current	-0.166	-2.778	0.006	< .01
SQ05 - Count of Grade Levels Historic	-0.178	-2.983	0.003	< .01
SQ06 - Self-Contained v. Departmental	-0.052	-0.777	0.438	
SQ06 - Self-Contained v. Co-teaching	-0.087	-1.298	0.196	
SQ06 - Self-Contained v. Resource	-0.172	-2.561	0.011	< .05
SQ31 - Sex	-0.064	-1.054	0.293	
SQ07 - Has Taken College Coursework	-0.016	-0.261	0.794	
SQ08 - Years Since Last College Course	-0.100	-0.953	0.343	
SQ09 - Has Taken Math Workshop	0.005	0.075	0.940	
SQ10 - Years Since Last Math Workshop	-0.195	-2.361	0.020	

Table 16

Predictors of How Positively or Negatively the Interaction with Parents Impacts Teacher ATM

Experience Factors	*β*	*t*	*p*	Sig
SQ 34 - Enjoyment of Math (Before)	0.082	1.357	0.176	
SQ 35 - Confidence with Math (Before)	0.079	1.314	0.190	
SQ 36 - Understanding of Math (Before)	0.043	0.704	0.482	
SQ 37 - Intrinsic Value of Math (Before)	0.036	0.596	0.552	
SQ 38 - Extrinsic Value of Math (Before)	-0.042	-0.693	0.489	
SQ33 - Age	-0.033	-0.544	0.587	
SQ01 - Number of Years Teaching Exper	0.013	0.207	0.836	
SQ02 - Number of Years at Current GL	0.029	0.478	0.633	
SQ03 - Number of Years Taught Math	0.033	0.552	0.582	
SQ04 - Minimum Grade Level Current	-0.035	-0.571	0.568	
SQ05 - Minimum Grade Level Historic	-0.008	-0.136	0.892	
SQ04 - Maximum Grade Level Current	-0.092	-1.523	0.129	
SQ05 - Maximum Grade Level Historic	-0.052	-0.865	0.388	
SQ04 - Range of Grade Levels Current	-0.127	-2.119	0.035	< .05
SQ05 - Range of Grade Levels Historic	-0.043	-0.707	0.480	
SQ04 - Count of Grade Levels Current	-0.133	-2.217	0.027	< .05
SQ05 - Count of Grade Levels Historic	-0.058	-0.952	0.342	
SQ06 - Self-Contained v. Departmental	0.054	0.803	0.423	
SQ06 - Self-Contained v. Co-teaching	0.015	0.221	0.825	
SQ06 - Self-Contained v. Resource	-0.063	-0.930	0.353	
SQ31 - Sex	-0.033	-0.546	0.586	
SQ07 - Has Taken College Coursework	0.061	1.012	0.313	
SQ08 - Years Since Last College Course	-0.039	-0.374	0.709	
SQ09 - Has Taken Math Workshop	0.018	0.297	0.767	
SQ10 - Years Since Last Math Workshop	0.003	0.030	0.976	

As indicated by Table 17, the influence of life experience needing and using mathematics (SQ 46) was positively correlated with pre-service enjoyment of math ($\beta = .252$, $t = 4.300$, $p < .001$), pre-service confidence with math ($\beta = .250$, $t = 4.260$, $p < .001$), pre-service understanding of math ($\beta = .231$, $t = 3.926$, $p < .001$), pre-service belief that math is intrinsically valuable ($\beta = .310$, $t = 5.363$, $p < .001$), pre-service belief that math is extrinsically valuable ($\beta = .352$, $t = 6.193$, $p < .001$), having had experienced teaching in a departmentalized setting ($\beta = .185$, $t = 2.795$, $p < .01$), having had experience co-teaching ($\beta = .143$, $t = 2.146$, $p < .05$), and having taken college coursework in math ($\beta = .145$, $t = 2.415$, $p < .05$).

While Survey Questions 41 through 46 asked about specific influencers of ATM that were identified by the researcher as possible influencers, the researcher sought to determine if other important influencing factors could be identified by survey participants that might give future studies a more comprehensive list. To meet this need, Survey Questions 39 and 40 were written as open-ended questions that asked participants to identify on their own the factors that most positively (SQ 39) and negatively (SQ 40) impacted their attitudes toward mathematics. These two questions were placed before Survey Questions 41 through 46 to deter participants from feeling limited by the predetermined factors. To score the responses to these questions, the researcher sought the assistance of two research assistants - one of whom was a pre-service teacher and the other of whom was an experienced school teacher and administrator. Coding of the responses was negotiated among the researcher and the two assistants.

Table 17

Predictors of How Positively or Negatively Life Experience Needing and Using Math Impacts Teacher ATM

Experience Factors	*β*	*t*	*p*	Sig
SQ 34 - Enjoyment of Math (Before)	0.252	4.300	0.000	< .001
SQ 35 - Confidence with Math (Before)	0.250	4.260	0.000	< .001
SQ 36 - Understanding of Math (Before)	0.231	3.926	0.000	< .001
SQ 37 - Intrinsic Value of Math (Before)	0.310	5.363	0.000	< .001
SQ 38 - Extrinsic Value of Math (Before)	0.352	6.193	0.000	< .001
SQ33 - Age	-0.008	-0.123	0.902	
SQ01 - Number of Years Teaching Exper	0.003	0.046	0.963	
SQ02 - Number of Years at Current GL	-0.005	-0.076	0.940	
SQ03 - Number of Years Taught Math	0.009	0.148	0.883	
SQ04 - Minimum Grade Level Current	0.093	1.541	0.124	
SQ05 - Minimum Grade Level Historic	0.077	1.270	0.205	
SQ04 - Maximum Grade Level Current	0.053	0.882	0.379	
SQ05 - Maximum Grade Level Historic	0.021	0.345	0.730	
SQ04 - Range of Grade Levels Current	-0.080	-1.324	0.187	
SQ05 - Range of Grade Levels Historic	-0.037	-0.620	0.536	
SQ04 - Count of Grade Levels Current	-0.091	-1.505	0.133	
SQ05 - Count of Grade Levels Historic	-0.043	-0.707	0.480	
SQ06 - Self-Contained v. Departmental	0.185	2.795	0.006	< .01
SQ06 - Self-Contained v. Co-teaching	0.143	2.146	0.033	< .05
SQ06 - Self-Contained v. Resource	0.024	0.346	0.729	
SQ31 - Sex	-0.007	-0.119	0.906	
SQ07 - Has Taken College Coursework	0.145	2.415	0.016	< .05
SQ08 - Years Since Last College Course	-0.126	-1.203	0.232	
SQ09 - Has Taken Math Workshop	0.054	0.886	0.376	
SQ10 - Years Since Last Math Workshop	0.012	0.142	0.887	

Factors Creating Positive Change in Teacher ATM

Survey Question 39 asked participants to what they most attribute positive changes in their attitudes toward math since they began teaching. Thirty-seven participants provided responses that were labeled by the coding team as non-responsive. Often, these were comments describing the extent to which the teacher liked or disliked math, rather than a description of a factor leading to change in ATM.

Thirty-one participants gave responses that the coding team coded as Repeated Exposure to Material. These participants felt that the comfort and confidence that come from working with the same mathematical content year after year had a positive impact on their attitudes toward math. This is a sharp contrast from the one participant who attributed positive changes to seeing the larger picture of how elementary math concepts fit together to serve as a foundation for future learning. Giving credence to the idea that the best way to learn something is to teach it, 13 teachers indicated that the process of teaching math to others had the largest positive impact on their ATM.

Thirty teachers gave responses that the coding team classified as Experience with New Mathematical/Instructional Strategies. In some cases, participants felt that the way that they had learned math concepts was damaging to their ATM. Being expected to teach the same concepts using different techniques and strategies, these teachers were able to re-learn the concepts in a way that was more comfortable or enjoyable for them. In other cases, teachers in this group felt that their ATM increased due to the realization that there are multiple ways to approach the same problem, multiple ways to think about the same concept, or multiple ways to teach the same strategy.

Twenty-eight teachers felt that their attitudes were positively impacted by increased exposure to hands-on methods of teaching mathematics. As these teachers learned to utilize manipulatives in their classrooms, they were also re-learning concepts in a new way. In addition to manipulatives, utilization of technology to create hands-on instruction was also mentioned.

Twenty-four teachers credit the positive changes in their ATM to the specific textbook series or curriculum used by their school. The Everyday Math series was mentioned by name by 10 of these participants. These participants credit the series' approach to the concepts, their organization of material, and their overall tone.

Twenty-one teachers believed that their positive changes in ATM were the result of their increased understanding of the importance of math. These teachers cited the utility of math in everyday life, the benefit of problem-solving skills, and the role of mathematical thought in life-long learning.

A few participants cited internal factors for their positive changes in ATM. One noted the nostalgia of working with math from his or her childhood. Two indicated that they purposely sought to improve their ATM out of a sense of responsibility to their students - wanting to give their students a better math experience than they had received.

Others cited external factors for their positive changes. Twenty-seven participants gave responses that the coding team classified as Seeing Students Get It. These participants noted the pleasure they received in watching their students struggle with and then understand mathematical concepts. Similarly, 13 participants mentioned experiencing these feelings when Seeing Students Enjoy Math.

In addition to their students, teachers were also impacted by their co-workers. Nine teachers indicated that Peer Collaboration was the key factor in positively affecting their ATM. Another three teachers indicated that co-teaching with a teacher who had positive ATM improved their ATM.

Twenty-one participants credited formal trainings, workshops, or graduate courses with improving their attitudes toward math. Meanwhile, two participants experienced positive changes as the result of purchasing and reading books to teach themselves about math and math pedagogy.

Five participants made statements that the coding team classified as Staying in the Safety Zone. Four of these mentioned that their attitudes toward math have improved because they remain at a low enough grade level to feel confident with the material. The other participant specifically attributed his or her positive changes to having access to the teacher's manual.

A listing of those factors that teachers attributed as most positively impacting their attitudes toward mathematics can be seen in Table 18.

Factors Creating Negative Change in Teacher ATM

Survey Question 40 asked participants to what they most attribute negative changes in their attitudes toward math since they began teaching. Thirty-one participants provided responses that were labeled by the coding team as non-responsive. Often, these were comments such as, "my feelings haven't changed", rather than a description of a factor leading to change in ATM.

Table 18

Factors Teachers Most Attribute to Causing Positive Change in Their ATM

Factor	Responses	Percent
Repeated Exposure to Material	31	11.3
Experience with New Mathematical/Instructional Strategies	30	10.9
Experience with Hands-On Methods of Teaching Math	28	10.2
Seeing Students Get It	27	9.8
Like Specific Textbook Series or Curriculum	24	8.7
Increased Understanding of the Importance of Math	21	7.6
Attendance at Training, Workshop, or Graduate Course	21	7.6
Teaching Math to Others	13	4.7
Seeing Students Enjoy Math	13	4.7
Peer Collaboration	9	3.3
Staying in the Safety Zone	5	1.8
Co-teaching	3	1.1
Felt a Responsibility to Children to Improve Own ATM	2	0.7
Reading Books to Learn About Math and Math Pedagogy	2	0.7
Nostalgia	1	0.4
Seeing How Elementary Math Fits In to Future Learning	1	0.4

Curricular issues dominated the influencers of negative change, with 62 participants noting one or more curricular issues as negative influences. Fourteen participants made general statements about their district's curriculum or textbook series, while not giving specifics as to what it was about the curriculum that negatively impacted them. Twenty-four discussed pacing, with 15 stating that the pacing is too fast for their students to master concepts, three stating that the pacing was too slow to challenge their bright students, and six stating that their district or colleagues control their pacing, which prevents them from speeding up or slowing down when doing so would be appropriate.

