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Examining the Attitudes Toward Mathematics of Preservice Elementary School Teachers
Enrolled in an Introductory Mathematics Methods Course
and the Experiences That Have Influenced the Development of These Attitudes

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of
Doctor of Philosophy
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Date of Approval:
October 25, 2005

Keywords: journals, reflection, achievement, value, enjoyment, motivation, confidence
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DEDICATION

To my daughter, Stefanie. Your encouragement sustained me throughout this seven-year endeavor. Thank you for always being there for me, providing everything from supportive hugs to computer assistance to transcribing interviews, and for never complaining about all of Mom’s time spent studying and writing.

To my son, Mark. Thank you for always being proud of me and for making me so proud of you.

To my husband, Sam. You entered my life midway through my doctoral program, a decision that would cause many to question your sanity. Your love and support made me even more determined to complete this journey.

To Grant. I know that you would be proud.
ACKNOWLEDGEMENTS

I would like to express my deep and heartfelt gratitude to my major professor, Dr. Denisse Thompson. She has been my teacher, my mentor, my colleague, and my friend. Dr. Thompson is the world’s busiest person, but she always made time for me when I needed her. I so appreciated the care and attention to detail that she gave in reviewing my manuscripts. I feel very fortunate to have learned from the best.

I am also incredibly grateful for the contributions of my other committee members, Dr. Richard Austin, Dr. Roger Brindley, Dr. Lou Carey, and Dr. Fredric Zerla. I learned so much about teacher education from observing Dr. Austin’s elementary mathematics methods course, and I thank him for his perspective on issues involving mathematics education. Dr. Brindley, qualitative researcher extraordinaire, taught me the value of thick, deep, and rich description and how to give voice to my sample, and I thank him for his great sense of fun. I would also like to thank Dr. Carey for her guidance with the quantitative portions of this study. I felt so fortunate when Dr. Carey agreed to join my committee, and I have come to admire her greatly, both professionally and personally. Dr. Zerla taught me about the history and beauty of mathematics, and I thank him for the mathematician’s perspective that he provided to this study.

Thank you to my parents for instilling in me the importance of getting an education. Thank you to all of my family and friends for all of their support and encouragement.
Lastly, I would like to thank the participants in this study. Thank you all so much for openly sharing your memories with me. Your candor and trust made this study possible.
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EXAMINING THE ATTITUDES TOWARD MATHEMATICS OF PRESERVICE ELEMENTARY SCHOOL TEACHERS ENROLLED IN AN INTRODUCTORY MATHEMATICS METHODS COURSE AND THE EXPERIENCES THAT HAVE INFLUENCED THE DEVELOPMENT OF THESE ATTITUDES

Joy Bronston Schackow

ABSTRACT

The reform movement in mathematics education has recognized affective factors as an important area where change is needed. This study examined the attitudes toward mathematics of preservice elementary teachers entering an introductory mathematics methods course. The methods course utilized constructivist instructional methods, such as the use of manipulatives, cooperative group work, problem solving, and calculators. Qualitative methods were used to explore participants’ attitudes toward mathematics and the experiences that have led to the development of these attitudes. The study sought to determine the extent to which preservice teachers’ attitudes toward mathematics changed during the methods course and the correlation between preservice teachers’ initial attitudes toward mathematics and their achievement in the methods course.

Thirty-three university students enrolled in one section of a mathematics methods course for elementary education majors completed the Attitudes Toward Mathematics Inventory at the beginning of the semester and again during week 12 of the 15-week semester. Throughout the semester, participants submitted reflective journal entries in
which they reflected on their attitudes toward and experiences with mathematics. The instructor responded to each journal.

Participants’ initial survey scores indicated that they valued mathematics, but their scores for Self-Confidence, Enjoyment, and Motivation were somewhat negative. As a whole, participants showed a statistically significant positive change in attitude on the second survey. In individual interviews, participants who showed significant positive changes in attitude mentioned manipulatives, journals, and the organized format of the course as aspects of the methods course that had positively influenced their attitudes toward mathematics. A statistically significant positive correlation was found between initial attitude survey scores and the methods course departmental final examination, which was used as a measure of achievement.

Through their journal entries and interviews, participants offered a clear view of the types of experiences that encouraged the development of positive and negative attitudes toward mathematics. These findings have implications for teacher educators who seek to improve the attitudes toward mathematics of preservice elementary school teachers and for mathematics teachers at all levels.
CHAPTER ONE
INTRODUCTION

The reform movement in mathematics education that began in the 1980s has recognized affective factors as an important area where change is needed. This emphasis on affective issues “is related to the importance that the reform movement attaches to higher-order thinking. If students are to be active learners of mathematics who willingly attack nonroutine problems, their affective responses to mathematics are going to be much more intense than if they are merely expected to achieve the satisfactory levels of performance in low-level computational skills” (McLeod, 1992, p. 575). Everybody Counts, the National Research Council’s (NRC) report on the future of mathematics education, focused on the need to change the public’s attitudes and beliefs about mathematics (NRC, 1989). The authors pointed out that affective issues involving both children and adults must be considered in order for mathematics education to improve. The National Council of Teachers of Mathematics (NCTM, 1989, 2000) has also focused on affective issues related to mathematics education. In the Curriculum and Evaluation Standards for School Mathematics (1989), two major goals were established related to affective factors: learning to value mathematics and developing confidence in one’s own mathematical ability. When discussing mathematical disposition and engagement in the Principles and Standards for School Mathematics (2000), NCTM stressed the importance of students’ confidence, interest, perseverance, and curiosity in learning mathematics.
The importance of developing self-confident, motivated students who value and enjoy mathematics has been well established, but the means for doing so are not as clear. Although results are not always consistent, studies have shown that children typically begin school with positive attitudes toward mathematics, but these attitudes tend to become less positive as they get older. By the time students reach high school, their attitudes toward mathematics have frequently become negative (McLeod, 1992).

Vanayan, White, Yuen, and Teper (1997) surveyed 1,320 third graders and 1,320 fifth graders from 60 schools. They found that 79% of the third graders gave a positive response to the statement, “I like math.” The percentage was somewhat lower, 73%, for fifth graders. However, roughly 60% of third graders and 65% of fifth graders indicated that they liked other subjects more than mathematics.

Prawat and Anderson (1994) found that fourth and fifth graders reported “twice the amount of negative as compared to positive affect while engaged in mathematics seatwork” (p. 219). Mink and Fraser (2002) administered an attitudinal survey to 120 fifth-grade students before implementing a program integrating children’s literature. The survey measured attitudes to reading, writing, and mathematics. Students responded to questions such as, “Do you like mathematics?” They found that the average item mean for attitudes to mathematics was lower than those for attitudes to reading and writing, indicating that the students liked reading and writing more than mathematics.

The tendency for attitudes to become more negative continues in middle school. Ruffell, Mason, and Allen (1998) interviewed 14 middle-school students in the Netherlands. Approximately 50% of the students claimed to like mathematics. They seemed unable to say what they liked about mathematics, but they were able to say what
they did not like. The authors pointed out that this is an example of how negative memories appear to dominate positive memories when forming attitudes. When describing a bad experience in mathematics, the words most often used were ‘nervous’ or ‘bored.’ The students associated mathematics with “repetition, lack of challenge, lack of novelty, routine, sitting at desks, working in silence, working alone, and knowing what to expect” (p. 7). The students generally viewed mathematics as good if “you get it right.” They described the best part of mathematics as doing investigations and working in a group. The general impression given by the students during these interviews was a dislike of mathematics.

By high school, negative attitudes toward mathematics have often become more apparent. Hoyles (1982) found that 14-year-old students tend to correlate their mathematical experiences with feelings of anxiety, shame, and failure. Olson (1998) surveyed high-school geometry students in order to examine their enjoyment of mathematics, previous experiences with mathematics, and perceived usefulness of mathematics in the future. She found that one-third of the students did not enjoy mathematics. When reflecting on their prior experiences with word problems, 38% described their experiences as frustrating.

Several large-scale studies have examined attitudes toward mathematics. In 1995, the Third International Mathematics and Science Study (TIMSS) examined attitudes, beliefs, and opinions related to mathematics. This study collected and analyzed data from students in 45 countries. Students were asked to state their level of agreement with the following statements: 1) I like mathematics, 2) Mathematics is boring, and 3) I enjoy learning mathematics. Mullis et al. (1997) reported that fourth-grade students had
relatively positive attitudes toward mathematics. Beaton et al. (1996) found that eighth graders had relatively neutral feelings about mathematics. In most countries, high school students expressed that they liked mathematics to some degree, but in Austria, the Czech Republic, Hungary, and Lithuania, more than half of the students reported that they disliked mathematics (Mullis et al., 1998).

Affect has been a focus of various national studies as well. The National Assessment of Educational Progress (NAEP) has included some mathematics attitude items on its regular assessments. At grade 12, the percentage of students who indicated that they liked mathematics has dropped from 51% in 1992 to 47% in 2000. However, the percent indicating they are good at mathematics has increased slightly from 50% in 1992 to 53% in 2000 (Strutchens, Lubienski, McGraw, and Westbrook, 2004). The Seventh Mathematics Assessment of the NAEP in 1996 also included data on student attitudes toward mathematics. Although over half of fourth graders and eighth graders agreed with the statement “I like mathematics,” the percentage of eighth graders who agreed with the statement was lower than the percentage of fourth graders who agreed. The percentage of twelfth graders who agreed was even lower. The frequency of positive responses was greater among twelfth graders who were taking mathematics than among those who were currently not taking mathematics (Mitchell, Hawkins, Stancavage, & Dossey, 1999).

Although many students value and enjoy mathematics and are motivated and confident in their abilities to do mathematics, there are still too many who do not feel this way. Negative attitudes toward mathematics are “thought to plague learners at every level of schooling” (Sherman and Christian, 1999, p.95). These negative feelings become even more significant when considering that some of these students will eventually choose to
become elementary school teachers and will be teaching a subject about which they may have negative attitudes. Several studies have examined the attitudes toward mathematics of preservice elementary school teachers, and none of these have indicated a preponderance of positive attitudes. Rech, Hartzell, and Stephens (1993) found that preservice elementary teachers have less favorable attitudes toward mathematics than the general university population. Cornell (1999) surveyed graduate students who were taking a mathematics instruction seminar for certification as elementary school teachers. He found that about half of the students reported a dislike of mathematics. In nearly all cases, positive attitudes were correlated with success and negative attitudes with failure. Philippou and Christou (1998) surveyed 162 first year prospective primary teachers in Greece. They found that “a considerable proportion of prospective teachers bring to the university negative feelings toward mathematics, a subject they will soon be supposed to teach” (p. 203).