Fifteen were negatively impacted by the changes that have taken place in elementary mathematics since they were young. Twelve of these were unhappy about the move away from traditional methods of teaching math, the traditional focus on skill and drill, and the traditional algorithms. The other three were unhappy about teaching multiple ways to solve the same problem - feeling that this served to confuse students.

Repetition was discussed by six participants, with four feeling that there was too much repetition in their curriculum, while two felt that there was not enough repetition in their curriculum. Other curricular issues discussed included a lack of flow, a lack of consistency, a heavy focus on word problems that hurts struggling readers, a lack of word problems and applications that are needed to inspire students, and the change in mathematical terminology over time.

After curricular issues, the influence of standardized tests on the teaching of mathematics caused participants the most trouble, with 33 participants citing it as a contributor toward negative ATM. In particular, 10 of these cited that they were forced to teach material that they deemed to be developmentally inappropriate for their students, and three cited the developmentally inappropriateness of asking students who are just learning to write to answer “extended response” questions in which they are to explain in writing the thought process they used to solve a math problem.

Just as many teachers experienced improvements in ATM when students demonstrated understanding of concepts, many mentioned that the opposite is also true. Of the 19 participants that discussed this phenomenon, 15 experienced feelings of discouragement when watching students struggle. Six discussed experiencing frustration when a student does not understand a concept and the teacher has run out of new ways to explain the concept.

Some teachers discussed what the coding team labeled as issues with the teaching situation. These included a lack of supplies or manipulatives (five participants), not having enough time (four participants), changing grade levels (two participants), changing text book series (one participant), lack of appropriate technology (one participant), being forced to use technology they do not want to use (one participant), having too many students at too many different levels (one participant), and inclusion (one participant).

Professional development was on the mind of 12 participants, with 10 stating that having a lack of professional development related to math contributed negatively toward their ATM, while two discussed bad experiences with professional development as having a negative impact on their ATM.

Nine teachers felt negatively influenced when made to face issues of their own mathematical competency in the course of teaching.

Seven participants were negatively impacted by the process of teaching elementary mathematics. Three of these disliked the paperwork and grading associated with mathematics assignments. One specifically discussed a dislike for teaching fractions.

The remaining three felt that their own attitudes toward mathematics were damaged by being limited to working with elementary math year after year.

Student issues were a concern for seven teachers, with four upset about receiving students who are not prepared to work at grade level, two brought down by students' negative attitudes toward mathematics, and one frustrated by students' inability to focus during math time. Parents were also causes of negative ATM for some teachers, with six teachers citing them as a primary cause. Three of these noted the lack of support, cooperation, and assistance from parents in the area of mathematics. The other three were upset by the negative attitudes that parents have toward mathematics. Those adults who work in the education field were not exempt from causing teachers to lower their attitudes toward mathematics. Two teachers were discouraged by witnessing co-workers with negative attitudes and low aptitudes for math, while another two noted the entire school's lack of focus on math as an important subject.

Lastly, three participants noted a reduction in their attitudes toward mathematics as they have experienced an increase in the belief that they are wasting the students' time with a subject area that is abstract and not needed in real, everyday life.

A listing of those factors that teachers attributed as most negatively impacting their attitudes toward mathematics can be seen in Table 19.

Math-Related Services

Research Question 3 asked what services, if any, teachers believed that Educational Service Agencies, districts, or schools might provide to facilitate positive

Table 19

Factors Teachers Most Attribute to Causing Negative Change in Their ATM

Factor	Responses	Percent
Curriculum Issues	62	22.5
The influence of standardized testing on teaching	32	11.6
Frustration when students do not understand	19	6.9
The teaching situation	15	5.5
Lack of (or poor) professional development	12	4.4
Teacher’s feeling of competence in math	9	3.3
Teacher’s dislike of the process of teaching math	7	2.5
Student issues	7	2.5
Parent issues	6	2.2
Coworker/Administration issues	4	1.5
Belief that math is not important for students’ futures	3	1.1

attitudes among elementary teachers. Survey Questions 47 to 59 were designed to gather insight into the services that teachers might need.

Survey Questions 47 and 48 asked participants if their schools (SQ 47) and their regional office/professional development center (SQ 48) offered workshops or courses that would be helpful to them in teaching mathematics. Teachers had mixed reviews of their schools, with 2.9% strongly agreeing that their schools offered such training opportunities, 27.0% agreeing, 17.2% undecided, 38.3% disagreeing, and 14.6% strongly disagreeing. Participants felt more positively about the offerings at their regional office/ professional development center, with 5.8% strongly agreeing that it provided such training opportunities, 47.4% agreeing, 28.8% undecided, 15.7% disagreeing, and 2.2% strongly disagreeing.

Survey Questions 49 through 57 asked participants to what extent they agreed that services identified by the researcher would benefit them and their teaching of mathematics. Results are shown in Table 20.

Table 20

Extent to Which Participants Agreed That Specified Services Would Benefit Them

	Percent Responding				
Survey Question	SD	D	U	A	SA
SQ 49. Training on Math Content.	1.8	14.5	13.8	51.3	18.5
SQ 50. Training on Teaching Math.	0.0	4.0	8.7	66.2	21.1
SQ 51. Training on Math Standards Tested.	1.1	13.5	10.9	57.1	17.5
SQ 52. Training on History of Math Concepts.	12.7	29.5	24.4	28.4	5.1
SQ 53. Better Resources.	5.9	27.8	19.4	35.2	11.7
SQ 54. Better Equipment.	3.7	18.4	15.4	41.5	21.0
SQ 55. More freedom and control over teaching.	4.4	20.0	26.8	35.7	12.9
SQ 56. Standard set of lesson plans to follow.	13.2	44.7	24.4	14.7	3.0
SQ 57. A “math mentor” in the first year or two.	2.6	22.3	20.8	44.2	10.2

Training appeared to be the service that teachers felt would have the most impact, with 87.3% agreeing that they would benefit from training on the methods of teaching math, 74.6% agreeing that they would benefit from training on the math standards tested on standardized tests, and 69.8% agreeing that they would benefit from a training focused on understanding mathematical content. Teachers felt that they would benefit from having more or better equipment (62.5% agreeing) and resources (46.9% agreeing). Just over half of the teachers agreed that they would have benefitted from having a math mentor in their first year or two teaching.

When it comes to control over the classroom, teachers overwhelmingly expressed a desire to have more, rather than less, freedom and control over their teaching, with 48.6% agreeing that they would benefit from having more control than they have at present and only 17.7% agreeing that they would benefit from having district-created lesson plans.

Are the needs that teachers have for resources and services impacted by their attitudes? To answer this question, Pearson *r* correlations were performed to determine if correlations existed between RMAS score and each of Survey Questions 47 through 57. The results are shown in Table 21. The only significant relationship was between RMAS score and the level of agreement that a math mentor in the first years of teaching would be beneficial (SQ 57), $r = -.154$, $p < .05$. Those with higher RMAS scores are less likely to feel that they would have benefitted from a math mentor.

Survey Questions 58 and 59 asked participants, in an open-ended format, about the services that would or would have most benefited them. The responses to these questions were coded in the same manner and at the same time as Survey Questions 39 and 40.

Table 21

Correlations Between RMAS Score and Desire for Resources and Services

Correlation	*N*	*r*	*p*	Sig
RMAS * SQ47	265	-0.033	0.598	
RMAS * SQ48	265	0.106	0.085	
RMAS * SQ49	265	-0.089	0.148	
RMAS * SQ50	265	-0.024	0.701	
RMAS * SQ51	265	0.057	0.351	
RMAS * SQ52	265	0.057	0.355	
RMAS * SQ53	265	-0.072	0.244	
RMAS * SQ54	263	0.028	0.654	
RMAS * SQ55	262	-0.040	0.519	
RMAS * SQ56	257	-0.094	0.133	
RMAS * SQ57	264	-0.154	0.012	$p < .05$

Survey Question 58 asked participants to think back to their first two years of teaching and to identify the services or resources that would have most benefited them as they began teaching mathematics. Responses and frequencies are shown in Table 22.

Fifty-two participants felt that they would have benefitted from having a math mentor to assist them through their first year or two. It is worth noting that these participants often worded their responses similar to, “I like the idea of a math mentor,” indicating that they likely had not considered the concept prior to seeing it in Survey

Table 22

District-Supplied Services or Resources From Which Teachers Feel They Would Have Most Benefited in Their First Two Years

Factor	Responses	Percent
Having a Math Mentor	52	18.9
More manipulatives	48	17.5
A curriculum map	21	7.6
Time for grade-level collaboration on lesson plans	17	6.2
A different (or any) curriculum / textbook	17	6.2
Ability to observe experienced teachers giving math lessons	14	5.1
More or better materials or resources (workbooks, etc.)	13	4.7
Teacher Aid or Co-Teacher	11	4.0
Teacher resources (manual, pre-made lesson plans, etc.)	8	2.9
More time for lesson planning	6	2.2
Technology/Computers/Computer Games	5	1.8
More control over order/pacing/assessments	3	1.1
Longer period of time each day in which to teach math	3	1.1
Other	7	2.5

Question 57. Other sources of peer-to-peer assistance included a desire for grade-level collaboration on lesson plans (n = 17), observation of more experienced teachers (n = 14), and having a co-teacher or teacher's aide during math lessons (n = 11).

Budgets for mathematics materials were often issues, with teachers expressing a desire for more manipulatives (n = 48), more or better math resources (n = 13), teacher resources (n = 8), and technology (n = 5). Also called into question was the district's focus on mathematics, with participants asking for curriculum maps (*n* = 21), better curriculum (*n* = 17), more time for lesson planning (*n* = 6), and a longer period of time each day allotted to math instruction (*n* = 3).

Less common recommendations for new teachers included having more control over order, pacing, and assessments (*n* = 3); reducing the amount of material covered (*n* = 2); having enough calculators for all students (*n* = 2); having a smaller class size (*n* = 1); having enrichment/challenge materials for advanced students (*n* = 1); and having kindergarten math standards (*n* = 1).

Many participants believed that the services that would have most benefitted them in their first two years of teaching mathematics included professional development. While 24 participants did not specify the topic of the needed professional development, many did. The results are listed in Table 23.

Survey Question 59 asked participants to identify the services or resources that would most benefit them today as they teach mathematics. Responses and frequencies are shown in Tables 24 and 25.

Larger budgets seem to be foremost on their minds, with teachers expressing a need for more manipulatives (*n* = 48); materials and resources (*n* = 18); technology, computers, or computer games (*n* = 13); enrichment/challenge materials for higher students (*n* = 6); an overhead projector, overhead calculator, or ELMO; teacher resources (*n* = 3); and pre-made math centers (*n* = 3).

Table 23

Professional Development Topics From Which Teachers Feel They Would Have Most Benefited in Their First Two Years

Factor	Responses	Percent
General (just said needed more training)	24	8.7
Methods of teaching mathematics	13	4.7
Training on textbook series (by textbook publisher or expert)	9	3.3
Using manipulatives to teach math	8	2.9
How to teach important concepts in multiple ways	4	1.5
Training on the math content itself	3	1.1
Differentiating math instruction	3	1.1
How to effectively spiral	2	0.7
Using games	2	0.7
Integrating math into other content areas	2	0.7
Handling the student who has fallen behind	2	0.7
Other	8	2.9

Peer collaboration was also important, with teachers asking for time for grade-level collaboration (*n* = 15), the opportunity to observe other experienced teachers (*n* = 7), a co-teacher or teacher's aide (*n* = *4*), or a math mentor (*n* = *4*). Teachers also expressed a desire for the school and district to improve their teaching situations, with teachers asking for more control over order, pacing, and assessments (*n* = 9); a longer period of time each day in which to teach math (*n* = 9); more time for lesson planning (*n* = 7); time (unspecified) (*n* = 7); and a curriculum map (*n* = 3).

Table 24

District-Supplied Services or Resources From Which Teachers Feel They Would Most Benefit

Factor	Responses	Percent
More manipulatives	48	17.5
More or better materials or resources (workbooks, etc.)	18	6.5
Time for grade-level collaboration on lesson plans	15	5.4
A different (or any) curriculum/textbook	13	4.7
Technology/Computers/Computer Games	13	4.7
More control over order/pacing/assessments	9	3.3
Longer period of time each day in which to teach math	9	3.3
Ability to observe experienced teachers giving math lessons	7	2.5
More time for lesson planning	7	2.5
Time (no specification)	7	2.5
Enrichment/Challenge materials for higher students	6	2.2
Teacher Aid or Co-Teacher	4	1.5
Having a Math Mentor	4	1.5
Overhead projector, overhead calculator, ELMO	4	1.5
Teacher resources (manual, pre-made lesson plans, etc.)	3	1.1
A curriculum map	3	1.1
Pre-made math centers	3	1.1
Other	8	2.9

Other services or resources requested by teachers included a reduction in the amount of material to be covered ($n = 2$); having the ability to "offload" students who are behind to another classroom or a pullout teacher ($n = 2$); calculators for all students ($n = 2$); departmentalized math ($n = 1$); and smaller class sizes ($n = 1$).

Table 25

Professional Development Topics From Which Teachers Feel They Would Most Benefit

Factor	Responses	Percent
General (just said needed more training)	29	10.5
Methods of teaching mathematics	16	5.8
ISAT (Standardized Test) Preparation	11	4.0
Handling the student who has fallen behind	8	2.9
Engaging/Motivating Students	7	2.5
Using manipulatives to teach math	7	2.5
How to teach important concepts in multiple ways	7	2.5
Training on textbook series (by textbook publisher or expert)	6	2.2
Using games	5	1.8
State Standards	4	1.5
How to teach problem solving/mathematical thinking	4	1.5
Differentiating math instruction	4	1.5
Integrating math into other content areas	4	1.5
Working with parents to make them better partners	3	1.1
Training on the math content itself	3	1.1
Using Technology to teach math	1	0.4

Participants also discussed a need for further professional development. While some teachers mentioned a desire for professional development without specifying the goal of that professional development (n = 29), others did specify the training that they felt would be of benefit to them. These results are shown in Table 25.

Conclusions

RQ 1 - Current Attitudes Toward Mathematics

Research Question 1 asked for a measurement of the current attitudes of elementary school teachers in Blue, Green, and Orange counties toward mathematics. The median Revised Math Attitudes Scale score of the teachers surveyed was 58, well above the score of 40, which would indicate a neutral attitude. In fact, less than 20% of those surveyed scored in a range that would indicate negative ATM. In an earlier study, Higdon (1975) found in-service teachers in the Houston area to have a mean RMAS score of 50.19, while prospective teachers in the same area had mean scores of 46.55. A more recent study by Rech, et al. (1993) showed prospective elementary teachers to have a mean RMAS score of 36.63, well below the general college population mean score of 45.39. If the teachers in the present study did enter the teaching profession with a median attitude toward math that was either negative or only slightly positive, as would be consistent with these previous studies, then some change must have taken place in the intervening period. This change could be the result of changing attitudes, or they could be a result of an attrition of those with negative ATM. Research Questions 1a and 1b explored the former possibility.

Research Question 1a asked to what extent, if any, there was a relationship between attitudes and quantity of experience (1a.1), between attitudes and types of experience (1a.2), and between attitudes and recency of mathematics training (1a.3).

RQ 1a.1 - Between ATM and quantity of experience. In agreement with the findings of Higdon (1975), number of years of experience teaching and number of years of experience teaching math did not correlate to the RMAS score in the present study. Age also did not correlate with RMAS score. The best quantity of experience predictor of RMAS score was the number of years that the teacher had taught at the current grade level, $\beta = 0.210$, $t = 3.428$, $p < .001$, indicating that comfort with specific math content and lessons may be an important factor in teacher ATM.

All four of the quantity of experience factors (age, number of years teaching, number of years teaching math, and number of years teaching at the current grade level) had significant, positive correlations with the belief that math has intrinsic value. Age had a significant, positive correlation with the belief that math has extrinsic value.

RQ 1a.2 - Between ATM and type of experience. The importance of comfort with the material currently being taught carried over to the exploration of the relationship between the RMAS score and the types of teaching experience had by the teachers. RMAS scores were significantly higher for those who currently teach at a single grade level, $r = -.38$, $t\ (23.858) = 2.071$, $p < .05$, whose current range of grades taught was smaller, $r\ (262) = -.234$, $p < .001$, and whose number of unique grade levels currently teaching was fewer, $r\ (262) = -.245$, $p < .001$. The fact that significant results existed for these three variables that focus on the teacher's current assignment and did not exist for the three similar variables that focus on the teacher's career may indicate that teacher ATM is more fluid than stable and may decrease rapidly upon being re-assigned to a different grade level or a broader range of grade levels. A longitudinal study would be necessary to confirm such a hypothesis.

Weaker but significant relationships were also found between RMAS score and the lowest grade level in which one currently teaches, r (262) = .149, $p < .05$, and between RMAS score and the lowest grade level in which one has taught in one's career, r (263) = .150, $p < .05$. This could either indicate that those who have lower attitudes toward mathematics tend to seek positions at the lower grade levels, or that those who teach at higher grade levels are more likely to have experiences that lead to a positive impact on their ATM. A longitudinal study that follows new teachers from the college to the classroom would be necessary to make this distinction.

Teachers who had experience teaching mathematics in a departmentalized setting had higher RMAS scores than those who had only taught in a self-contained classroom, t (212) = -3.591, $p < .001$. While this may indicate that the ability to focus on teaching mathematics increases ATM, it is likely that much of this difference is a result of those with higher ATM being more likely to seek or accept positions where their teaching will focus on mathematics.

Those who had experience co-teaching mathematics also had higher RMAS scores than those who had taught only in a self-contained classroom, t (78.821) = -3.566, $p < .01$. These results may indicate that working collaboratively with another teacher on lesson plans or observing another teacher delivering a lesson had a positive impact on ATM. If the co-teacher of the participant was a special education teacher assisting with an inclusive environment, it is possible that having the ability to have another person help struggling students resulted in the higher ATM. The survey used in this study did not delineate the nature of the co-teaching experience or if that experience was in the past or ongoing, both of which would be important pieces of information should one seek to gain insight into this relationship.

RQ 1a.3 - Between ATM and post-certification training experience. Those teachers who had experienced training focused on mathematics or mathematics instruction after entering the classroom were more likely to have higher RMAS scores. Those who had taken a college course related to mathematics had higher RMAS scores, t (263) = -2.173, $p < .05$, as did those who had taken one or more full-day workshops related to mathematics, t (263) = -2.619, $p < .01$. There was no correlation between RMAS score and the length of time since the teacher had taken the significant training.

RQ 1b - Perceptions of change in ARM components. Research Question 1b asked how veteran teachers' current ARM compare with their perceptions of their own ARM prior to entering the classroom. Five ARM components were considered - enjoyment of math, confidence with math, understanding of elementary math, belief that math is intrinsically valuable, and belief that math is extrinsically valuable.

Participants perceived a significant increase in their level of enjoyment of math since entering the classroom, t (274) = 10.899, $p < .001$. Enjoyment of mathematics was positively correlated with having experience teaching in a departmentalized classroom ($\beta = 0.134$, $t = 2.442$, $p < .05$), with having taken a full-day math workshop ($\beta = 0.118$, $t = 2.323$, $p < .05$), with the lowest grade level currently being taught ($\beta = 0.124$, $t = 2.444$, $p < .05$), and with the lowest grade level taught in one's career ($\beta = 0.103$, $t = 2.034$, $p < .05$). Enjoyment of math was negatively correlated with the number of unique grades currently being taught by the teacher ($\beta = -0.212$, $t = -4.280$, $p < .001$) and the range of grades currently being taught by the teacher ($\beta = -0.209$, $t = -4.210$, $p < .001$).

Participants perceived a significant increase in their level of confidence with math since entering the classroom, $t(274) = 12.042$, $p < .001$. Confidence in math was positively correlated with having taken a full-day math workshop ($\beta = 0.166$, $t = 3.322$, $p < .01$) and with the minimum grade level currently being taught ($\beta = 0.178$, $t = 3.568$, $p < .001$). Confidence in mathematics was negatively correlated with the number of unique grades currently being taught by the teacher ($\beta = -0.247$, $t = -5.031$, $p < .001$) and with the range of grades currently being taught by the teacher ($\beta = -0.242$, $t = 4.916$, $p < .001$).

Participants perceived a significant increase in their level of understanding of elementary math since entering the classroom, $t(274) = 13.275$, $p < .001$. The level of understanding of elementary math was positively correlated with the lowest grade level currently being taught ($\beta = 0.176$, $t = 3.508$, $p < .01$) and with the lowest grade level taught in one's career ($\beta = 0.128$, $t = 2.508$, $p < .05$). Understanding of elementary mathematics was negatively correlated with the number of unique grade levels currently being taught by the teacher ($\beta = -0.244$, $t = -4.940$, $p < .001$) and the range of grades currently being taught by the teacher ($\beta = -0.258$, $t = -5.251$, $p < .001$).

Participants perceived a significant increase in their level of belief that math is intrinsically valuable, $t(272) = 12.413$, $p < .001$. Level of belief that math is intrinsically valuable was positively correlated with age ($\beta = 0.118$, $t = 2.632$, $p < .01$), with the number of years the teacher has taught ($\beta = 0.116$, $t = 2.621$, $p < .01$), with the number of years the teacher has taught at the current grade level ($\beta = 0.098$, $t = 2.198$, $p < .05$), with the number of years the teacher has taught math ($\beta = 0.107$, $t = 2.411$, $p < .05$), and with having taken a full-day math workshop ($\beta = 0.110$, $t = 2.484$, $p < .05$). Level of belief that math is intrinsically valuable was negatively correlated with the number of unique grade levels currently being taught by the teacher ($\beta = -0.116$, $t = -2.627$, $p < .01$) and the range of grades currently being taught by the teacher ($\beta = -0.105$, $t = -2.377$, $p < .05$).

Participants perceived a significant increase in their level of belief that math is extrinsically valuable since entering the classroom, $t\ (273) = 12.107$, $p < .001$. Level of belief that math is extrinsically valuable was positively correlated with age ($\beta = 0.106$, $t = 2.147$, $p < .05$) and with the lowest grade level currently being taught ($\beta = 0.121$, $t = 2.436$, $p < .05$). Level of belief that math is extrinsically valuable was negatively correlated with the number of unique grades currently being taught by the teacher ($\beta = -0.107$, $t = -2.155$, $p < .05$).

RQ 2 - Possible Causes of Changes in ARM

Research Question 2 asked what factors veteran teachers self-identify as being the leading post-college causes of change in their ARM. Six factors that had been identified for review as agents of change in teacher ARM were the experience of teaching math to students, professional development workshops about math or the teaching of math, the current focus on improving ISAT and other standardized test scores, instructional feedback from a principal or dean, interaction with parents, and personal life experience needing and using math.

An overwhelming 87.9% of participants felt that the experience of teaching math had a positive impact on their attitudes toward mathematics. No other factor tested served as a predictor of the effect that experience had on participant ATM.