Many believe that in order to teach mathematics well, one needs to have a positive attitude toward the subject, and that the task of improving the attitudes toward mathematics of future elementary teachers begins at the university. Sherman and Christian (1999) said that improving the attitudes toward mathematics of preservice elementary teachers is “an important concern for university education courses in order to facilitate positive mathematics attitudes in future elementary pupils” (p. 96). Hungerford (1994) cited the need to improve the mathematics education of future elementary teachers by altering curriculum and attitudes. He suggested that elementary school teachers who do not know much mathematics, who care little about what it means to do mathematics, and who are afraid of mathematics will be unlikely to foster positive attitudes toward
mathematics in their own students. Thus the system continues to move in a vicious cycle that must be broken, and teacher educators must carefully consider the impact of their training programs on the attitudes of prospective teachers (Philippou & Christou, 1998).

Several studies have demonstrated success in improving attitudes toward mathematics of preservice elementary teachers enrolled in mathematics methods courses. These methods courses utilized constructivist instructional methods such as the use of hands-on manipulatives, cooperative group work, problem solving, and the use of technology. My own experience teaching elementary mathematics methods courses has reinforced this notion. In addition, my informal use of reflective journal writing with my students has led me to believe that perhaps this type of reflection can provide an additional tool for teacher educators who seek to understand how attitudes toward mathematics are formed and how to improve their students’ attitudes toward mathematics.

Purpose of the Study

The purpose of this study was to examine the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course. The study focused on the following attitudes: value, enjoyment, motivation, and self-confidence. Qualitative methods were used to explore these attitudes and the experiences that have led to the development of these attitudes. The study sought to determine the extent to which preservice teachers’ attitudes toward mathematics changed during the methods course. The study also examined the correlation between preservice teachers’ initial attitudes toward mathematics and their achievement in the methods course.
Research Questions

1. What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?

2. To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course? To what do preservice teachers whose attitudes toward mathematics were altered attribute this change?

3. What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

4. What do preservice elementary school teachers’ reflective journal entries reveal about their attitudes toward mathematics and the experiences that have influenced the development of those attitudes?

5. What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most extreme (either positive or negative) attitudes?
Definitions

*Attitude toward mathematics.* This term will refer to “a general emotional disposition toward the school subject of mathematics” (Haladyna, Shaughnessy, & Shaughnessy, 1983, p. 20).

*Beliefs about mathematics.* This term will refer to the ways in which an individual cognitively understands the nature of mathematics, as well as “the ways in which a teacher understands classrooms, students, the nature of learning, the teacher’s role in a classroom, and the goals of education” (Kagan, 1990, p. 423).

*Reflective journals.* In reflective journal writing, students reflect on experiences and organize their thoughts and feelings in order to communicate clearly. Students are often given prompts that direct their reflection.
CHAPTER TWO
REVIEW OF LITERATURE

The literature review begins with a description of the affective domain and includes sections relating to beliefs about mathematics, attitudes toward mathematics, and the effects of attitudes and beliefs on achievement in mathematics. It also includes sections relating to journal writing with mathematics, phenomenology, and reflection. The chapter concludes with a summary of these areas as they relate to the present study and a description of the significance of the study.

The Affective Domain

McLeod (1992) identified three major components of the affective domain in learning mathematics. First, students hold certain beliefs about mathematics. These beliefs can greatly influence a student’s affective reactions to learning mathematics. Second, as students repeatedly encounter mathematical situations, they will develop positive and negative attitudes toward mathematics. Third, when students are learning mathematics, interruptions and blockages are bound to occur. These can lead to both positive and negative emotional responses in students.

Beliefs About Mathematics

Although beliefs are mainly cognitive in nature, they play an important role in the development of attitudes and emotions about mathematics. Students’ beliefs about
mathematics can greatly influence the feelings they have about learning mathematics. Schoenfeld (1992) pointed out that some commonly held beliefs can undermine students’ problem-solving performance. Some examples of such beliefs are that mathematics primarily involves memorization of rules and procedures, and that if a mathematical problem cannot be solved quickly, it cannot be solved at all. Schoenfeld provided the following compilation of some of the beliefs about mathematics that many students typically hold:

- Mathematics problems have one and only one right answer.
- There is only one correct way to solve any mathematical problem—usually the rule the teacher has most recently demonstrated to the class.
- Ordinary students cannot be expected to understand mathematics; they expect simply to memorize it and apply what they have learned mechanically and without understanding.
- Mathematics is a solitary activity, done by individuals in isolation.
- Students who have understood the mathematics they have studied will be able to solve any assigned problem in five minutes or less.
- The mathematics learned in school has nothing to do with the real world.
- Formal proof is irrelevant to processes of discovery or invention. (p. 359)

Schoenfeld argued that students abstract these beliefs in large measure from their own classroom experiences. These beliefs are consistent with the traditional manner in which mathematics has been presented to students. These beliefs can also shape students’ behavior “in ways that have extraordinarily powerful (and often negative) consequences” (Schoenfeld, 1992, p. 359). Such beliefs as these conflict with the goals of the current
reform efforts (NCTM, 1989, 2000) and may be the cause of the negative affective reactions of many students to efforts to develop mathematical problem-solving skills (McLeod, 1994).

Research on Beliefs about Mathematics

Studies have shown that teachers’ beliefs about mathematics teaching and learning are mostly formed during their own schooling and are developed as a result of their own experiences as mathematics students. Their conceptions about mathematics and how it should be taught are deeply rooted and are difficult to change (Thompson, 1992). In order to understand how these beliefs develop over time, it is important to consider the beliefs of students at various stages of schooling.

Students begin to develop beliefs about mathematics at an early age. Kloosterman, Raymond, and Emenaker (1996) followed 29 students in grades one through four over a period of three years to determine the stability and developmental trends in their beliefs about mathematics. They found that the students’ beliefs remained relatively stable over the three years. They also found that students had a narrow view of the usefulness of mathematics, citing such trite responses as “you need math to get to third grade” (Kloosterman et al., p. 49). Their perspectives on group versus individual work reflected their own classroom experiences with each. Those students whose teachers used cooperative learning tended to show approval for it and those whose teachers did not include group work as a part of instruction tended to prefer working alone.
Beliefs of middle school students have also been studied. Wilson (1995) surveyed 59 eighth-grade students in order to determine their conceptions of what it means to do mathematics. She found that the students’ beliefs were predominantly traditional in nature. Even after 9 months of participating in a reform-oriented class, the majority of the students still felt strongly about including “listening to the teacher explain” in their conception of school mathematics.

By high school, students have developed core beliefs. Fleener (1996) investigated high school students’ beliefs about mathematics during a four-week summer residential mathematics and science program. She pointed out that many of the core beliefs that students have about mathematics are a result of their personal experiences in mathematics classrooms. The researcher found that the students had well-defined core beliefs about the nature and discovery of mathematical truths and the importance of engaging in mathematical inquiry. Their responses suggested that they did not view mathematics as a “dynamic, changing discipline” (Fleener, 1996, p. 316).

Teacher Beliefs About Mathematics

Teacher beliefs and their influence on teacher behavior in the classroom have been researched and discussed extensively. Kagan (1990) defined teacher beliefs as “the highly personal ways in which a teacher understands classrooms, students, the nature of learning, the teacher’s role in a classroom, and the goals of education” (p. 423). Richardson (1996) listed three categories of experiences that influence the development of beliefs about teaching: (a) personal experience, (b) experience with schooling and instruction, and (c) experience with formal knowledge. In order to understand how a
teacher’s belief system can significantly influence how that teacher interprets and implements curricula, it is important to distinguish between teacher beliefs and teacher knowledge. Two teachers can have similar knowledge, but use very different teaching approaches based on their differing beliefs (Ernest, 1989).

Thompson (1992) cited some features of teacher beliefs that distinguish them from knowledge. One of these features is that beliefs, unlike knowledge, can be held with varying degrees of conviction. Another distinction is that truth or certainty is associated with knowledge while disputability is associated with beliefs. Thompson also pointed out that what we view as knowledge can actually be belief because it can change in light of new theories. Pajares (1992) also discussed some distinctions between beliefs and knowledge. He pointed out that beliefs are deeply personal and unaffected by persuasion. He described what he called the “perseverance phenomenon,” which says that early experiences strongly influence beliefs (p. 317). They become highly resistant to change. The earlier a belief is incorporated into a person’s belief structure, the more difficult it is to change.

Teachers’ beliefs about teaching and learning can influence their teaching practices (An, 2000; Fang, 1996; Kagan, 1992; Thompson, 1992). Stipek, Givvin, Salmon, and MacGyvers (2001) surveyed 21 fourth- through sixth-grade teachers at the beginning and end of the school year in order to assess their beliefs about mathematics and teaching mathematics. The teachers were also videotaped teaching, and the observed behavior was coded to characterize each teacher’s classroom practices. They found substantial coherence between the teachers’ beliefs and their classroom practices. Teachers who held traditional beliefs about mathematics emphasized performance and
speed in their classrooms rather than emphasizing learning and understanding. These teachers also gave students less autonomy and created a classroom environment where mistakes were viewed as something to be avoided rather than creating an environment where there was no risk of being embarrassed if a mistake was made.

The beliefs that teachers hold can also affect their students’ beliefs. G. Carter (1997) studied seven teachers and the relationship between their beliefs about mathematics and the beliefs of their students. She found that students of teachers with beliefs that were aligned with the NCTM Standards had significantly different beliefs about factors that lead to success than other students. These students believed that working hard and striving for understanding were essential for success.

Often teachers’ existing belief systems conflict with the pedagogical techniques and practices that they are being encouraged by the profession to adopt. Mathematics teachers of today are being asked to shift their mathematics instruction away from the traditional teaching that they most likely received as students to a constructivist perspective of mathematics instruction. Discussing traditional mathematics instruction, Van de Walle (2004) said:

Traditional teaching, still the predominant instructional pattern, typically begins with an explanation of whatever idea is on the current page of the text followed by showing children how to do the assigned exercises. Even with a hands-on activity, the traditional teacher is guiding students, telling them exactly how to use the materials in a prescribed manner. The focus of the lesson is primarily on getting answers. Students rely on the teacher to determine if their answers are correct. Children emerge from these experiences with a view that mathematics is
a series of arbitrary rules, handed down by the teacher, who in turn got them from some very smart source (pp. 12-13).

Anderson and Piazza (1996) cited several barriers to reform in mathematics education that inhibit the change process in teachers. They pointed out that many of the beliefs and attitudes of some teachers are “in direct conflict with those inherent to constructivism” (p. 54). When discussing barriers to the reform movement in mathematics education, Ross, McDougall, and Hogaboam-Gray (2002) reviewed one hundred fifty-four empirical studies on reform in mathematics education that were published between 1993 and 2000. They found that “the most important obstacle [to reform] is that teachers’ beliefs and prior experiences of mathematics and mathematics teaching are not congruent with the assumptions of the Standards” (p. 132).

Ambrose (2001) suggested several avenues for changing belief systems. The first involves the process of reflection and examination of personal beliefs. In this way, inconsistencies can be identified. The second involves making connections among beliefs. This allows one to activate new beliefs in situations where they might not previously have been activated. Another way that belief systems can be changed is by developing a new belief that is connected to existing beliefs. The last belief change is the reversal of an existing belief. However, this type of paradigm shift is rare.