Of the 142 teachers who had taken a full-day workshop in mathematics since beginning their teaching careers, 80.3% felt that they were very positively or positively impacted by the workshops that they have attended. Workshops were more likely to have positively impacted females (β = -0.195, t = -2.347, $p < .05$) and those who had also taken college coursework in mathematics since entering the classroom (β = .199, t = 2.405, $p < .05$).

Teachers had mixed feelings about standardized testing, with 38.5% indicating that the focus on improving test scores has improved their attitudes toward math, while 32.2% indicated that such a focus had a negative impact on their attitudes. Significant negative correlations existed between the impact that standardized tests had on teacher ATM and the number of unique grade levels taught over one's career (β = -0.172, t = -2.874, $p < .01$), the range of grades taught over one's career (β = -0.153, t = -2.554, $p < .05$), and the number of years since a college course in mathematics had been taken (β = -0.218, t = -2.121, $p < .05$). Those with experience teaching in a resource capacity were also more negatively impacted by standardized testing than their peers who had only taught in a self-contained classroom (β = -0.149, t = -2.204, $p < .05$).

Few teachers felt that their attitudes toward math were negatively impacted by interaction with their principals or deans, with 47.6% indicating a positive impact and only 7.6% indicating a negative impact. The influence of feedback from instructional leaders on teacher attitudes was positively correlated with the lowest grade level in which one has taught in one's career (β = .132, t = 2.201, p < .05). The influence of feedback from instructional leaders on teacher attitudes was negatively correlated with age (β = -.238, t = -4.054, p < .001), number of years of teaching experience (β = -.238, t = -4.054, p < .001), number of years teaching at the current grade level (β = -.230, t = -3.904, p < .001), number of years teaching mathematics (β = -.203, t = -3.419, p < .01), range of grade levels taught in one's career (β = -.201, t = -3.389, p < .01), the count of grade levels taught in one's career (β = -.178, t = -2.983, p < .01), the count of unique grades in which one currently teaches (β = -.166, t = -2.778, p < .01), and the range of grade levels in which one currently teaches (β = -.165, t = -2.751, p < .01). Teachers who had taught in a resource capacity were more likely to report being negatively impacted by interaction with instructional leaders than those who had only taught in a self-contained classroom (β = -0.172, t = -1.054, p < .05).

Interaction with parents was reported to have a positive impact on attitudes by 49.4% of teachers and a negative impact on attitudes by 7.6% of teachers. The influence of interaction with parents on teacher attitudes was negatively correlated with the range of grades in which one currently teaches (β = -.127, t = -2.119, p < .05) and the number of unique grade levels in which one currently teaches (β = -.133, t = -2.217, p < .05).

Most participants indicated that their personal experience needing and using mathematics had a positive impact on their attitudes toward mathematics, with 83.2% indicating a positive impact and 3.7% indicating a negative impact. The influence of needing and using mathematics in one's personal life was positively correlated with pre-service belief that math is extrinsically valuable ($\beta = .352$, $t = 6.193$, $p < .001$), with pre-service belief that math is intrinsically valuable ($\beta = .310$, $t = 5.363$, $p < .001$), with pre-service enjoyment of math ($\beta = .252$, $t = 4.300$, $p < .001$), with pre-service confidence in math ($\beta = .250$, $t = 4.260$, $p < .001$), with pre-service understanding of math ($\beta = .231$, $t = 3.926$, $p < .001$), with having experienced teaching in a departmentalized setting ($\beta = .185$, $t = 2.795$, $p < .01$), with having taken college coursework in math after entering the classroom ($\beta = .145$, $t = -2.415$, $p < .05$), and with having had experience co-teaching mathematics ($\beta = .143$, $t = 2.146$, $p < .05$).

RQ 2 - Other Factors Creating Change in Teacher ATM

Open-ended survey questions were used to determine if there were other factors that teachers identified as influencing their attitudes toward mathematics since entering the classroom. Teachers listed several factors as contributing to positive shifts in their attitudes toward math. The most common were repeated exposure to the same mathematical content ($n = 31$), experience with new mathematical or instructional strategies ($n = 30$), experience with hands-on methods of teaching math ($n = 28$), seeing students "get it" ($n = 27$), liking a specific textbook series or curriculum ($n = 24$), gaining an increased understanding of the importance of math ($n = 21$), and attendance at a workshop or graduate course ($n = 21$).

Teachers also listed several factors that had a negative influence on their attitudes toward math. Discontent with the curriculum (its content, order, or pacing) was the leading negative force upon teacher attitudes, mentioned by 62 participants. Other factors included the influence of standardized testing on teaching ($n = 32$), frustration experienced when students do not understand (*n* = 19), the teaching situation (*n* = 15), and poor professional development opportunities (*n* = 12).

RQ 3 - Math-Related Services

Research Question 3 asked what services, if any, teachers believed that Educational Service Agencies, districts, or schools might provide to facilitate positive attitudes among elementary teachers.

When it came to professional development opportunities, only 29.9% of teachers agreed that their schools offered meaningful math-related workshops, while 52.9% indicated that their schools did not do so. The regional professional development center was seen by 53.2% as providing meaningful math trainings, while 17.9% indicated that it did not.

When asked if they would benefit from specific types of training, 87.3% agreed that they would benefit from training related to methods of teaching mathematics, 74.6% agreed that they would benefit from training related to math standards and standardized testing, 69.8% agreed that they would benefit from training related to better understanding mathematical content, and 42.2% agreed that they would benefit from training related to the history of mathematical concepts. In the open-ended questions, participants added that they would benefit specifically from training on handling students who have fallen behind, on engaging and motivating students, on the use of manipulatives, on the use of their specific textbook series, and on how to teach important concepts in multiple ways.

While the majority of teachers surveyed did not agree with statements that they would benefit from having more equipment or resources, requests for equipment and resources were common in the open-ended questions. In the open-ended questions, teachers asked for more manipulatives, more or better materials and resources (workbooks, etc.), more technology equipment, and more teacher resources (manuals, etc.)

While only 24.9% of teachers agreed with the statement that a math mentor would have been helpful in their first two years, it is interesting to note that a full 18.9% of respondents listed the concept in the open response area as the resource from which they would have most benefitted in their first two years of teaching. Other forms of peer-to-peer collaboration were brought out in the open-ended questions, including time for grade-level collaboration on lesson plans, having the ability to observe experienced teachers giving math lessons, and working with a co-teacher or teacher's aide.

In questions related to curriculum and pacing, teachers indicated that they wanted guidance from the district in the form of a curriculum map, especially in the early years of teaching. However, with that information in hand, teachers wanted more control to make decisions on their instruction. This included a desire to have input on textbook selection; the ability to make decisions about order, assessment, and pacing; and the freedom to adjust the amount of time devoted to mathematics instruction as needed.

Conclusion Summary

The teachers surveyed in Blue, Green, and Orange Counties appear overall to have positive attitudes toward mathematics. More positive attitudes toward mathematics tend to correlate with variables that indicate that a teacher has had the opportunity for repeated and focused exposure to mathematical content, such as the number of years teaching at the current grade level, teaching at a single grade level, presently teaching a smaller range of grade levels, and teaching in a departmentalized setting. Other correlates were also discovered.

Teachers perceived positive change in enjoyment of math, confidence in math, understanding of elementary math content, the belief that math is intrinsically valuable, and the belief that math is extrinsically valuable. Quantity of experience variables did not correlate with changes in enjoyment, confidence, or understanding, suggesting either that the bulk of the change in these attitude factors occurs within the first year of teaching and/or that these variables fluctuate in a non-linear path throughout one's career based on other factors (such as being reassigned to a different grade level). Positive changes in enjoyment, confidence, and understanding were more pronounced among those presently teaching the least number of unique grade levels and the lowest range of grade levels.

Most teachers believe that their experience in the classroom has improved their attitudes toward mathematics. Classroom experience provided teachers with repeated exposure to the same material, the ability to relearn mathematical concepts in ways different than those in which they originally learned them, and to see students succeed. Life experience needing and using math, as well as professional development on mathematical topics, were seen by most teachers as having positive impacts.

Teachers were divided as to the influence of standardized testing on their attitudes, with nearly equal amounts indicating that it had a positive impact, a negative impact, or no impact. Interaction with instructional leaders (principals and deans) and parents had neutral to positive impacts on most teachers' ATM.

Most teachers agreed that they would benefit from math-related training opportunities. However, only half of teachers believed that their regional professional development center offered meaningful mathematics trainings, and less than a third believed that their districts did so. Teachers requested trainings on handling students who had fallen behind, on engaging and motivating students, on the use of manipulatives, on using their specific textbook series, and on teaching important concepts in multiple ways.

While equipment, resources, and math mentors were not needed by the majority of teachers, most of those who indicated that they would benefit from those resources and services felt strongly enough about those needs to include them in the open-ended response section as the most important need.

From their districts, teachers wanted to have control with guidance and the opportunity for collaboration. In other words, they wanted the districts to provide them with curriculum maps, expectations, and training on the textbook series in use. They then wanted peer collaboration as a means of providing them with meaningful instructional improvement. Given all of that guidance and support, they then wanted to have the freedom and control to make the decisions that affect their classrooms, such as order, assessment, pacing, and time dedicated to math instruction.

Implications and Recommendations

This study was designed to be practical - giving direction to practitioners, as well as exploratory - giving direction to future research. As such, implications and recommendations are provided for teacher education institutions, for schools and districts, for Education Service Agencies, and for researchers.

Implications and Recommendations for Teacher Education Institutions

As indicated in Chapter 2 of this document, several teacher education institutions are seeking direct ways to create positive change in the attitudes toward mathematics of the prospective teachers that they serve. Unfortunately, many of the studies related to these attempts base their successful results on assessments given at the start of a math-related course (when students seek to understate their attitudes to decrease expectations) and again at the end of the course (in the same room in which the experience took place, while the experience is still fresh in their minds, where their responses are likely to indicate their attitudes toward the instructor or the course itself than toward math in general.) The extent to which these increases remain with the prospective teacher through their final year of college and into the workforce remains mostly unclear.

The results of the present study suggest that such time and effort may be better directed elsewhere. Attitudes toward math appear to be significantly higher among veteran teachers than among prospective teachers, regardless of the length of service. Most of the factors that appear to lead to this increase are tied to the occupation and the experience of teaching and, as such, cannot be replicated by the college. In other words, these colleges are attempting to solve a problem that, in many cases, will solve itself.

This is not to say that colleges can do nothing to affect permanent and positive change in the ATM of prospective teachers. However, rather than attempting to impact attitudes directly, a college's efforts may better serve its students by preparing its students to take full advantage of the positive attitude-changing factors they will experience upon entering the classroom, as well as to circumvent the negative attitude-changing factors. Possible recommendations include:

- When veteran teachers were asked for factors that had a negative impact on their attitudes toward mathematics and were asked what services they would like, issues surrounding the order, content, and pacing of curriculum topped the list. Colleges would do well to expose students to the top three or four textbook series utilized by schools in their state. Not only would this give students an increased chance of having prior familiarity with the mathematics curriculum mandated by their school district in their first year, but it would provide them with the more generalized skill of being able to parse any math textbook or textbook series to determine its flow, its ordering of concepts, timing issues, its assumptions, its understandability, its strengths, and its weaknesses. Moreover, students will have experience discussing ways to overcome a textbook's weaknesses with other resources, reducing a textbook's ability to discourage them.
- Veteran teachers benefitted from seeing multiple ways to approach the same concept or problem. At times, their attitudes were improved when they learned a new way to think about a topic that had not made sense to them in their own schooling. On the opposite end, some teachers were disturbed by the fact that

some concepts are taught by their textbooks in a different way than the way it was taught to them. Colleges can prepare students to embrace new approaches to old problems, while giving them experience in judging the benefits and detriments of various approaches. Comparing the approaches taken by various textbook series is one way to open a prospective teacher to the idea that there may be multiple approaches to the same concept or problem, while also giving him or her an understanding of the fact that he or she may draw from numerous sources to find ways to help different students to succeed.