Wideen, Mayer-Smith, and Moon (1998) reviewed 93 empirical studies on learning to teach. Their review supported findings of others that many traditional teacher education programs have little effect on firmly held beliefs of preservice teachers. However, they did note some successful programs. These programs typically build upon the existing beliefs of beginning teachers rather than trying to cultivate a reversal of
beliefs (Wideen et al., 1998). The authors explained that learning to teach was a “deeply personal activity” (p.161), and the first step involved having beginning teachers examine their existing beliefs. These prospective teachers should then be encouraged to consider how their existing belief system correlates with the expectations of the university and the teaching profession.

**Beliefs of preservice and beginning teachers.** Research involving teacher training programs and their attempts to change the beliefs of their participants have shown little consensus. Although many of these programs have been successful in showing a significant change in beliefs, some have not. Ambrose (2001) described a case study that examined one such program aimed at changing preservice teachers’ beliefs about mathematics and teaching by building on existing beliefs. The program allowed preservice elementary school teachers to work with individual children once a week for eight weeks. The emphasis of the sessions was on problem solving and using a concrete approach to develop conceptual understanding. Donna, the case-study student teacher, believed that children had the ability to solve problems on their own. She also believed that standard algorithms were the best way to solve problems and were the focal point of mathematics. She viewed effective teaching as involving explaining things to children and being nice to them. Data from field notes, surveys, interviews, and written work revealed a change in Donna’s belief about how a child develops self-confidence. Initially she had assumed that a nice, encouraging teacher would lead to a self-confident student. She altered her belief when she observed that her student became dependent on her nonspecific praise. She also developed the belief that children often need a variety of
experiences with a topic in order to learn it, and that they do not always learn what is taught.

Stuart and Thurlow (2000) described another program that was designed to change the beliefs of preservice elementary school teachers. A methods course focused on how students’ beliefs about the nature of mathematics, themselves as learners, and teaching-learning processes would influence their decisions about classroom practices. Interviews, journals, mathematics autobiographies, exams, and class writings were all used to collect data about the beliefs of these preservice teachers. The researchers found that students did successfully reevaluate and change their beliefs about teaching mathematics by the end of the semester course. The authors reinforced the importance of reflection to allow the students an opportunity to bring their beliefs to a conscious level where they could be examined.

Other preservice teaching programs have been successful in changing the beliefs of their participants as well. Vacc and Bright (1999) followed 34 preservice elementary school teachers through their coursework and student teaching. During their mathematics methods course, the participants were introduced to Cognitively Guided Instruction (CGI), an instructional program where teachers make instructional decisions based on their knowledge from cognitive science (Carpenter & Fennema, 1991, as cited in Vacc & Bright, 1999). Their training program incorporated professional development schools where the student teachers could connect the theory they were being taught in the methods courses with actual classroom practices. They accomplished this through observation of teachers using CGI in the classroom and field experiences where they could put into practice the theories they had learned in the methods course. They found
significant changes in the students’ beliefs and perceptions about teaching and learning mathematics after completing the mathematics methods course and again after the student-teaching experience.

Mewborn (2002) tracked an elementary school teacher over a four-year period, from her first mathematics methods course, through her student teaching experience and first two years of teaching. This beginning teacher changed some of her beliefs about teaching and learning mathematics, as well as classroom practices reflecting these beliefs, during the course of the four years. Mewborn attributed these changes to Dewey’s notion of the reflective thinking process (as cited in Mewborn, 2002). Reflective thought about herself and her teaching experiences through journals, a written autobiography, interviews, and informal conversations with the researcher allowed her to alter the structure of her belief system.

Some teacher-training programs designed to alter the belief systems of its participants have found that prior beliefs were resistant to change (McDaniel, 1991; Weinstein, 1990). Kagan (1992) reviewed 40 preservice teaching programs and found that preexisting beliefs and prior experiences played a central role in how preservice teachers interpreted the content of education courses. Each study that she examined demonstrated that these beliefs were stable and inflexible to change. She identified some essential elements for changing preservice teachers’ beliefs. According to Kagan, preservice teachers must have the opportunity to interact with and study students. She also said that university courses must focus not only on theory, but also on practical strategies and procedural knowledge.
Sometimes prospective teachers will appear to have altered their beliefs as a result of the training program, but their classroom practices may not reflect these changes. Frykholm (1996) found that even when preservice teachers’ beliefs appear to be aligned with the teachings of the teacher-training program, their student teaching practices might not reflect these beliefs. His study followed 44 preservice mathematics teachers over a period of two years. Based on data that were collected through classroom observations, pre- and post-lesson conferences, lesson plans, seminar sessions, surveys, and informal conversations, the prospective teachers appeared to be proponents of the goals, content, and recommendations set out in the NCTM Standards documents (NCTM, 1989, 1991). However, the author found that “an overwhelming majority of the lessons observed bore little or no resemblance to the values so highly espoused by the student teachers” (p. 665). He suggested that the mathematics community must broaden, and sometimes even challenge, the belief systems of many present and future mathematics teachers.

In similar studies, the same trend was observed. Raymond (1997) followed six first- and second-year elementary school teachers over a 10-month period. Data were gathered through interviews, observations, document analysis, and a beliefs survey. The beginning teachers’ stated beliefs were not always consistent with their teaching practice. Their actual teaching practices were more traditional than their stated beliefs about mathematics teaching and learning. For example, one teacher in the study said that she believed that dividing the class into groups to work with manipulatives was the best way to introduce and deepen the students’ conceptual understanding. However, due to this teacher’s concerns about classroom management and time constraints, her actual teaching practices were more traditional and rarely included this type of activity.
Benken and Wilson (1998) studied a preservice mathematics teacher through her methods courses and student teaching. They found that her view of mathematics learning as sequential and built upon a foundation kept her from allowing her students to explore and investigate problems before teaching them what she considered the basics. The authors viewed this teacher’s own conceptions about mathematics and mathematics teaching as her main obstacle to implementing the teaching methods that she had expressed a desire to use with her students. These results support the findings of Tabachnick and Zeichner (1984) that preservice teachers brought their own perspectives to teaching, and the student teaching experience tended to solidify rather than alter these perspectives.

Beliefs of experienced teachers. Studies involving changing beliefs of experienced teachers have also shown conflicting results. Some have demonstrated a change in the teachers’ beliefs as a result of professional development programs (Pligge, Kent, and Spence, 2000; Simon and Schifter, 1993). Vacc, Nesbitt, Bright, and Bowman (1998) examined changes in teachers’ beliefs over a period of two years of professional development for the program Cognitively Guided Instruction (CGI). Teachers attended several professional development workshops and met on a monthly basis to discuss their progress in implementing CGI. In addition, each teacher was observed teaching mathematics once a month by experienced CGI teachers. The researchers found that generally the teachers did change their beliefs about teachers’ views of children, the role of teacher and student, and skill acquisition and problem solving. However, the changes
varied by category and grade level, and several teachers did not change their beliefs in these areas.

Sometimes belief systems are so strong that desired changes in a teacher’s classroom practices are not possible. A case study that followed a veteran middle school teacher over a period of two years showed that he was unable to make desired modifications in his teaching practices (Wilson and Goldenberg, 1998). The teacher was interviewed and observed regularly. The researchers reported that his initial teaching style reflected a narrow view of mathematics and mathematics teaching. Over the course of the study, he was able to increase his focus on concepts rather than on procedures, but he continued to portray mathematics as a rigid subject to be mastered rather than as a way of thinking or a subject to be explored. The authors believed that this view of mathematics was the primary obstacle preventing him from shifting from a teacher-focused classroom toward a student-centered class environment where exploration was encouraged. Although the teacher felt that he was making tremendous strides in this direction, the researchers disagreed. They concluded that his underlying epistemology had changed very little.

Consistencies between teachers’ stated beliefs and their classroom practices may be related to their abilities to reflect on their actions (Gellert, 1999; Lock and Lee, 2001). Thompson (1992) recognized the importance of the process of reflection in connecting beliefs to practice:

It is by reflecting on their views and actions that teachers gain an awareness of their tacit assumptions, beliefs, and views, and how these relate to their practice.
It is through reflection that teachers develop coherent rationales for their views, assumptions, and actions, and become aware of viable alternatives. (p. 139)

**Attitudes Toward Mathematics**

Attitude toward mathematics is defined as “a general emotional disposition toward the school subject of mathematics” (Haladyna, Shaughnessy, & Shaughnessy, 1983, p. 20). A positive attitude toward mathematics is generally valued because:

1. A positive attitude is an important school outcome in and of itself.
2. Attitude is often positively, although slightly, related to achievement.
3. A positive attitude toward mathematics may increase one’s tendency to elect mathematics courses in high school and college and possibly one’s tendency to elect careers in mathematics or mathematics-related fields. (Haladyna et al., p.20)

McLeod (1992) cited two different ways in which attitudes toward mathematics appear to develop. Attitudes may result from the automatizing of a repeated emotional reaction to mathematics. For example, if a student has repeated negative experiences with a particular area of mathematics, the intensity of the emotional impact will usually lessen over time. Eventually the reaction will become more automatic and stable and can then be measured by a survey or questionnaire. The second source of attitudes is the assignment of an already existing attitude to a new but related task. A student who has a negative attitude toward one particular area in mathematics may attach the same attitude to a related concept.
Teacher Attitudes Toward Mathematics

Although teacher beliefs and their role in learning to teach and classroom practices have been studied extensively, this has not been the case with teacher attitudes. The growing interest in cognitive psychology within the field of education has drawn interest away from attitudes and toward beliefs (Richardson, 1996). However, there have been some studies that have examined teachers’ attitudes toward mathematics.

Attitudes toward mathematics of preservice elementary teachers. Research involving teacher attitudes toward mathematics has focused largely on preservice elementary teachers. Rech, Hartzell, and Stephens (1993) found that preservice elementary teachers have less favorable attitudes toward mathematics than the general university population. Cornell (1999) surveyed graduate students who were taking a mathematics instruction seminar for certification as elementary school teachers. He found that about half of the students reported a dislike of mathematics. In nearly all cases, positive attitudes were correlated with success and negative attitudes with failure. Philippou and Christou (1998) studied 162 prospective primary teachers in Greece and found that “a considerable proportion” of them expressed negative feelings toward mathematics (p. 203).

Some studies have looked at teacher training programs designed to improve attitudes toward mathematics of preservice elementary school teachers. In one such study, McGinnis, Kramer, and Watanabe (1998) collected data from 1995 to 1997, as the participants completed a teacher preparation program. The Maryland Collaborative for Teacher Preparation (MCTP) is an undergraduate program for specialist mathematics and
science elementary/middle level teachers. The program’s goal is to promote development of confident teachers who can teach mathematics and science using technology, who can make connections between the disciplines, and who can challenge diverse learners by creating an exciting learning environment for them. The program focused on developing students’ understanding of key concepts and making connections between mathematics and science. The authors described the program as:

compatible with the constructivist perspective (i.e., address conceptual change, promote reflection on changes in thinking, and stress logic and fundamental principles as opposed to memorization of unrelated facts). (p. 4)

The researchers found that the students’ attitudes about mathematics and science were affected in the desired direction as they progressed through the preparation program. The authors pointed out that their students were somewhat distinctive because they had expressed an interest in teaching mathematics and/or science by making connections between the two.