- Many teachers felt that their attitudes toward mathematics were positively impacted by an increased understanding of the importance of math. However, the belief that math is intrinsically valuable was the least likely to change from negative to positive on its own. Colleges, with their access to mathematicians and to faculty in occupational programs (business, health care, etc.) are well suited to provide students with opportunities to explore both the intrinsic and extrinsic value of mathematics, making future teachers more receptive to increases in other attitudinal factors. Such experiences may also help future teachers to feel less frustrated and more confident when asked the questions, “why do I have to learn this?” or “when am I ever going to use this?”.

Implications and Recommendations for Schools and Districts

The present study has several implications for schools and districts. These include the following:

- First-year teachers have special needs that include:
    - An introduction to the mathematics text being used, either by a representative of the textbook publisher or by another teacher who has had experience with the book.
    - A formal or informal timeline for the year's mathematics instruction.
    - Opportunities to observe veteran teachers using a wide variety of methods. Where this is logistically impossible, a district may consider encouraging its experienced teachers to videotape select lessons to share with first-year teachers.
    - A math mentor with whom to review lesson plans for mathematical accuracy, for age-appropriateness, and for pacing.
- When an experienced teacher must be reassigned from one grade level to another, that teacher should be offered the same kinds of support structures as first-year teachers.
- When logistically possible, principals should give teachers a structure in which to work collaboratively on mathematics instruction. This may be in the form of co-teaching or collaborative lesson planning.
- Nearly all aspects of ARM appear to be negatively impacted when a teacher is required to teach math to multiple grade levels, especially when those grade levels

are widely spread apart. The decision to have one teacher provide mathematics instruction in multiple grade levels should not be made lightly and, when possible, only with the enthusiastic support of the teacher involved.

- While most teachers agreed that they would benefit from professional development related to mathematics, the majority felt that their school did not provide such trainings. Schools that do not currently provide such opportunities should consider doing so.

Implications and Recommendations for Education Service Agencies

Teachers indicated that they would benefit from training related to methods of teaching math, math standards and testing, and mathematical content. However, nearly half of the teachers surveyed say that they have never attended a full-day workshop related to math. The same amount indicated that their ESA does not provide meaningful math-related trainings. The ESA in Blue, Green, and Orange counties must determine if this discrepancy is indicative of a true lack of professional development opportunities that are in line with teacher needs, of poor marketing, or of some other factor.

Participants wanted to see workshop offerings that focused on:

- What to do with students who have fallen behind the class
- Engaging and motivating students to do math
- Using manipulatives to teach math
- Training focused on their specific textbook series, provided by the textbook publisher or someone who has had experience with the series
- Training on how to teach important concepts in multiple ways

While the schools themselves are capable of offering generalized training, such as how to use learning centers in a mathematics classroom, the ESA has the unique ability to offer training specified to particular grade levels or topics, as it may draw participants from many schools. In addition to providing focused versions of the topics above (such as *Multiple Ways to Teach Multiplication*), ESAs may also provide support for first-year teachers and teachers who have been reassigned to a new grade level. For example, the ESA would be wise to offer workshops with such titles as, *I've Been Reassigned to Fourth Grade - What Do I Need to Know About Teaching Fourth Grade Math*.

ESAs may also provide support to district initiatives by writing grants to supply schools with math mentors, coaches to support those initiating collaborative lesson planning, or a warehouse lendable math manipulatives and resources .

Implications and Recommendations for Researchers

The present study focused on the ARM of teachers with one or more years of experience teaching mathematics. Most studies in the area of teacher ARM have focused on preservice teachers, specifically those enrolled in math-related courses. This leaves two important types of studies that should be pursued.

First, a serious and important gap in research exists about teacher ARM between the time that the prospective teacher completes his or her last math-related course (whether it be a content course or a methods course) and the end of the first year of full-time teaching. A study that tracks the ARM of prospective teachers from the end of their junior year in college to the end of their first year of teaching would provide important information about the nature of changes in ARM.

Second, a longitudinal study that tracks the ATM of a cohort of teachers over several years would provide valuable information in quantifying the variability of and causes of shifts in ATM over time. How severe are the drops in ATM when a teacher is reassigned to a new grade level? What other factors may dull or intensify such a drop? How quickly do teachers rebound from such drops?

The exploratory nature of the present study should provide future researchers with insight that will help them in the creation of their surveys or interviews. Several factors that did not correlate to teacher ATM may be removed from examination to provide more focus. For example, it appears that earning one's teaching certificate as a traditional student or as a returning student does not have a significant impact on ATM or changes in ARM. Other factors that did correlate to teacher ATM may be pursued in more depth. Factors that became apparent in open-ended questions may be added as pre-defined factors to determine their true prevalence.

The researcher of the present study recommends that future research consider the following questions, either as research questions or as subquestions:

- In the present study, a correlation was shown between the number of years a teacher has taught at his or her current grade level and ATM. This was backed up by comments in the open-ended area where teachers cited repeated exposure to material as the main force of positive change in ATM. How and to what extent are teachers' ATM affected by reassignment to a new grade level? Is there a difference in the direction and amount of change depending on if the teacher is reassigned to a higher or a lower grade level? Is there a difference in the direction and amount of change depending on the distance between the former and new grade level? What types of support structures seem to mediate drops in ATM?

- In the present study, those who teach math at multiple grade levels demonstrated a lower ATM than those who teach math at a single grade level. What are the difficulties faced by those who teach math at multiple grade levels that may cause them to have more negative ATM than teachers who teach at a single grade level? At first thought, one might suspect that such teachers would have higher ATM, as they were likely assigned to such a position by choice, have likely demonstrated talent for teaching math, and likely have a broader perspective on mathematics. The present study indicates that this is not the case. Why? Are the same difficulties face by those who teach other subjects at multiple grade levels, and are their attitudes toward those subjects similarly affected?
- In the present study, a correlation was shown between the lowest grade level taught (both currently and career) and ATM. What is the nature of the relationship between the lowest grade level of math taught and ATM? Are prospective teachers with lower ATM seeking positions in the lower grade levels in part due to fears about teaching math? Are the differences in attitudes a result of the teaching experience, with teachers of higher grade levels experiencing more positive change?
- In the present study, those with experience co-teaching math demonstrated higher ATM than those without such experience. What is the nature of the relationship between co-teaching and ATM? Does co-teaching have a stronger impact on those

who teach in a scenario with one main teacher and one special education-focused teacher, or in a scenario with equal co-teachers? Does the positive impact of such an experience carry over to future years in which one no longer has the opportunity to co-teach? What specific aspects of the co-teaching experience cause change in ATM?

- In the present study, a positive correlation was shown between having taken training in math (workshops or coursework) after entering the classroom and ATM. However, the length of time since the training did not correlate with the ATM of those who have had such training. Are those with higher ATM simply more likely to attend trainings in mathematics (which themselves have no long-term impact), or do the trainings truly have an impact that can be measured over the long-term? If trainings do have an impact on teacher ATM, how long after the training does such an impact remain? What can be changed about the way that trainings are marketed to encourage teachers with lower ATM to attend?
- In the present study, participants listed “Seeing Students Get It” as a primary open-ended response to causes of positive force in ATM and “Discouragement with Struggling Students” as a cause of negative force. To what extent does variability in a teacher’s ATM follow groups of students? Can a class with difficulties in math lower the ATM of their new math teacher each year? Can a class that excels in math raise the ATM of their new math teacher each year? In other words, what is the impact of student ATM and achievement in math on teacher ATM?

- In the present study, opportunities for peer collaboration were not specifically addressed, yet they commonly appeared as a request in open-ended questions. If presented as an option to all teachers in a survey or interview, what percentage of teachers would welcome more opportunities for peer collaboration? What types of collaboration would they embrace? Since many forms of peer collaboration require those involved to be free at the same time, from where do they see this time coming? Would teachers willingly give up a free period to observe another teacher or stay after school to collaborate on a lesson plan?

REFERENCES

Abrams, L. M., Pedulla, J. J., & Madaus, G. F. (2003). Views from the classroom: Teachers' opinions of statewide testing programs. *Theory Into Practice*, *42*(1), 18-29.

Aiken, L. R. (1963). Personality correlates of attitude toward mathematics. *The Journal of Educational Research*, *56*(9), 476-480.

Aiken, Jr., L. R. (1972). Research on attitudes toward mathematics. *Arithmetic Teacher*, *19*(3), 229-234.

Aiken, Jr., L. R. (1974). Two scales of attitude toward mathematics. *Journal for Research in Mathematics Education, 5*(2), 67-71.

Aiken, L. R., & Dreger, R. M. (1961). The effect of attitudes on performance in mathematics. *Journal of Educational Psychology*, *52*(1), 19-24.

Alci, B., & Erden, M. (2006). The effects of primary school teachers' attitudes towards the mathematics achievement forth grade students by gender. *Erzincan Egitim Fakultesi Dergisi*, Cilt 8, Sai 1, 13-21.

Ambrose, R. (2004). Initiating change in prospective elementary school teachers' orientations to mathematics teaching by building on beliefs. *Journal of Mathematics Teacher Education*, *7*(2), 91-119.

Ball, D. L. (1988a). *The subject matter preparation of prospective mathematics teachers: Challenging the myths.* Retrieved May 5, 2008, from http://eric.ed.gov:80/ERICWebPortal/contentdelivery/servlet?accno=ED301468

Ball, D. L. (1988b). Unlearning to teach mathematics. *For the Learning of Mathematics*. Retrieved March 28, 2008, from http://ncrtl.msu.edu/http/ipapers/html/pdf/ip881.pdf

Ball, D. L. (1990). The mathematical understandings that prospective teachers bring to teacher education. *Elementary School Journal*, *90*, 449-466.

Ball, D. L. (1993). With an eye on the mathematical horizon: Dilemmas of teaching elementary school mathematics. *The Elementary School Journal, 93*(4). Retrieved May 2, 2008, from http://aim.psch.uic.edu/documents/ed594/ball.d_1993.pdf

Ball, D. L., Hill, H. C., & Bass, H. (2005, Fall). Knowing mathematics for teaching. *American Educator,* 14-17, 20-22, 43-46.

Battista, M. T. (1986). The relationship of mathematics anxiety and mathematical knowledge to the learning of mathematical pedagogy by preservice elementary teachers. *School Science and Mathematics*, *86*, 10-19.

Benbow, R. M. (1993, April). *Tracing mathematical beliefs of preservice teachers through integrated content-methods courses.* Paper presented at the Annual Meeting of the American Education Research Association, Atlanta, GA.

Brady, P., & Bowd, A. (2005). Mathematics anxiety, prior experience and confidence to teach mathematics among pre-service education students. *Teachers and Teaching: Theory and Practice*, *11*, 37-46.

Cady, J. A., & Rearden, K. (2007). Pre-service teachers' beliefs about knowledge, mathematics, and science. *School Science & Mathematics*, *107*, 237-245.

Cady, J., Meier, S. L., & Lubinski, C. A. (2006). Developing mathematics teachers: The transition from preservice to experienced teacher. *Journal of Educational Research*, *99*, 295-305.

Campbell, S. (2002). Early mathematics education: A case of the blind leading the blind? *Philosophy of Mathematics Education Journal, 15*.

Carroll, J. (1998). *Understanding professional development through the analysis of the mathematical life histories of primary school teachers.* Retrieved December 21, 2008 from http://www.aare.edu.au/98pap/car98138.htm

Cohen, R. S., & Leung, P. (2004). *Math-anxious, elementary teachers' change processes in a graduate course aimed at building math confidence and reducing anxiety.* Paper presented at the annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Delta Chelsea Hotel, Toronto, Ontario, Canada. Retrieved April 23, 2008, from http://www.allacademic.com/meta/p117677_index.html

Conference Board of the Mathematical Sciences. (2001). *The Mathematical Education of Teachers (CBMS Issues in Mathematics Education)*. Providence, RI: American Mathematical Society and Mathematical Association of America.

Cooney, T. J. (1985). A beginning teacher's view of problem solving. *Journal for Research in Mathematics Education*, *16*(5), 324-336.

Cordingley, P., Bell, M., Rundell, B., & Evans, D. (2003). *The impact of collaborative Continuing Professional Development (CPD) on classroom teaching and learning.* Research evidence library at EPPI-Centre, Institute of Education, London. Retrieved November 1, 2009 from http://eppi.ioe.ac.uk/EPPIWeb/home.aspx?&page=/reel/reviews.htm

Darling-Hammond, L. (1999). Teacher quality and student achievement: A review of state policy evidence. *Education Policy Analysis Archives*. Center for the Study of Teaching and Policy document #R-99-1, University of Washington, Seattle, WA.

DiMartino, P., & Zan, R. (2001). *The problematic relationship between beliefs and attitudes.* In R. Soro (Ed.), Current State of Research on Mathematical Beliefs X, Proceedings of the MAVI-10 European Workshop, June 2-5, 2001. Finland: University of Turku.

Dreger, R. M., & Aiken, L. R. (1957). The identification of number anxiety in a college population. *Journal of Educational Psychology, 48*(6), 344-351.

Dutton, W. H. (1954). Measuring attitudes toward arithmetic. *The Elementary School Journal*, *55*(1), 24.

Dwyer, E. E. (1993). *Attitude scale construction: A review of the literature.* Retrieved March 12, 2010, from http://eric.ed.gov (Publication No. ED359201).

Eccles, J. S., & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society*, *11*(2), 367.

Emenaker, C. (1996). A problem-solving based mathematics course and elementary teachers' beliefs. *School Science and Mathematics, 96*(2), 75-84.

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 249-254). London: Falmer Press.

Fennema, E., & Sherman, J. A. (1976). Fennema-Sherman Mathematics Attitudes Scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics, 7*(5), 324-326.

Frank, M. L. (1990). What myths about mathematics are held and conveyed by teachers? *Arithmetic Teacher*, 37(5), 10-12.

Garner, M. V. (1963). *A study of the educational backgrounds and attitudes of teachers toward algebra as related to the attitudes and achievements of their anglo-american and latin-american pupils in first-year algebra classes of Texas.* Ed.D. dissertation, University of North Texas, United States. Retrieved November 8, 2009, from Dissertations & Theses: Full Text. (Publication No. AAT 6304501).

Gibson, H. L., Brewer, L. K., Magnier, J.-M., McDonald, J. A., & Van Strat, G. A. (1999). *The Impact of an Innovative User-Friendly Mathematics Program on Preservice Teachers' Attitudes Toward Mathematics*. Paper presented at the Annual Meeting of the American Educational Research Assocation (Montreal, Quebec, Canada, April 19-23, 1999).

Goldin, G. A. (2002). Affect, meta-affect, and mathematical belief structures. *Education*, *59*, 72.

Gough, M. F. (1954). Mathemaphobia: Causes and treatments. *Clearing House, 28,* 290-294.

Gschwend, L., & Moir, E. (2007). Growing together: New and veteran teachers support each other through practices that target the needs of high school educators. *Journal of Staff Development, 28*(4), 20-24.

Hannula, M. S. (2002). Attitude towards mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*(1), 25-46.

Hannula, M. S. (2005). *Affect in mathematical thinking and learning [Abstract].* Paper presented at The Future of Mathematics Education and Mathematics Learning, August 18, 2005, Strobl, Austria. Retrieved December 26, 2008 from http://www.didaktik-der-mathematik.jku.at/didaktik-mathe/abstracts/Abstract_Hannula.pdf

Harper, N., & Daane, C. (1998). Causes and reduction of math anxiety in preservice elementary teachers. *Action in Teacher Education, 19*(4), 29-38.

Hembree, R. (1990). The Nature, Effects, and Relief of Mathematics Anxiety. *Journal for Research in Mathematics Education*, *21*(1), 33-46.

Higdon, D. W. (1975). Prospective and experienced elementary teachers: A comparison of mathematical achievement and attitudes. Retrieved March 12, 2010, from http://eric.ed.gov (Publication No. ED107528).

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371-406.

Hill, H. C., Schilling, S. G., & Ball, D. L. (2004). Developing measures of teachers' mathematics knowledge for teaching. *The Elementary School Journal, 105*(1), 11-30.

Howell, D. M. (2006). *A Comparative Analysis of Self-Reported Teacher Self-Efficacy and Student Performance in the Elementary Classroom.* Doctoral dissertation, Idaho State University, Moscow, ID.

Illinois Interactive Report Card. (2009). Database and website created by Northern Illinois University with support from Illinois State Board of Education. Reports generated July 18, 2009, from http://iirc.niu.edu

Jackson, C. D., & Leffingwell, J. R. (1999). The Role of Instructors in Creating Math Anxiety in Students from Kindergarten through College. *Mathematics Teacher*, *92* (7), 583.

Jacobs, J. E., & Bleeker, M. M. (2004). Girls' and boys' developing interests in math and science: Do parents matter? *New Directions for Child & Adolescent Development*, *2004*(106), 5-21.

Karp, K. S. (1991). Elementary school teachers' attitudes toward mathematics: The impact on students' autonomous learning skills. *School Science and Mathematics, 91*(6), 265-270.

Kelly, W. P., & Tomhave, W. K. (1985). A study of math anxiety/math avoidance in preservice elementary teachers. *Arithmetic Teacher*, *32*(5), 51-53.

Kolstad, R., Hughes, S., & Briggs, L. D. (1994). Teacher Attitudes Toward Mathematics. *Journal of Instructional Psychology*, *21*, 44-48.

Lehmann, C. H. (1987). *The Adult Mathematics Learner: Attitudes, Expectations, Attributions.* Retrieved March 12, 2010, from http://eric.ed.gov (Publication No. ED283680).

Leinhardt, G., & Smith, D. A. (1985). Expertise in mathematics instruction: Subject matter knowledge. *Journal of Educational Psychology, 77*(3), 247-271.

Liljedahl, P. G. (2005). Mathematical discovery and affect: The effect of AHA! experiences on undergraduate mathematics students. *International Journal of Mathematical Education in Science & Technology*, *36*(2/3), 219-235.

Lucas, D. M., & Fugitt, J. (2007). The perception of math and math education in the rural midwest. Working paper no. 37. *The Working Paper Series*. Appalachian Collaborative Center for Learning, Assessment, and Instruction in Mathematics, Ohio University, Athens, OH.

Ma, X. (1999). A meta-analysis of the relationship between anxiety toward mathematics and achievement in. *Journal for Research in Mathematics Education, 30(5), 521-541*.

Ma, X., & Kishor, N. (1997). Assessing the Relationship Between Attitude Toward Mathematics and Achievement in Mathematics: A Meta-Analysis. *Journal for Research in Mathematics Education*, *28*, 26-47.

Ma, X., & Xu, J. (2004). Determining the Causal Ordering between Attitude toward Mathematics and Achievement in Mathematics. *American Journal of Education*, *110*(3), 256-280.

Marzano, R. J. (2000). *A new era of school reform: Going where the research takes us.* Aurora, CO: Mid-continent Research for Education and Learning. Retrieved December 25, 2008, from http://www.peecworks.org/PEEC/PEEC_Research

McLaren, K. L. (2005). *The Influence of Instructional Model on the Conceptual Understanding of Preservice Elementary Teachers.* Ph.D. dissertation, University of Maryland, College Park, MD. Retrieved August 5, 2007 from ProQuest Digital Dissertations database (Publication No. AAT 3184287).

McLeod, D. B. (1992). Research on affect in mathematics education: A reconceptualization*.* In Douglas A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575-596). New York: Macmillan Publishing Company.

McLeod, D. B. (1994). Research on affect and mathematics learning in the JRME: 1970 to present*. Journal for Research in Mathematics Education*, *25*(6), 637-647.

Miles, K. H., & Darling-Hammond, L. (1997). Rethinking the allocation of teacher resources: some lessons from high-performing schools. *Educational Evaluation and Policy Analysis, 20*(1), 9-29.

Morris, H. (2001). Issues Raised by Testing Trainee Primary Teachers' Mathematical Knowledge*. Mathematics Education Research Journal*, *3*, 37-47.

Muis, K. R. (2004). Personal Epistemology and Mathematics: A Critical Review and Synthesis of Research*. Review of Educational Research*, *74*(3), 317.

Mullis, I. V. S., Martin, M. O., & Foy, P. (2005). *IEA's TIMSS 2003 International Report on Achievement in the Mathematics Cognitive Domains: Findings from a*

Developmental Project. Chestnut Hill, MA: International Association for the Evaluation of Educational Achievement.

National Center for Education Statistics. U.S. Department of Education Institute of Education Sciences. (2008). Data retrieved through a report generated December 26, 2008 from http://www.nces.ed.gov/nationsreportcard/states/profile.asp.

National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics.* Reston, VA: Author.

National Mathematics Advisory Panel. (2008). *Foundations for success: The final report of the National Mathematics Advisory Panel.* Washington, DC: U.S. Department of Education. Retrieved November 25, 2009, from http://www.ed.gov/about/bdscomm/list/mathpanel/report/final-report.pdf

Neale, D. C. (1969). The role of attitudes in learning mathematics. *Arithmetic Teacher, 16* (8), 631-640.

Pachnowski, L. M. (1997). *Teachers' Definition of Math: Creating and Implementing an Instrument.* Paper presented at the Annual Meeting of the Midwestern Educational Researchers Association (Chicago, IL, October 15-18, 1997).

Pehkonen, E., & Pietilä, A. (2003). *On relationships between beliefs and knowledge in mathematics education.* Proceedings of the CERME-3 (Bellaria) meeting. http://www.dm.unipi.it/cluster-pages/didattica/CERME3/proceedings/Groups/TG2/TG2_pehkonen_cerme3.pdf

Perry, B., Way, J., Southwell, B., White, A., & Pattison, J. (2005). Mathematical beliefs and achievement of pre-service primary teachers. *Building Connections: Research, Theory and Practice,* 625-632.

Peskin, A. S. (1964). *Teacher understanding and attitude and student achievement and attitude in seventh grade mathematics.* Ph.D. dissertation, New York University, NY. Retrieved December 26, 2008, from Dissertations & Theses: Full Text database. (Publication No. AAT 6506584).

Phillips, G. W. (2007a). *Chance favors the prepared mind: Mathematics and science indicators for comparing states and nations.* Washington, DC: American Institutes for Research.

Phillips, G. W. (2007b). *Expressing international educational achievement in terms of U.S. performance standards: Linking NAEP achievement levels to TIMSS.* Washington, DC: American Institute for Research.

Poffenberger, T. N., & Norton, D. A. (1956). Factors determining attitudes toward arithmetic and mathematics. *Arithmetic Teacher*, *3*, 113-116.

Polo, M., & Zan, R. (2005). *Teachers' use of the construct 'attitude': Preliminary research findings.* Retrieved 12/27/2008 from http://cerme4.crm.es/Papers %20definitius/2/Polo.Zan.pdf

Rech, J., Hartzell, J., & Stephens, L. (1993). Comparisons of Mathematical Competencies and Attitudes of Elementary Education Majors with Extablished Norms of a General College Population. *School Science and Mathematics, 93*(3), 141-144.