Gibson and Van Strat (2001) also conducted a longitudinal study that tracked preservice teachers’ attitudes toward teaching and learning mathematics and science while enrolled in a teacher preparation program that utilized constructivist instructional methods. The Urban Preservice Degree Articulation in Teacher Education (UPDATE) program’s goal was to “provide a pathway for urban para-educators of color to become certified teachers” (Gibson & Van Strat, 2001, p. 2). Thirteen of the fourteen preservice teachers who participated planned to teach elementary school. The students completed two mathematics content courses and one methods course. All three were taught using instructional strategies such as collaborative group work, problem solving, manipulatives,
and calculators. Their results showed a significant positive change in the preservice teachers’ attitudes.

Philippou and Christou (1998) conducted a study in Greece that involved a teacher preparation program whose goal was to help preservice primary teachers acquire mathematical concepts and teaching methods while improving their self-confidence in doing mathematics. The program consisted of two mathematics content courses and one methods course. In these courses, students were provided opportunities to experience success with mathematics. There was a focus on mathematics as a “constantly changing creation of human activity” (p. 193). This was accomplished by including the historical development of basic concepts and allowing students to develop conceptual understanding through discussions and hands-on activities. Using a pre-test, post-test design, students were given instruments to measure their attitudes toward mathematics prior to beginning the program, after the first course, and after completing the entire program. They found significant differences in attitude at the conclusion of the program, indicating significantly more positive attitudes toward mathematics. In addition, the prospective teachers participated in 45-minute interviews where their own evaluations of their feelings prior to the program and of the effectiveness of the program relating to attitudes were given.

Quinn (1997) examined the effects of an elementary mathematics methods course that stressed the use of manipulatives, technology, and cooperative learning in the teaching of mathematics on the attitudes of preservice teachers. He found that the preservice elementary teachers’ attitudes improved significantly after completing the methods course.
In a similar study by Anderson and Piazza (1996), preservice elementary teachers, as part of their teacher preparation program, were enrolled in a mathematics content course that focused on an inquiry approach utilizing group problem solving and manipulatives. Each of the 48 prospective teachers wrote an essay about their learning experience in the course, and common themes were identified from the essays. Twenty-one of the students said that they felt less anxiety about learning/teaching mathematics as a result of the course. Ten of the students said that they felt a greater sense of confidence.

**Attitudes toward mathematics of preservice secondary teachers.** Much of the research involving teacher attitudes has focused on the elementary school level. However, Camacho, Socas, and Hernandez (1998) surveyed prospective secondary mathematics teachers in Spain about their beliefs and attitudes. They found that only 50% of the preservice teachers expressed enjoyment in doing mathematical work. The researchers felt that these results “put into doubt an ability to generate a positive attitude towards mathematics in the classroom” (p. 323).

Wagner, Lee, and Ozgun-Koca (1999) also studied beliefs and attitudes of preservice secondary teachers. They surveyed participants in the United States, Turkey, and Korea about their attitudes toward mathematics, teaching mathematics, and their teaching program. They reported that student teachers in the United States had more self-confidence than those from the other countries. Teachers from the U.S. also supported the use of manipulatives and technology while those from the other countries did not. The authors pointed out that their findings supported the assumption that student teachers’ beliefs and attitudes were affected by their experiences. Teachers from Turkey and Korea
did not have experience with these materials as the American teachers did. These researchers recommended that preservice teachers be encouraged to reflect on their experiences as students and as prospective teachers.

**Concepts related to teacher attitude.** Other areas in the affective domain have been studied that are related to teacher attitude and have implications for mathematics education. Most of the research that has been done in this area has examined various combinations of these concepts. One such concept is confidence in learning or teaching mathematics. Self-concept can be thought of as a generalization of confidence in learning mathematics. A variation of self-concept is the notion of self-efficacy, which represents a person’s “beliefs concerning his or her ability to successfully perform a given task or behavior” (Hackett & Betz, 1989). Mathematics self-efficacy can be distinguished from other attitudes in that mathematics self-efficacy is a problem-specific assessment of one’s confidence in his or her ability to accomplish a particular task. Personal teaching efficacy has been defined as a belief in one’s ability to teach effectively (Huinker and Madison, 1997).

Wenner (2001) reported the results of three studies concerning teaching efficacy that were conducted over a five-year period. He examined the efficacy beliefs about mathematics and science of prospective and practicing teachers and found that experience had a positive effect on personal teaching efficacy. Practicing teachers scored higher than preservice teachers on knowing how to support mathematics skill and concept development, effectiveness in monitoring use of manipulatives, ability to teach
mathematics effectively, and understanding of concepts well enough to be effective in teaching.

In a similar study, Huinker and Madison (1997) considered the effect of a methods course in mathematics and science on the personal teaching efficacy of preservice elementary school teachers. They based their study on the premise that the more positive the impact of the methods course on the personal teaching efficacy of the preservice teacher, the more likely that person is to become an effective teacher. The mathematics methods course was based on a constructivist philosophy and included use of manipulatives, collaborative group work, and investigation and discussion of challenging problems. They found that the methods course enhanced the personal teaching efficacy of the participants. The preservice teachers’ confidence in their abilities to teach mathematics effectively had increased.

In a study that investigated the effect of mathematics attitudes on preservice elementary teachers’ global self-concept, Sherman and Christian (1999) surveyed 88 preservice teachers at both the beginning and the end of a semester-long methods course. Like the previous studies, the methods course focused on the use of manipulatives, problem solving, mathematical discussions, and cooperative learning to understand mathematics teaching methods. The students were given questionnaires for both mathematics attitudes and global self-concept. There was a significant improvement in the teachers’ mathematics attitudes. However, there was no significant difference in their global self-concepts. The authors concluded that global self-concept is not easily impacted or altered. They suggested that global self-concept does not change much as
individuals age, and that future studies might investigate global self-confidence of specific age group populations.

**Connecting Teacher Beliefs and Attitudes about Mathematics**

Stipek, Givvin, Salmon, and MacGyvers (2001) surveyed 21 fourth- through sixth-grade teachers to assess their self-confidence and enjoyment of mathematics and mathematics teaching and to see if these attitudes were related to the teachers’ beliefs. They found that teachers who held more traditional beliefs about mathematics and learning had lower self-confidence and enjoyed mathematics less than teachers who viewed mathematics instruction as inquiry-based. These authors speculated that less confident teachers are drawn to beliefs and practices that allow them to teach in a prescribed way, following the procedures spelled out in the textbook.

Philippou and Christou (1998) also discussed the correlation between teacher beliefs and attitudes toward mathematics. They pointed out that because many prospective elementary school teachers have negative attitudes toward mathematics, they are likely to view and teach mathematics in a more traditional manner. According to Philippou and Christou, these teachers’ traditional teaching methods are then likely to promote the development of negative attitudes in their own students.

**The Effects of Attitudes and Beliefs on Achievement in Mathematics**

There has been little consensus in the research literature concerning the relationship between attitudes toward mathematics and achievement in mathematics. Ma and Kishor (1997) conducted a meta-analysis of 113 studies that examined the
relationship between attitudes toward mathematics and achievement in mathematics. In reviewing the literature, they reported that although some researchers have found the correlation between the two to be quite low, ranging from zero to 0.20, others have found statistically significant correlations ranging from 0.20 to 0.40. Still others have found quite strong correlations above 0.40 (p. 27).

In their meta-analysis, Ma and Kishor used 113 studies that examined the relationship between attitude toward mathematics (ATM) and achievement in mathematics (AIM). In total, 82,941 students in 12 grade levels participated in the studies. Most samples were mixed for gender and ethnicity. The smallest sample size was 10 and the largest was 23,132. A study was considered to be appropriate for this meta-analysis if it:

1. had a definition of ATM similar to the one used in this study.
2. investigated the relationship between ATM and AIM.
3. measured ATM and AIM using psychometrically-developed instruments.
4. did not include any experimental interventions on either attitude or achievement.
5. contained students at the elementary and/or secondary school level.
6. reported quantitative data in sufficient detail for calculation of an effect size.

(p. 30)

Because each of the 113 studies in the meta-analysis used different instruments to measure achievement, the researchers made sure that “the vast majority” of the AIM instruments were developed psychometrically. The authors noted that this was necessary in order “to ascertain that the reliability and validity of the instruments could be justified” (p. 32).
Researchers found that the effect of ATM on AIM was not strong. The ATM-AIM relationship was very similar for both males and females. This relationship between attitudes and achievement was weakest at the elementary school level. Students in grades 1-4 showed a Pearson product-moment $r = 0.03$, and students in grades 5-6 showed a correlation of $r = 0.14$. However, the relationship strengthened even more as students reached secondary school. Secondary students showed a correlation of $r = 0.26$. The authors suggested that future measures of attitudes should involve attitudes toward specific mathematical topics or activities rather than toward mathematics in general. They also suggested that researchers examine both direct and indirect effects when studying the causal ATM-AIM relationship.

Large-scale national and international studies have also examined the relationship between attitudes and achievement. Simich-Dudgeon (1996) investigated the relationship between mathematics attitudes of Hispanic and Asian students in the 1992 National Assessment of Educational Progress (NAEP) Mathematics Trial State Assessment, by gender and ethnicity, and by their mathematics performance scores. They also examined attitude variables and how well these variables predicted Hispanic and Asian students’ mathematics achievement. In discussing these NAEP results, the author cited various research projects that have studied the relationship between certain demographic and background variables and mathematics achievement:

- Confidence in learning mathematics has a positive correlation with mathematics achievement, and gender differences in confidence levels are usually associated with gender differences in mathematics achievement (Reyes & Stanic, 1988)
Male students attributed their success in mathematics to ability more frequently than female students; female students attributed their success to effort more often than male students. Female students were more likely than male students to associate failure in mathematics to a lack of ability and to the difficulty of the task (Wolleat, Pedro, Becker, and Fennema, 1980).

The perceived usefulness of mathematics was identified as one of the most important variables in understanding sex-related differences in mathematics achievement and as an important predictor of student selection of optional mathematics courses (Fennema & Sherman, 1978).

Self-efficacy has been a reliable predictor of whether a student will attempt a task, and the amount of effort and perseverance that he or she will put forth (Radhawa, Beamer, & Lundberg, 1993).

Mathematics performance and self-efficacy measures are significantly and positively correlated with attitudes toward mathematics, and self-efficacy is a stronger predictor of the choice of a mathematics-related major than mathematics achievement variables (Radhawa et al., 1993).

Attitudes toward mathematics may be related to (a) majority and minority status within a culture, (b) ethnicity, and (c) a combination of gender and ethnicity (Iben, 1991).

For this study, records of 32,009 fourth-and eighth-grade Hispanic and Asian students from the 1992 NAEP Trial State Assessment data set were used. Descriptive statistics were used to generate cross tabulations of students’ background characteristics, including their attitudes toward mathematics and their average mathematics performance.
The students were asked to agree or disagree with eight statements regarding their attitudes about mathematics. These included such statements as: I like mathematics, I am good at mathematics, and I understand most of the mathematics class.

Results indicated that most of the attitude variables were significant predictors of Hispanic and Asian students’ mathematics achievement. More Asian students than Hispanic students believed that they were “good at math” and “understand math.” These two attitudes were correlated with higher mathematics achievement at both grade levels. However, results indicated that “like math” was not a significant predictor of mathematics achievement. The author suggested that this finding may mean that a student’s affinity for mathematics does not necessarily reflect his or her self-assessment of mathematics ability or judgment of understanding of mathematics instruction.

Three attitude variables represented dimensions of mathematics usefulness: math is mostly memorizing facts, math is used in jobs, and math is for solving problems. Agreement with the statement “math is mostly memorizing facts” was a significant predictor of low mathematics achievement for both male and female Hispanic and Asian students. Agreement with the statement “math is used in jobs” was a significant predictor of higher mathematics achievement in Hispanic and Asian students in both gender groups. However, agreement with “math is for solving problems” was a significant predictor of achievement for female and male Hispanic students but not for Asian students of either gender group.

Braswell et al. (2001) investigated this relationship between students’ attitudes toward mathematics and their mathematics achievement on the 2000 NAEP assessment. They reported that students at all three grade levels that were tested, grades 4, 8, and 12,
demonstrated a positive relationship between performance on the NAEP and attitudes. Those who agreed with the statements, “I like mathematics” and “Math is useful for solving problems,” had higher average achievement scores than those who disagreed with these statements.

Tocci and Engelhard (1991) investigated the relationship of attitudes toward mathematics and mathematics achievement using data from the Second International Mathematics Study (SIMS) for 3,846 eighth-grade students from the United States and 3,528 eighth-grade students from Thailand. One of the attitude dimensions investigated in this study was Mathematics and Myself. This was designed to assess the extent to which students enjoyed studying mathematics, felt confident in their abilities to do mathematics, and wanted to achieve in mathematics. Another attitude dimension was Mathematics and Society. This assessed students’ views about the usefulness and importance of mathematics to society. Researchers also measured Mathematics Anxiety, or the extent to which students were anxious about mathematics. The researchers found that achievement had a statistically significant correlation with both Myself and Society. They also found that achievement had an inverse relationship with Anxiety, indicating that a high level of mathematics anxiety was correlated with low mathematics achievement.

In 1995, the Third International Mathematics and Science Study (TIMSS) found a positive relationship between attitudes and achievement in mathematics. Students who performed well in mathematics generally had positive attitudes toward the subject and those with positive attitudes tended to have higher achievement scores (Papanastasiou, 2000a, 2000b). Students in grades 3 and 4 showed a high correlation between mathematics achievement and their perception of the role of luck, talent, and having good
memory, as well as their perception of the role of hard work and memorization in being successful with mathematics (Gadalla, 1999). Self-confidence was a strong predictor of mathematics achievement for girls, but not for boys. In grades 7 and 8, attitude explained more of the variation in achievement than it did for the younger students (Gadalla, 1999). The factors that related most to achievement were self-efficacy, educational aspirations, and external attributions of success (Papanastasiou, 2000b).

High achievement is not always associated with positive attitudes toward mathematics. Leung (2002) also examined data from the Third International Mathematics and Science Study (TIMSS). He found that students in grades 4 and 8 from the East Asian countries of Hong Kong, Japan, Korea, and Singapore outperformed students from other countries in mathematics achievement. However, students from these countries expressed relatively negative attitudes toward mathematics. Although over 80% of eighth grade students from Singapore reported that they liked mathematics, students from the other three East Asian countries disagreed. Japan and Korea were among those countries whose students expressed the greatest dislike of mathematics. Less than 55% of Japanese eighth-grade students and less than 60% of Korean eighth-grade students reported liking mathematics.

Students from these four countries were among the seven countries (the other three were Latvia, Lithuania, and Portugal) in which over 40% of students reported that they did not think they did well in mathematics. This was unexpected given the high achievement levels of these countries. Leung pointed out that this could be a result of the

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1 Note: Hong Kong is currently part of China, but it was considered a separate country at the time the TIMSS study took place.
common culture that these countries share. These cultures stress the importance of humility or modesty. Children are taught not to be boastful, so they may be hesitant to state that they do well in mathematics even if they believe that they do. Leung also said that if students in these cultures are consistently taught to rate themselves low, they might internalize the idea and actually have low self-confidence. He also pointed out that the school systems in these countries featured competitive examinations and high expectations, which left many students who were viewed as failures by the system and possibly by themselves.

There continues to be a lack of consensus concerning the link between attitudes and achievement. Many studies have demonstrated a correlation between the two. Although some research suggests that attitude and achievement are not dependent on each other, they do interact with each other in “complex and unpredictable ways” (McLeod, 1992, p. 582). McLeod says that as research methodology becomes more flexible and qualitative methods such as interviews become more widely used, “we can expect research on attitude to make new contributions to the field of mathematics education” (p. 582).

Journal Writing and Mathematics

The National Council of Teachers of Mathematics (NCTM) has emphasized the importance of communication as an essential part of mathematics and mathematics education. “Through communication, ideas become objects of reflection, refinement, discussion, and amendment” (NCTM, 2000, p. 60). Writing is an excellent way for students to communicate about mathematics.
The assertion that writing can contribute to learning depends essentially on a Vygotskyan view of the relationship between language and thought, where both language and thought are transformed in the act of representation (Borasi & Rose, 1989). Writing contributes to the learning process because it actively engages students in structuring meaning; students can go at their own pace; and it “provides unique feedback, since writers can immediately read the product of their own thinking on paper” (Emig, 1977, as cited by Borasi & Rose, 1989, p. 348).

*Writing to learn* focuses on learning and writing as processes that involve the learner in actively building connections between what is being learned and what is already known. Not all writing activities may qualify as *writing to learn*. Journal writing is one particular form of *writing to learn* where students keep a log or personal notebook. Unlike diaries, journals focus on particular academic subjects and go beyond an account of the day’s events. In journal writing, students reflect on experiences and organize their thoughts in order to communicate clearly. Students are often invited to reflect on their learning by expressing their thoughts and feelings about what they are learning. The teacher is expected to read the journal entries and respond to them in a supportive and non-evaluative way.

The first six standards in the *Professional Standards for Teaching Mathematics* (NCTM, 1991) involve the process of teaching mathematics. Stewart and Chance (1995) described how these standards can be connected to journal writing:

- Standard 1: Worthwhile Mathematical Tasks: This standard promotes teaching that is based on students’ understanding, interests, experience, and learning styles. Entries from students’ journals give such information.
Standard 2: The Teacher’s Role in Discourse: “The objectives of this standard have connections to journal writing that include listening to students’ ideas, asking students to express their ideas in writing, and deciding when and how to react and respond to students’ ideas and comments” (p. 94).

Standard 3: The Student’s Role in Discourse: Journal writing provides students the opportunity to “respond to and question the teacher, to make connections, and to communicate mathematically and otherwise” (p. 94).

Standard 4: Tools For Enhancing Discourse: Journal writing can enhance discourse by supplying a setting for using the tools of discourse. These include pictures, diagrams, analogies, stories, written hypotheses, explanations, and arguments.

Standard 5: The Learning Environment: Journal writing can have a large impact on the classroom environment. Students are often asked to write ideas for improving the teaching and learning of mathematics. The implementation of their ideas can make the classroom “more student centered, more collaborative, and more supportive of students’ learning” (p. 94).

Standard 6: Analysis of Teaching and Learning: This involves interconnected and ongoing assessments for teachers who must adjust and alter their instruction when necessary. One goal of this standard is to observe, listen to, and gather information about students. Journals certainly provide an opportunity for all of these.

Countryman (1992) listed some purposes of using journals in mathematics classrooms. These included the following: “to increase confidence, to increase participation, to decentralize authority, to encourage independence, to replace quizzes and tests as a means of assessment, to monitor progress, to enhance communication
between teacher and student, to record growth” (p. 42). She also suggested that when using journals with mathematics students, a teacher should expect language that is “informal, conversational, personal, and contextual” and “questions, observations, doubts, digressions, examples, drawings, sketches” (p. 43).

Journal-writing prompts can be used to help students focus their thoughts in a particular direction. Dougherty (1996) identified three types of journal-writing prompts: (a) mathematical content prompts, which focus on mathematical topics and their relationships; (b) process prompts, which offer students an opportunity to reflect on their preferred solution strategy and to consider ways in which they learn; and (c) affective/attitudinal prompts. This type of prompt asks the students to write about past experiences and how these experiences have affected their attitudes about mathematics.

Journal Writing with Elementary School Mathematics Students

Journal writing can be adapted to any grade level. Even kindergartners can benefit from this type of activity. Fuqua (1998) wanted her kindergarten students to be able to record how they solved a problem and share their results with others. Instead of individual journals, she used a big book that served as a class mathematics journal. She decided to call it a ‘Problem-solving Book’ rather than a ‘math journal’ because she wanted the focus to be on logico-mathematical thinking.

In her article, Fuqua described some of the activities that were recorded in the class journal. The first entry occurred when one of the children brought Halloween rings to school. There were three types of rings: bats, spiders, and pumpkins. After the rings
had been distributed, one of the children wondered if the ring types had been evenly distributed. He asked, “Who has the most—the bats or the spiders or the pumpkins?” (p. 74). When the teacher asked how this could be determined, another child suggested they count and make a graph. They divided the paper into three columns. At the top of each column was a picture of one of the rings. Each person wrote his/her name in the column that represented his or her ring. They then counted the total in each column and found that there were five names for each kind of ring. Another day the class was discussing where to go for recess. The teacher told them that they would all need to go to the same place. Two of the children took a piece of paper and wrote at the top, “Do you wot to go on the his or the lidprising” (Do you want to go on the hills or the little playground?) (p. 75). Each child signed under the heading of his or her choice.

Fuqua pointed out that these activities illustrated the children’s problem-solving abilities. She said that this process made them think about and use various symbols, including letters, words, and drawings, to represent their thoughts. They were also actively involved in reasoning, comparing, counting, and other mathematical concepts.

Scott, Williams, and Hyslip (1992) described their experiences with journal writing in second grade classrooms. To maximize the experience, the students were led through an instructional sequence: motivational experiences, verbal interaction, class and individual journal writing, sharing, and responding.

Before each journal entry, teachers presented multisensory mathematics activities that were unusual, unexpected, or used unfamiliar materials. These activities stimulated thinking and lively discussions. The activities might involve partners, small groups, furniture rearrangement, special guests, music, color, or a variety of manipulatives. Each
of these activities was followed by an oral language experience. The class might discuss how they would explain their mathematics activity to an absent classmate. Another method involved a soft ball. The teacher would begin a sentence such as, “Today we used tangrams and my square was . . ..” She would then toss the ball randomly to students. The student who caught the ball had to finish the sentence and begin another one. He or she then tossed the ball again.