Reynolds, A. (1995). The Knowledge Base for Beginning Teachers: Education Professionals' Expectations versus Research. *The Elementary School Journal, 95* (3), 199-221.

Richardson, F. C., & Suinn, R. M. (1972). The mathematics anxiety rating scale: Psychometric data. *Journal of Counseling Psychology, 19*(6), 551-554.

Robson, C. (2002). *Real world research: A resource for social scientists and practitioners - researchers* (2nd ed.). Boston, MA: Blackwell Publishing.

Rowan, B., Correnti, R., & Miller, R. J. (2002). What largescale, survey research tells us about teacher effects on student achievement: Insights from the prospects study of elementary schools. *The Teachers College Record*, *104*(8), 1525-1567.

Ruffell, M., Mason, J., & Allen, B. (1998). Studying attitude to mathematics. *Educational Studies in Mathematics*, *35*(1), 1-18.

Rule, A. C., & Harrell, M. H. (2006). Symbolic drawings reveal changes in preservice teacher mathematics attitudes after a mathematics methods course. *School Science & Mathematics*, *106*(6), 241-258.

Sanders, W. L., & Rivers, J. C. (1996). *Cumulative and residual effects of teachers on future student academic achievement.* Knoxville: University of Tennessee Value-Added Research and Assessment Center, Knoxville, TN.

Schofield, H. L. (1981). Teacher effects on cognitive and affective pupil outcomes in elementary school mathematics. *Journal of Educational Psychology*, *73*(4), 462-471.

Schoenfeld, A. H. (1988, Spring). When good teaching leads to bad results: The disasters of "well taught" mathematics courses. *Educational Psychologist, 23(2)*, 145-166.

Sierles, F. S., (2003). How to do research with self-administered surveys. *Academic Psychiatry, 27*(2), 104-113.

Sloan, T. R., Vinson, B., Haynes, J., & Gresham, R. (1997). *A Comparison of Pre- and Post- Levels of Mathematics Anxiety among Preservice Teacher Candidates Enrolled in a Mathematics Methods Course.* Paper presented at the Annual Meeting of the Midsouth Educational Research Association (Nashville, TN, November 12-14, 1997).

Smith, K. H. (2000). *Early childhood teachers' pedagogical content knowledge in mathematics: A quantitative study.* Doctoral dissertation, Georgia State University, Atlanta, GA.

Smith, M. L. (1991). Put to the test: The effects of external testing on teachers. *Educational Researcher, 20*(8), 8-11.

Southwell, B., White, A. L., Way, J., & Perry, B. (2005). *Attitudes versus achievement in pre-service mathematics teacher education.* Retrieved March 12, 2010, from https://www.aare.edu.au/05pap/sou05705.pdf

Squire, B. F., Cathcart, W. G., & Worth, J. E. (1981). Effect of mode of instruction on prospective elementary teachers. *Alberta Journal of Educational Research, 27*(1), 35-45.

Staub, F., & Stern, E. (2002). The nature of teachers' pedagogical content beliefs matters for students' achievement gains: Quasi-experimental evidence from elementary mathematics. *Journal of Educational Psychology, 94*(2), 344-355.

Steele, D. F. (1994). *Helping preservice teachers confront their conceptions about mathematics and mathematics teaching and learning.* Paper presented at the Annual Meeting of the American Educational Research Association (New Orleans, LA, April 1994).

Stigler, J. W., & Hiebert, J. (1997). Understanding and improving classroom mathematics instruction. *Phi Delta Kappan, 79*(1), 14-21.

Stodolsky, S. S. (1985). Telling math: Origins of math aversion and anxiety. *Educational Psychologist*, *20*(3), 125-133.

Sullivan, P. (2003). Editorial: Incorporating knowledge of, and beliefs about, mathematics into teacher education. *Journal of Mathematics Teacher Education, 6* (4), 293-296.

Sullivan, P., & Leder, G. (1992). Students' influence on novice Australian teachers' thoughts and actions regarding mathematics teaching: Two case studies. *The Elementary School Journal, 92*(5), 621-642.

Swars, S., Hart, L. C., Smith, S. Z., Smith, M. E., & Tolar, T. (2007). A longitudinal study of elementary pre-service teachers' mathematics beliefs and content knowledge. *School Science and Mathematics, 107*(9), 325-335.

Szydlik, J. E., Szydlik, S. D., & Benson, S. R. (2003). Exploring changes in pre-service elementary teachers' mathematical beliefs. *Journal of Mathematics Education, 6*, 253-279.

Tapia, M. & Marsh, G. E., II (2002). *Confirmatory Factor Analysis of the Attitudes toward Mathematics Inventory.* Retrieved March 12, 2010, from http://eric.ed.gov (Publication No. ED471301).

Tapia, M. & Marsh, G. E. II (2004). *An instrument to measure mathematics attitudes.* Academic Exchange Quarterly, 8(2). Retrieved February 28, 2008, from http://www.rapidintellect.com/AEQweb/cho25344l.htm

Trice, A. D., & Ogden, E. P. (1987). Correlates of Mathematics Anxiety in First-Year Elementary School Teachers. *Educational Research Quarterly*, *11*(3), 2-4.

Tuft, E. A. (2005). *What is Mathematics? Stability and Chagne in Prospective Teachers' Conceptions of and Attitudes Toward Mathematics and Teaching Mathematics.* Doctoral dissertation, Michigan State University, MI.

Tulock, M. (1957, December). Emotional blocks in mathematics. *The Mathematics Teacher,* 572-576.

Van de Walle, J. A. (1973). *Attitudes and perceptions of elementary mathematics possessed by third and sixth grade teachers as related to student attitude and achievement in mathematics.* Paper presented at the annual meeting of the National Council of Teachers of Mathematics, Houston, TX, April 1973. Retrieved December 25, 2008 from http://eric.ed.gov:80/ERICWebPortal/contentdelivery/servlet/ERICServlet?accno=ED076425

Vinson, B. M. (2001). A comparison of preservice teachers' mathematics anxiety before and after a methods class emphasizing manipulatives. *Early Childhood Education Journal*, *29*(2), 89-94.

Wilkins, J. L. M. (2000). Preparing for the 21st century: The status of quantitative literacy in the United States. School Science and Mathematics, 100(8), 405-418. Retrieved December 14, 2008, from ProQuest Education Journals database. (Document ID: 67232623)

Wilkins, J. L. M., & Ma, X. (2003). Modeling change in student attitude toward and beliefs about mathematics. *Journal of Educational Research*, *97*(1), 52-63.

Wood, E. F., & Floden, R. E. (1990). *Where Teacher Education Students Agree: Beliefs Widely Shared before Teacher Education.* Retrieved October 20, 2009, from http://eric.ed.gov:80/ERICWebPortal/contentdelivery/servlet?accno=ED331781

Woodard, T. (2004). The effects of math anxiety on post-secondary developmental students as related to achievement, gender, and age. *Inquiry*, *9*(1), 1-91.

Wright, S. P., Horn, S. P., & Sanders, W. L. (1997). *Teacher and classroom context effects on student achievement: Implications for teacher evaluation.* Journal of Personnel Evaluation in Education, 11, 57-67. Retrieved December 25, 2008 from http://www.sas.com/govedu/edu/teacher_eval.pdf

Yee, D. K., & Eccles, J. S. (1988). Parent perceptions and attributions for children's math achievement. *Sex Roles, 19*(5), 317-333.

Zan, R., Brown, L., Evans, J., & Hannula, M. (2006). Affect in mathematics education: An introduction. *Educational Studies in Mathematics, 63*(2), 113-121.

Zan, R., & DiMartino, P. (2007). Attitude toward mathematics: Overcoming the positive/negative dichotomy. The Montana Mathematics Enthusiast, 3, 157-168. Retrieved December 27, 2008, from http://www.math.umt.edu/TMME/Monograph3

APPENDIX A

Survey Instrument

The Green, Blue, & Orange Counties Study to Identify the Services and Supports Needed by Elementary Teachers in the Area of Mathematics

TEACHER SURVEY

Instructions

THANK YOU for taking the time to complete this survey. Your participation and insights are vital to the impact this study will have in our region.

Please take some time (approximately 15 minutes) to answer the 60 questions in this survey to the best of your ability. Once done, fold the survey in half, place it in the envelope provided, and return it by mail.

Please attempt to answer all questions OPENLY and HONESTLY. Your building and district administrators *<u>will not</u>* see your individual responses. In fact, your survey cannot be traced back to your school or your district. Results are being collected at the county level only.

Overall results and findings will be made available upon request. If you would like to receive a copy of the final report, contact:

John Salzer, [redacted]

Your time and support are greatly appreciated!

My Math Experience

1. Including this year, how many years have you taught? ________

2. Including this year, how many years have you taught at your current grade level? ________

3. Including this year, how many years have you taught Math as a part of your assignment? ________

4. In what grade(s) do you currently teach math?
   ○ K ○ 1st ○ 2nd ○ 3rd ○ 4th ○ 5th ○ 6th ○ 7th ○ 8th ○ High

5. Please check all grades in which you have taught math during your career.
   ○ K ○ 1st ○ 2nd ○ 3rd ○ 4th ○ 5th ○ 6th ○ 7th ○ 8th ○ High

6. In what context(s) have you taught math during your career? (select all that apply)
   ○ Self-contained classroom ○ Departmentalized classroom ○ Co-teaching ○ Resource

7. Since you began teaching, have you taken any college courses in mathematics or methods of teaching mathematics?
   ○ Yes ○ No

8. If so, approximately how long ago was your last course? ○ This year ○ ________ year(s) ○ N/A

9. Since you began teaching, have you attended a full-day workshop focused on mathematics?
   ○ Yes ○ No

10. If so, approximately how long ago was your last workshop? ○ This year ○ ________ year(s) ○ N/A

My Personal Feelings About Math (As they are TODAY)

(This section © Aiken)

Each of these statements expresses a feeling which a particular person may have toward mathematics. Please express, on a five-point scale, the extent of agreement between the feeling expressed in each statement and your own personal feeling.

Strongly Disagree (SD) | Disagree (D) | Undecided (U) | Agree (A) | Strongly Agree (SA)

11. I am always under a terrible strain when learning mathematics.	SD	D	U	A	SA
12. I do not like mathematics, and it scares me to have to learn new math.	SD	D	U	A	SA
13. Mathematics is very interesting to me, and I enjoy math courses.	SD	D	U	A	SA
14. Mathematics is fascinating and fun.	SD	D	U	A	SA
15. Mathematics makes me feel secure, and at the same time, it is stimulating.	SD	D	U	A	SA
16. My mind goes blank, and I am unable to think clearly when working in math.	SD	D	U	A	SA
17. I feel a sense of insecurity when attempting mathematics.	SD	D	U	A	SA
18. Mathematics makes me feel uncomfortable, restless, irritable, and impatient.	SD	D	U	A	SA
19. The feeling that I have toward mathematics is a good feeling.	SD	D	U	A	SA
20. Mathematics makes me feel as though I'm lost in a jungle of numbers and can't find my way out.	SD	D	U	A	SA
21. Mathematics is something which I enjoy a great deal.	SD	D	U	A	SA
22. When I hear the word math, I have a feeling of dislike.	SD	D	U	A	SA
23. I approach math with a feeling of hesitation, resulting from a fear of not being able to do math.	SD	D	U	A	SA
24. I really like mathematics.	SD	D	U	A	SA
25. Mathematics is a course in school which I have always enjoyed studying.	SD	D	U	A	SA
26. It makes me nervous to even think about having to do a math problem.	SD	D	U	A	SA
27. I have never liked math, and it is my most dreaded subject.	SD	D	U	A	SA
28. I am happier learning about math than any other subject.	SD	D	U	A	SA
29. I feel at ease in mathematics, and I like it very much.	SD	D	U	A	SA
30. I feel a definite positive reaction to mathematics; it's enjoyable.	SD	D	U	A	SA

Basic Demographics

31. I am a:
    - ○ Male ○ Female

32. I earned my teaching certificate (choose the best fit):
    - ○ Immediately after my schooling ○ Later in life, after raising a family ○ Later in life, after pursuing another career

33. My current age is: ___________

Changes in My Personal Feelings About Math

Think back to the year **before** you began teaching. How has your relationship with mathematics changed since then? Please attempt to remember your feelings back then as you evaluate each of the following statements within that context.