The class next moved to written communication. The teacher wrote students’ comments on the chalkboard or chart paper. She then wrote the ideas in complete sentences in an oversized journal to model the writing process. This was done as a large group activity until the students became familiar with the process of writing about mathematics. Then individual journals replaced the class journal. Some children expanded phrases from the experience chart while others expressed their ideas with pictures and diagrams. Students could volunteer to share their journal entries with the class, although reading them aloud was never required. The authors reported that “students of all ability levels found their work and progress valued by peers, teachers, and others” (p. 17).

The teachers read the journals and responded to them on a weekly basis. In responding to journal entries, teachers modeled correct spelling, punctuation, and grammar although the journal entries were never corrected in any way. The desired focus was on thinking and process rather than the finished product. Responses always closed with a question encouraging further thought. The authors reported that journal entries reflected improved attitudes toward mathematics as well as growth in mathematical thinking and use of mathematical language. Students’ self-esteem grew as well. Journal
entries included statements such as, “I think I can be a math teacher,” and “I am smart now” (Scott et al., 1992, p. 18).

Journal Writing with Intermediate and Middle School Mathematics Students

Evans (1984) conducted a study involving two fifth-grade classes in the same school. Both classes were taught using the same procedures and textbook. The only difference in approach was that one of the teachers incorporated the use of journal writing during mathematics class. Three types of prompts were used. The first involved asking the students to describe how to do something. Rather than writing to the teacher, students wrote to an uninformed third party. This required them to be more specific in their descriptions. The second type of writing they did was definitions. Describing something new in their own familiar terms gave students a chance to gain understanding of the new concept. The third type of writing was “troubleshooting.” Students were asked to explain their errors on homework or quizzes. Not only did this allow students to analyze their own mistakes, but it also helped the teacher identify students who did not know what they had done wrong. This allowed for immediate reteaching of the concept.

The study looked at two areas of the mathematics curriculum, multiplication and geometry. Evans gave pretests and posttests to both classes. Her results are found in Table 1. In both units, the control group scored higher than the test group on the pretest. However, the test group scored higher than the control group on both posttests. This was especially true on the geometry unit. In looking at individual scores, a pattern emerged. Students with the lowest pretest scores in the test group made the most gains.
Table 1

Results from Evans’ Study with Journal Writing (in percent)

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<th>Group</th>
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<tr>
<td>Test</td>
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<tr>
<td>Control</td>
<td>23</td>
<td>54</td>
<td>76</td>
<td>24</td>
<td>60</td>
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</table>

Note. From “Writing to Learn in Math,” by C.S. Evans, 1984, Language Arts, 61, p. 834.

Gordon and Macinnis (1993) described the use of dialogue journal writing with students in grades four, five, and six. Dialogue journals are distinguished from other forms of journal writing because of the importance given to the communication between student and teacher. Dialogue journals are written conversations between a student and a teacher. They are intended to provide students with an opportunity to share privately in writing their reactions, questions, and concerns about school experiences with the teacher. Two types of writing were used in the journals: prompted writing, where the teacher poses questions and free writing or open-ended writing. Prompts were usually centered on the students’ understanding of decimals. For example, students were asked to respond to such questions as: “What do you think decimals are?” “Which is larger, 0.5 or 0.42, and why?” Open-ended entries allowed students to write on anything of interest or concern to them in mathematics.

For one year, the 180 students from seven classes in fourth, fifth, and sixth grade wrote entries in their mathematics journals. The students were allowed 10-15 minutes to write in the journals during the mathematics class. The teacher read the journals and
returned them by the next week. Approximately 25 journals were handed in daily. The authors reported that the students appeared to enjoy the writing. They displayed a “keen interest in the teacher’s response” (p. 39). The authors reported the following observations based on what the students told them in their journals:

1. Intermediate grade-level students have some conceptual knowledge, but generally speaking, acquire better understanding of the decimal system by sixth grade.

2. Students were able to assess what they viewed as their own strengths and weaknesses. They wanted to be heard, as they related comments about what might help them learn better.

3. Students had sufficient awareness of themselves as learners to indicate what worked or did not work for them.

4. Personal feelings were readily expressed as trusting relationships were built in the journal communication.

5. Students shared their difficulties and problems with decimal learning because the journal was not seen as an evaluative tool.

6. Students shared their discoveries and their insights in their journals.

The teacher’s responses to the journal entries consisted of comments, questions, and notes of encouragement. No attempt was made to teach mathematical concepts through the journal responses, but misconceptions and concerns were acknowledged. The students were assured that the problem would be addressed. The journals allowed the teachers “the opportunity to reflect on the teaching/learning process and to better meet the instructional needs of each of the students” (p. 42).
DiPillo (1997) designed a project that used journal writing with fifth and sixth grade students. Over an eight-week period, twenty-six fifth graders and twenty-eight sixth graders wrote in their journals for five to eight minutes, three or four times a week, in response to specific prompts. Teachers responded to each journal entry by offering written comments, questions, or encouragement. Teachers also wrote in their own journals, describing classroom activities and reflecting on how information from the students’ journals had influenced their instruction. Four categories of prompts were used: (a) instructional prompts, such as “What is a fraction?” (b) contextual prompts, such as “What is the hardest thing you learned this week?” (c) reflective prompts, such as “How has writing in your journal helped you in math?” and (d) miscellaneous prompts, such as “Discuss the school subject that is most like mathematics.”

In her article, DiPillo described some of the students’ responses to the prompts. She found that fifth graders tended to make their responses more concrete than the sixth graders did by using diagrams. Fifth graders were also more likely to respond by using personal feelings and giving examples. Sixth graders gave more textbook-type definitions, procedures, and explanations. Overall, students expressed positive attitudes about mathematics. Many, however, voiced concern with grades. These students frequently indicated negative attitudes toward mathematics. DiPillo reported that the vast majority of the students expressed enjoyment about mathematics journals. Their responses “revealed five different categories of benefits: (a) opportunities to express their feelings, (b) better retention of information, (c) increased understanding of mathematics, (d) stimulation of thinking about mathematics, and (e) improved writing ability” (p. 311).
Jurdak and Zein (1998) conducted a teaching experiment to measure the effect of journal writing on achievement in and attitudes toward mathematics. The participants in the study were students between the ages of 11 and 13 who were attending an international school in Beirut, Lebanon. Mathematics instruction in this school was conducted either in English or French. The journal-writing group received the same instruction as the no-journal-writing group. However, the journal-writing group spent 7 to 10 minutes at the end of each class period, three times a week for 12 weeks, engaged in prompted journal writing.

Results showed that the journal writing had a positive impact on conceptual understanding, procedural knowledge, and mathematical communication, but not on problem solving, school mathematics achievement, and attitudes toward mathematics. The authors suggested that the failure of journal writing to improve school mathematics achievement could be due to the fact that school tests normally measure instruction-specific content rather than general abilities such as procedural knowledge and conceptual understanding. They also pointed out that the failure of journal writing to improve attitudes toward mathematics was in sharp contrast with the positive attitudes that the students expressed toward journal writing itself. The authors noted that previous studies reporting positive effects of writing on attitudes toward mathematics were conducted at high school or college levels.

Journal Writing with High School Mathematics Students

Waywood (1994) described work he had done from 1985 to 1990 developing a pedagogical model of journal writing in mathematics at a secondary school for girls. He
explored the theme of student’s questioning in order to show a connection between mathematics learning and writing. By 1990 journal writing had been integrated into the teaching and assessment of the school’s mathematics program for grades 7 through 11. The pedagogical model for journal writing at the school consisted of the following elements:

1. A clear task specification: The journal was to be kept in a separate book. An entry was completed after each mathematics lesson. Each entry was to summarize the day’s lesson, which included discussing the lesson, asking questions, and showing examples.

2. A developmentally structured feedback sheet: This feedback sheet served to connect the task specification with assessment. On it were progress descriptors for each of the required components of the entry. The teacher would circle those criteria that the student had met.

3. A set of assessment descriptors: These were specific to grade levels. Essentially, this was a rubric used for assigning letter grades to the journal writing. The journal component counted for 30% of the entire grade for mathematics. The purpose of the assessment descriptors was to maintain consistency with grading in the school.

4. The final step in this process was the inclusion of Journals on the report cards that went home to parents.

Waywood examined the questions that students in one tenth-grade class had posed in their journals. He wanted to answer the question: Do questions posed by students in journals contribute to a profile of a student’s learning in mathematics? In
order to answer this question, he presented five short case studies of students’ questioning in journals. Four of the students studied were in the same tenth-grade class. These students were chosen because their journals represented the range of grades given to the journal component of the assessment. The other case examined involved two journals from the same student, one written in grade 9 and the other in grade 11.

Waywood (1994) stated that “questioning is clearly an activity to be prized in students of mathematics” (p. 325). He identified the following three beliefs about questions that were reflected in the progress descriptors used on the feedback sheet:

1. Questions are tools. They can be used to focus and direct thinking as well as focusing and directing learning.

2. The more specific the question the better.

3. There is a distinctly mathematical questioning.

Waywood also looked at how grades assigned to journals compared with other assessment tasks in discriminating between and ranking students. In addition to the journals, he included problem solving, projects, and skills. Grades for these other components were produced by three teachers working independently. He found no evidence to suggest that the grading of journals was in any way distinguishable from the grading of the other tasks.

Waywood’s conclusion was that journal writing did discriminate between students at a particular level. He found that through years of journal use, it was possible to recognize changes in successive journals. Therefore, he found that journals provided meaningful profiles of students’ learning in mathematics.
Stewart and Chance (1995) investigated the use of journals by students and their teachers in four secondary first-year algebra classes over an entire school year. Two of the classes wrote in journals, two did not. Journal entries were made three times a week during the last five minutes of class. The prompts were in three categories: mathematics concepts and procedures, curriculum issues, and free writing. On Mondays, the instructor gave the students a prompt that focused on the mathematics concepts and procedures being taught. One example was, “Subtracting is the same as adding the opposite because…” On Wednesdays, students responded to curriculum prompts such as “One mathematics activity I really enjoy is … because…” Thursdays were reserved for free writing, where the only requirement was that the entries involve the writers as students of mathematics. Students often wrote about their accomplishments, frustrations, and personal problems that interfered with schoolwork.

Students handed in journals at the end of the class. The instructor read the entries, made occasional written comments, and returned the journals to the students. Writing was not judged on grammatical accuracy, although complete sentences and paragraphs were encouraged. No grades were given for journal writing. Students were given pretests at the beginning of the school year and posttests at the end of the year. Achievement was significantly higher for the journal-writing students. Similar tests performed on the changes in anxiety scores suggested for journal-writing students a decrease in anxiety that approached significance (Stewart & Chance, 1995).
Journal Writing with College Mathematics Students

Using writing in college mathematics courses can improve performance in mathematics (Abdalkhani and Menon, 1998; Austin, 1998). Britton (1992) wanted to incorporate writing into his calculus, precalculus, and statistics classes. He had his students write weekly journal entries of one to two pages. He read each journal entry and returned them the next class meeting. The primary topic for the journals was a summary explanation of the mathematics studied that week. Frequently the journals included exercises the students had worked and wanted the instructor to check or to determine why they did not get the correct answer. Other journal material included questions for the teacher, lists of items not understood, and comments about the course. The journals were evaluated using three levels: minus, if unsatisfactory; check, if satisfactory; and plus, for an exceptionally good entry.