34. How would you classify your level of **ENJOYMENT** of math?:

	1 (Very Low)	2	3	4 (Neutral)	5	6	7 (Very High)
Before you began teaching.	1	2	3	4	5	6	7
Now	1	2	3	4	5	6	7

35. How would you classify your **CONFIDENCE** with math?:

Before you began teaching.	1	2	3	4	5	6	7
Now	1	2	3	4	5	6	7

36. How would you classify your **UNDERSTANDING OF** elementary school math ?:

Before you began teaching.	1	2	3	4	5	6	7
Now	1	2	3	4	5	6	7

37. How would you classify your belief that math is **INTRINSICALLY VALUABLE** (for its logic, beauty, culture, etc.)?:

Before you began teaching.	1	2	3	4	5	6	7
Now	1	2	3	4	5	6	7

38. How would you classify your belief that math is **EXTRINSICALLY VALUABLE** (college and career opportunities, etc.)?:

Before you began teaching.	1	2	3	4	5	6	7
Now	1	2	3	4	5	6	7

39. To what do you most attribute POSITIVE changes in your attitude toward mathematics since you began teaching?

____

____

____

40. To what do you most attribute NEGATIVE changes in your attitude toward mathematics since you began teaching?

____

____

____

Please classify how the following have influenced your attitudes toward mathematics by circling the appropriate response.

Very Negative (VN) | Negative (N) | No Influence (=) | Positive (P) | Very Positive (VP)

41. Experience teaching math to students.	VN	N	=	P	VP
42. Professional development workshops about math or teaching math.	VN	N	=	P	VP
43. The focus on improving ISAT and other standardized test scores.	VN	N	=	P	VP
44. Instructional feedback from my principal or dean.	VN	N	=	P	VP
45. Interaction with parents.	VN	N	=	P	VP
46. My own life experience needing and using mathematics.	VN	N	=	P	VP

Services

Please answer the following questions related to services provided by your school, your district, or your regional professional development center.

Strongly Disagree (SD) | Disagree (D) | Undecided (U) | Agree (A) | Strongly Agree (SA)

47. My school offers workshops and courses that are (or would be) helpful to me in teaching math.	SD	D	U	A	SA
48. My regional office / professional development center offers workshops and courses that are (or would be) helpful to me in teaching math.	SD	D	U	A	SA
49. I would benefit from taking a workshop or course designed to help me better understand the mathematics content I teach.	SD	D	U	A	SA
50. I would benefit from taking a workshop or course designed to give me skills and tools to better teach mathematics.	SD	D	U	A	SA
51. I would benefit from an inservice or a workshop designed to help me understand the math standards and what is tested.	SD	D	U	A	SA
52. I would benefit from a class on the historical origins and development of elementary mathematics (why we do things the way we do).	SD	D	U	A	SA
53. I could teach math more effectively with better resources, such as textbooks, workbooks, worksheets, and teaching guides.	SD	D	U	A	SA
54. I could teach math more effectively with better equipment, such as calculators and manipulatives.	SD	D	U	A	SA
55. I could teach math more effectively with more freedom and control over what and how I teach.	SD	D	U	A	SA
56. I could teach math more effectively if my district provided a standard set of lesson plans to follow.	SD	D	U	A	SA
57. In my first year or two of teaching, I would have benefited from having a "math mentor" who could sit with me each week to discuss how I would teach the following week's math content.	SD	D	U	A	SA

58. Think back to your first two years of teaching. What service(s) or resource(s) would have benefitted you the most as you began teaching mathematics?

____

____

59. Now think about today. What service(s) or resource(s) would help you the most as you teach mathematics?

____

____

60. Thank you so much for your time. Are there any general comments you would like to make?

____

____

____

APPENDIX B

Principal Letter

The Orange, Green, and Blue Counties Study to Identify the Services and Supports Needed by Elementary Teachers in the Area of Mathematics

Thank you for your support of this project and of math education in our region.
John Salzer

Dear Principal,

In conjunction with the doctoral program at Olivet Nazarene University, I am conducting a study to determine the regional need for providing services and support to elementary school teachers who may have difficulty with or negative feelings toward mathematics.

In order to determine if there is a need for such services and supports, and to identify which services and supports will be most beneficial, it is important that I obtain the participation of as many K-5 teachers in our region as possible.

I would like your permission to send you or your secretary copies of the attached survey to be distributed to the mailboxes of the certified teachers in your building who teach mathematics. Each teacher will receive a copy of the survey, a self-addressed stamped envelope in which to return the survey, and a token of appreciation for their time.

Out of respect for you, your teachers, and your school:

- Participation by your teachers will be entirely voluntary and will only take 15 to 20 minutes. After the initial placement of the survey in their mailboxes, they will receive no further contact unless they request to be notified when results are published.
- Your teachers remain anonymous. Each has his or her own self-addressed, stamped envelope in which to return the survey directly to me, with no identifiable information.
- Neither your school building, nor your district, is identified in the survey. All results will be tallied at the county and regional levels.

If you are willing to allow me to distribute these surveys, please sign the attached consent form and return it in the envelope provided. Your assistance is greatly appreciated!

Sincerely,

John Salzer
[redacted]
Phone: [redacted]
Fax: [redacted]
e-Mail: [redacted]

APPENDIX C

Principal Permission Form

The Orange, Green, and Blue Counties
Study to Identify the Services and Supports
Needed by Elementary Teachers
in the Area of Mathematics

Consent to Distribute

I give consent for the *Study to Identify the Services and Supports Needed by Elementary Teachers in the Area of Math* **survey to be distributed to the teachers in my school building.**

I understand that the participation of my building and of each individual teacher is voluntary.

I understand that the responses provided by my teachers will remain anonymous and will only be used when compiled with other participants from across the county and region.

Number of **certified K-5 teachers** in your building who teach mathematics:___________________

To whom should the packet of surveys be addressed for distribution?

☐ Me ☐ My Secretary (Please print name)_________________________________

At the conclusion of the study, would you like to receive a summary of the study's results?

☐ Yes ☐ No

_______________________________________ _______________
Building Principal or Assistant Principal Signature Date

_______________________________________ _______________
School Building City

Return this page in the red envelope provided.

APPENDIX D

Distribution Instructions

The Orange, Green, and Blue Counties
Study to Identify the Services and Supports
Needed by Elementary Teachers
in the Area of Mathematics

Please distribute one packet to each certified teacher in your building who teaches a math class in grades K - 5.

An approval to distribute is attached.

If you have any questions, please call John at the [redacted].

Thank you for your help!!!

APPENDIX E

Teacher Letter

The Orange, Green, and Blue Counties Study to Identify the Services and Supports Needed by Elementary Teachers in the Area of Mathematics

Thank you for taking the time to share your thoughts, experience, and feelings.
John Salzer

Dear Teacher,

In conjunction with the doctoral program at Olivet Nazarene University, I am conducting a study to determine the regional need for providing services and support to elementary school teachers in the area of mathematics.

In order to determine if there is a need for such services and support, and to identify which services and support programs will be most beneficial, it is important that I obtain the participation of as many K-5 teachers in our region as possible.

Please take 15 minutes out of your busy day to share your experience with mathematics and teaching mathematics by completing the enclosed survey. When finished, please fold the survey in half and return it in the addressed, stamped envelope provided.

Because I know how valuable your time is, I would like to offer a small token of appreciation for you to share with your math students. After completing the survey, you may mail in the enclosed postcard to receive a set of Monkey Ruler Bookmarks for your students.

Please note that your privacy will be respected:

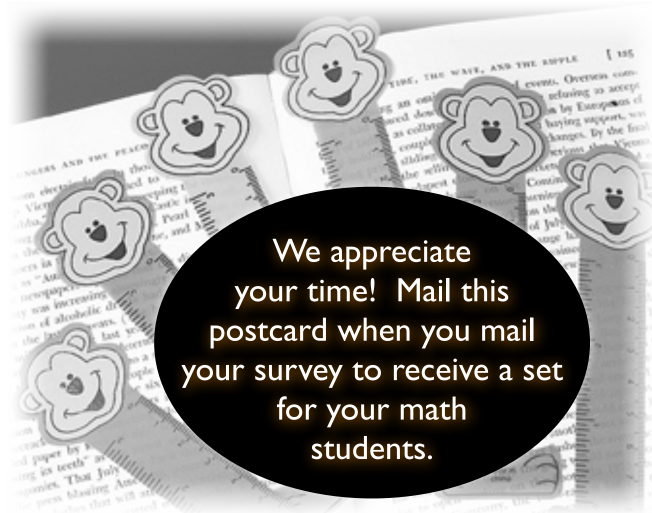
- Participation is encouraged, but is voluntary. After the initial placement of this packet in your mailbox, you will receive no further contact unless you request to be notified when results are published.
- You will remain anonymous. Your ability to be open and honest when answering survey questions is important, so I have taken the extra time and expense to ensure your complete anonymity. Because you will be mailing the survey directly to me at [redacted], you can be assured that your survey can not be traced to you, your school, or your district. Results will be analyzed at the county and region levels.

Sincerely,

John Salzer
[redacted]
Phone: [redacted]
Fax: [redacted]
e-Mail: [redacted]

APPENDIX F

Postcard



Thank You!

To receive a set of monkey ruler bookmarks for your students, send this card in the mail at the same time you send your completed survey.

THANK YOU for your time!

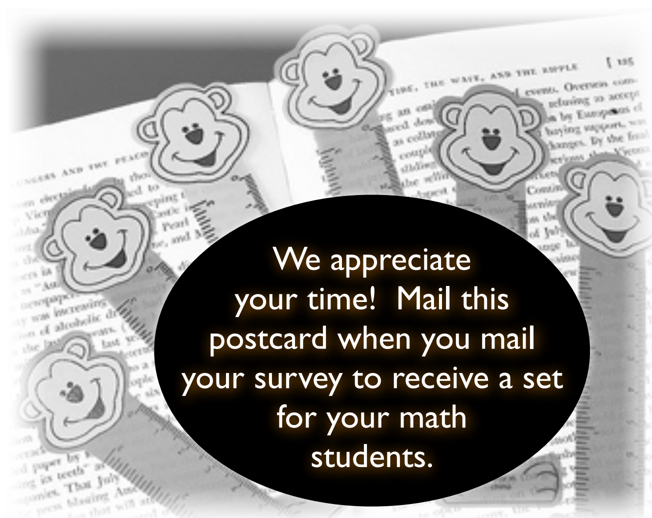
Teacher:__________________________

School:___________________________

City:_____________________________

Number of Math Students:____________

John Salzer
[redacted]



Thank You!

To receive a set of monkey ruler bookmarks for your students, send this card in the mail at the same time you send your completed survey.

THANK YOU for your time!

Teacher:__________________________

School:___________________________

City:_____________________________

Number of Math Students:____________

John Salzer
[redacted]