The author stated that his primary reason for using journals was that students learned better if they had to describe the material they were studying. He discussed three additional advantages for the required journals. He found that students made more of an effort to keep up with their work when using journals. The increased communication between students and their instructor was also a definite advantage. One of the indirect advantages that he found was that collecting the journals was also a means of recording attendance without having to take roll during class.

Borasi and Rose (1989) did a study involving the use of journals with college mathematics students. The students were enrolled in a course entitled “Algebra for Professional Programs.” This was a 3 semester-hour course that was taken predominantly by business students in their first or second year of college. The writing experience was
structured so as to make journal writing an integral and valued component of the course without modifying the goals and content of the course, nor the teaching approach usually employed by the instructor. This approach consisted mainly of lectures by the teacher, followed by the assignment of homework practice and follow-up discussion.

The students were asked to write three entries per week, with the journals collected every other Friday and returned on the following Monday, along with comments by the teacher. Credit toward the course grade was assigned for maintaining the frequency and volume of writing, but not on the basis of mechanics or content. Although topics for the entries were intentionally left open and flexible, the instructor produced a list of 36 suggested ideas. These included the following writing topics:

- Reflect on math ideas or feelings about math.
- Describe your favorite math class.
- How should we use class time to best advantage?
- How do I go about doing word problems?
- Where do the rules of math come from?

In addition to the open entries that they were supposed to write at home, students were occasionally asked to write in their journal during class, in response to a topic assigned by the instructor. As a follow-up to the journal writing activity, the students were asked to write an evaluation at the end of the semester by responding to the following open-ended questions:

1. How has writing in your journal affected your learning of mathematics?
2. How do you feel about journal writing for this course?
3. What are the benefits of journal writing for mathematics classes?
4. How could journal writing be changed to be more effective? (p. 351)

Twenty-three complete sets of journals and evaluations were analyzed in order to examine both what happened when journal writing was used in this specific setting and what meanings the participants attributed to the experience. As a result of a content analysis of these sets of data, a number of potential benefits of journal writing were identified and explored. Researchers found that students demonstrated an increased learning of mathematical content as well as improving their problem-solving skills. They also found that writing in journals provided a therapeutic effect for students when they wrote about feelings and attitudes. The dialogue between students and teachers through the journals created a supportive class atmosphere.

*Journal Writing with Mathematics Teachers*

Burk and Littleton (1995) conducted the Pre-Algebra Experience, which was a project developed to improve mathematics instruction in the middle grades. The primary goal of the project was “to stress to middle school mathematics teachers the content necessary for students to succeed in high school algebra” (p. 576). The teachers attended a three-week summer institute. The thirty participants were asked to keep journals during the workshop. The teachers were asked to respond daily to the question “What did you learn today?” The following prompts were among those given to the teachers to encourage reflective thinking:

- How does what you learned fit with what you already know?
- Do you think that you can use in your classroom what you have learned? How? Why?
• Are you confused or surprised by anything you learned today? What? Why?
• How has what you have learned changed you?

The second phase of journal writing began when school started and the participants were actually involved in mathematics instruction. Participants were instructed to write in their journal twice a week. In these journals, teachers were told to (1) record the date of the entry, which should cover only one day and be written on the day of the experience; (2) briefly describe the context of the sequence of events; (3) select one or two significant incidents to describe in detail; and (4) analyze this incident. Why is it significant? What is your interpretation of this incident? What did you learn from it? What questions did it raise for you?

The authors found that the use of reflective journals during this project served the following purposes: The journals (a) guided instruction during the institute; (b) documented the institute’s effectiveness for evaluation purposes; (c) cemented learning and encouraged reflection on that learning; (d) linked understandings gained in the institute to actual classroom practice; and (e) involved teachers in an instructional strategy that they could implement with their students.

*Journal Writing with Preservice Teachers*

Studies involving journal writing with teacher education students enrolled in educational psychology courses have shown that students believed that they had benefited from the journals. Some students said that they found that journal writing allowed them to reflect on their own experiences and made the material more relevant to
them (C. W. Carter, 1997). Others said that the journals required them to organize their thinking and encouraged reflection and construction of meaning (Good and Whang, 2002).

Garmon (2001) used dialogue journals with 21 students enrolled in a multicultural education course for preservice teachers. Students were given prompts for their journal entries. Two of these prompts asked the students what they liked/disliked about the journals and whether or not they found journals valuable. From this data, the author identified the following benefits of dialogue journals and relative frequencies of mention: (1) facilitating learning of course material (27%); (2) promoting self-reflection and self-understanding (25%); (3) providing procedural conveniences and benefits, such as scheduling and grading policies for journals (21%); (4) providing an opportunity to express ideas (14%); (5) getting feedback on ideas and questions (8%); and (6) improving the teacher-student relationship (5%). The author concluded that the use of journals in teacher education courses “may offer a number of important benefits for some prospective teachers” (p. 47).

Phenomenology

Conceptual Overview

The word phenomenon is derived from the Greek word phaenesthai, which means to flare up, to show itself, to appear. Thus phenomenology, in a broad sense, looks at that which appears in consciousness, the phenomenon, as the “impetus for experience and for generating new knowledge. Phenomena are the building blocks of human science and the basis for all knowledge” (Moustakas, 1994, p. 26). Phenomenology asks the foundational
question: “What is the meaning, structure, and essence of the lived experience of this phenomenon for this person or group of people?” (Patton, 2002, p.104). Phenomenology differs from other sciences in that it gains insights from the way people describe their experiences “pre-reflectively, without taxonomizing, classifying, or abstracting it” (Van Manen, 1990, p.9). Many have embraced this notion of studying phenomena, and phenomenology has come to mean different things to different people.

A German philosopher named Edmund Husserl (1859-1938) was the founder of pure phenomenology. Husserl believed that everything in life was directed toward the goal of achieving consistency and harmony (Kim, 1989). Husserl’s basic philosophical assumption was that knowledge and understanding come from experience. This understanding comes initially from sensory experience of phenomena, but later these experiences must be “described, explicated, and interpreted” (Patton, 2002, p. 106) in order to lead to understanding.

Whereas Husserl focused on phenomenological psychology, Alfred Schutz (1899-1959) approached phenomenology from a sociological perspective (Wagner, 1970). Sociology is concerned with the subjective meaning and understanding of social action. In this context, action can relate to any human conduct where the acting person attaches meaning to the conduct. This action is considered social when it is “directed upon the conduct of others” (Wagner, 1970, p. 8). Schutz made a major contribution to the field of phenomenological sociology by combining his familiarity with Husserl’s philosophy with his own extensive knowledge of sociology. His most important contributions to this field involved “uncovering, describing, and analyzing the essential features of the world of everyday life” (Psathas, 1989, p. 8).
Phenomenology has also been viewed as an inquiry paradigm, an interpretive theory, a research methods framework, and a major qualitative tradition (Patton, 2002). Although the term *phenomenology* can have several different meanings, they all share a desire to explore how people make sense of their experiences and transform experience into consciousness.

*Phenomenological Methodology*

Exploring how human beings make sense of their experiences requires methodology that “focuses on descriptions of what people experience and how they experience what they experience” (Patton, 2002, p. 107). Patton described a phenomenological approach to qualitative research as:

- capturing and describing how people experience some phenomenon--how they perceive it, describe it, feel about it, judge it, remember it, make sense of it, and talk about it with others. (p. 104)

Van Manen (1990) explained that consciousness is the way people access the world and their own lived experiences. Since one cannot reflect on lived experience while it is actually occurring, “phenomenological reflection is not introspective but retrospective” (Van Manen, 1990, p. 10).

Van Manen (1990) explained that in human sciences such as phenomenology, objectivity and subjectivity might take on meanings that differ from the traditional perspective. Here the ‘object’ refers to the object of the researcher’s inquiry, so ‘objectivity’ means that the researcher remains true to the object. This involves describing and interpreting the object while remaining faithful to it. ‘Subjectivity’ means
that the researcher can examine the object of the study in a unique and personal way while not being misled by his or her own “unreflected preconceptions” (Van Manen, 1990, p. 20).

Moustakas (1994) described steps that a phenomenological researcher can take in investigating and describing how people experience some phenomenon. The first step is called *epoche*. This is a Greek word that means to refrain or abstain from judgment. *Epoche* requires the researcher to set aside his or her own prior assumptions, judgments, and knowledge. This involves acknowledging personal bias and preconceptions and doing one’s best to eliminate them.

The next step is phenomenological reduction. This comes from the Latin word *reducere*, which means ‘to lead back.’ Reduction involves going back to the data and “bracketing out” the researcher’s biases that were identified during epoche (Patton, 2002). The process allows the researcher to view the data “on its own terms” (Patton, 2002, p. 485). Reduction entails locating key phrases that are relevant to the phenomenon being studied, interpreting the meanings of these key phrases, and inspecting these meanings for revelations about the phenomenon being studied.

After the bracketing has been completed, the data are ‘horizontalized.’ This implies that all elements and perspectives of the data are equal in weight. Data are organized into meaningful clusters, and invariant themes within the data are identified. In doing this, the researcher performs an ‘imaginative variation’ on each theme. This refers to the researcher approaching the phenomenon from various perspectives in order to understand that there is not just one single truth to be found.

At this point, the researcher is ready to synthesize the “meanings and essences of
the experience” (Moustakas, 1994, p. 144). This involves a structuring of the meaning found in the data. In order to do this, the researcher must be careful not to allow his or her biases to interfere with the process. Often researchers check each other’s work and collaborate to find consensus when discrepancies arise. This process adds validity and reliability to the findings.

Reflection

*The Oxford Dictionary* (1996) defines the verb *reflect* as “meditate on; think about … consider; remind oneself” (p. 1261). In the field of education, much has been written about reflective practice in teaching (Canning, 1991; Clift, Houston, & Pugach, 1990; Jay, J.K., 2003; McEntee et al., 2003). Most of the ideas concerning reflective practice in teaching are based on the work of John Dewey. Dewey (1933) defined reflection as “active, persistent, and careful consideration of any belief or supposed form of knowledge in light of the grounds that support it and the further conclusions to which it tends” (p. 9). Dewey’s view of reflective thought involved identifying a problem and searching for a solution to that problem.

Dewey’s notion of reflective thinking lends itself well to the use of reflective practice in teaching. Reflective teachers actively seek solutions to their classroom problems. Alternative solutions are considered and re-considered. Because Dewey’s notion of reflection involves “consideration of any belief or supposed form of knowledge,” each teacher must consider his or her own personal beliefs and assumptions when making classroom decisions. A reflective teacher considers various solutions to a classroom problem, assesses each potential solution with regard to research and personal
beliefs, and then implements the solution. If one solution fails, the reflective teacher will consider other possible solutions in the same manner.

Although much has been written about reflective practice in teaching and the use of reflection in identifying and considering personal beliefs, little has been written concerning the use of reflection in examining and possibly improving attitudes toward mathematics. This type of reflection involves recalling and reliving lived experiences. In reflective journal writing, participants reflect on experiences and organize their thoughts and feelings in order to communicate clearly. Phenomenology explores how people make sense of their experiences (Patton, 2002). Reflective journals are an excellent way for people to relive and make sense of their experiences.

Summary and Implications for Teacher Education

The reform movement in mathematics education has recognized the importance of affective issues and the connection between these issues and higher-order thinking. Beliefs about mathematics and attitudes toward mathematics are two of the three major components of the affective domain in learning mathematics.

Teachers’ beliefs have been shown to influence their teaching practices (An, 2000; Fang, 1996; Kagan, 1992; Stipek et al., 2001; Thompson, 1992) and the beliefs of their students (G. Carter, 1997). A teacher who regards mathematics as a set of rules needed to produce accurate results will most likely teach the subject differently than a teacher who views mathematics as a way of dealing with ideas that grow out of problem situations. Because beliefs are based on subjective evaluations and personal experiences and are so difficult to change, teacher educators need to be aware of the influence beliefs
have on teacher behavior in the classroom. The ways that prospective teachers perceive and interpret knowledge “may be shaped by belief systems beyond the immediate influence of teacher educators” (Nespor, 1987, p. 326). Thompson (1992) pointed out that “the task of modifying long-held, deeply rooted conceptions of mathematics and its teaching in the short period of a course in methods of teaching remains a major problem in mathematics teacher education” (p. 135).

Often teachers’ existing belief systems conflict with the pedagogical practices they are being encouraged by the profession to adopt. Research involving mathematics belief changes in teacher training programs has shown little consensus. Many studies have demonstrated a change in the beliefs of prospective and new teachers (Ambrose, 2001; Mewborn, 2002; Stuart and Thurlow, 2000; Vace and Bright, 1999), while others have shown an inconsistency between new teachers’ stated beliefs and their classroom practices (Benken and Wilson, 1998; Frykholm, 1996; Raymond, 1997). Studies with practicing teachers have also shown conflicting results. Although some teachers have demonstrated a belief change after a professional development program (Pligge et al., 2000; Simon and Schifter, 1993; Vacc et al., 1998), others have not (Wilson and Goldenberg, 1998).

Several avenues have been proposed for changing teachers’ belief systems. These include reflection and examination of personal beliefs and building new beliefs upon existing beliefs. The benefits of teacher self-reflection have been shown in many of the studies included in this review (Anderson and Piazza, 1996; Gellert, 1999; Lock and Lee, 2001; Mewborn, 2002; Stuart and Thurlow, 2000; Wagner, Lee, and Ozgun-Koca, 1999). This suggests that teacher education programs designed to build on preservice teachers’
existing beliefs by providing them opportunities to reflect on these beliefs would be effective.

Attitudes toward mathematics have not been studied as extensively as beliefs. Studies have shown that students’ attitudes toward mathematics tend to become more negative as they get older and the relationship between their attitudes and achievement tends to get stronger. Studies have also shown that many preservice elementary school teachers have negative attitudes toward mathematics (Rech et al., 1993; Cornell, 1999; Philippou and Christou, 1998). This should be a concern for teacher educators because teachers with negative attitudes toward mathematics are unlikely to cultivate positive attitudes in their own students (Hungerford, 1994). “Improving pre-service students’ attitudes toward mathematics is an important concern for university education courses in order to facilitate positive mathematics attitudes in future elementary pupils” (Sherman and Christian, 1999, p. 96). Improving the attitudes of preservice elementary school teachers is a crucial step in breaking the cycle of teachers with negative attitudes fostering negative attitudes in their own students (Philippou and Christou, 1998).

Several studies involving teacher training programs that utilized constructivist instructional methods have shown positive results in improving the attitudes and teacher self-efficacy of preservice elementary teachers (Anderson and Piazza, 1996; Gibson and Van Strat, 2001; Huinker and Madison, 1997; McGinnis et al., 1998; Philippou and Christou, 1998; Quinn, 1997; Sherman and Christian, 1999). Although these results are encouraging, future studies that follow these teachers past their teacher training programs and into their first few years of teaching to see if the attitude changes remain stable over time would be beneficial.
Preservice teachers bring to teacher education certain attitudes and beliefs that have developed over time and are often resistant to change. However, mathematics methods courses and teacher training programs provide an opportunity to change these attitudes in a positive way, as well as alter beliefs so that they are more in line with those set out by the mathematics education profession. The National Council of Teachers of Mathematics (2000) has recognized the importance of reflection as a component of mathematical communication. Reflection has been effective in changing preservice teachers’ beliefs about mathematics (Ambrose, 2001; Mewborn, 2002; Stuart and Thurlow, 2000). It has also been useful in connecting teachers’ stated beliefs to actual classroom practice (Gellert, 1999; Lock and Lee, 2001; Thompson, 1992).

Journal writing offers an opportunity for reflective thought that has been shown to encourage learning (Borasi and Rose, 1989; Burk and Littleton, 1995; Carter, 1997; Garmon, 2001; Good and Whang, 2002). This study explored the use of reflection, through reflective journals, as a tool for teacher educators seeking to both understand how attitudes toward mathematics are formed and to improve these attitudes. More research is needed in this direction, especially in the underrepresented area of teacher attitudes toward mathematics. Teacher attitudes have been linked to beliefs (Philippou and Christou, 1998; Stipek et al., 2001), and beliefs have been linked to classroom practices. If we want teachers to adopt child-centered inquiry-based instruction, then teacher educators and researchers need to focus more of their efforts in the area of teacher attitudes toward mathematics.
Significance of the Study

The reform movement in mathematics education has recognized the need for change in the area of affect. Although the importance of developing self-confident, motivated students who value and enjoy mathematics has been well established, the means for doing so are not so clear. Children’s attitudes toward mathematics tend to become less positive as they get older, and often by the time they reach high school or college, their attitudes have become negative (McLeod, 1992).

Researchers have found that many preservice elementary school teachers at the university have negative attitudes toward mathematics (Christian, 1999; Cornell, 1999; Hungerford, 1994; Philippou and Christou, 1998; Rech et al., 1993). These researchers have suggested that improving the attitudes toward mathematics of preservice elementary school teachers at the university should be a main concern of teacher educators. If preservice elementary school teachers can develop more positive attitudes toward mathematics, then they will be more likely to foster positive attitudes in their own elementary school students. Perhaps these elementary school students would then be less likely to develop negative attitudes as they get older. If this trend were to continue, eventually we could have fewer preservice elementary school teachers with negative attitudes, and the cycle of teachers passing on negative attitudes toward mathematics to their students would be broken.

Several studies have demonstrated success in improving attitudes toward mathematics of preservice elementary teachers enrolled in mathematics methods courses (Anderson and Piazza, 1996; Gibson and Van Strat, 2001; Huinker and Madison, 1997; McGinnis et al., 1998; Philippou and Christou, 1998; Quinn, 1997; Sherman and
Christian, 1999). These methods courses utilized constructivist instructional methods such as the use of hands-on manipulatives, cooperative group work, problem solving, and the use of technology. However, none of these studies used the additional tool of reflective journals where participants reflected on their own attitudes toward and experiences with mathematics.

Journal writing offers an opportunity for reflective thought that has been shown to encourage learning (Borasi and Rose, 1989; Burk and Littleton, 1995; Carter, 1997; Garmon, 2001; Good and Whang, 2002). However, in these studies, students’ reflections focused largely on course content and pedagogy. When they did use affective prompts, they focused mainly on feelings and attitudes. In the present study, participants reflected on their own attitudes toward mathematics and also the experiences that have led to the development of these attitudes. It has been the researcher’s experience that this type of reflection seems to promote an awareness of and possibly an improvement in participants’ attitudes toward mathematics. The following journal from a participant in Pilot Study II demonstrated this newly acquired insight:

I have learned a lot about myself through these reflective journals. I always knew that I didn't like math but I never sat down and tried to figure out why I don't like it. These journals have helped me figure out those reasons and in turn they have helped me like math. After I learned what I didn't like about it and why, I was able to realize that it wasn't math that I didn't like; it was the teachers that didn't help me overcome this dislike. If I had been taught to do math correctly, I wouldn't have grown up so frustrated with it, and I would have been able to learn it. But because I was
so frustrated with math and my teachers never took time out to help me overcome the frustration, I decided to hate math and not care about it.

In addition to the use of a different type of reflection, one that focuses on attitudes and experiences that have led to the development of those attitudes, the present study offers another contribution to the field of mathematics education. Information that is gained from exploring how attitudes toward mathematics are formed can inform not only teacher educators, but also mathematics teachers at all levels. It is important for mathematics teachers to know which types of experiences, especially classroom experiences, lead to formation of positive attitudes toward mathematics in students and which lead to formation of negative attitudes. Teachers can then try to avoid those situations that negatively influence attitudes toward mathematics and promote those that positively affect students’ attitudes.

The need for change in the area of attitudes toward mathematics has been well established by the field of mathematics education. This study sought to affect this change in two important ways. Improving the attitudes toward mathematics of future elementary school teachers and informing practicing mathematics teachers about how to create classrooms where the development of positive attitudes is promoted and the development of negative attitudes is diminished are both important contributions to the field of mathematics education.
CHAPTER THREE

METHOD

In this chapter, the research design that was used to achieve the goals of this study is outlined. The study included both qualitative and quantitative data collection and analyses in order to provide a detailed perspective of the attitudes toward mathematics of preservice elementary school teachers and the experiences that have led to the development of these attitudes. The study sought to answer the following research questions:

1. What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?

2. To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course? To what do preservice teachers whose attitudes toward mathematics were altered attribute this change?

3. What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

4. What do preservice elementary school teachers’ reflective journal entries reveal about their attitudes toward mathematics and the experiences that have influenced the development of those attitudes?
5. What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most extreme (either positive or negative) attitudes?

Pilot Studies

After using reflective journals with preservice elementary school teachers for three years, a more formal pilot study was completed in spring, 2003 for the purpose of familiarizing the researcher with the interview protocol that was used in this study and the use of Hyener’s guidelines for thematic analysis, which are described below. Details of Pilot Study I are found in Appendix A.

A second pilot study was completed in spring, 2004 for the purpose of determining if any changes in preservice elementary school teachers’ attitudes toward mathematics occurred during a mathematics methods course. Details of Pilot Study II are found in Appendix B. Changes that were made to the present study based on the pilot studies are noted where applicable in the remainder of this chapter.

Present Study

This study was a mixed methods study. Quantitative methods were used to answer questions 1, 2, and 3. Qualitative methods were used to provide more detail to answer question 2. Questions 4 and 5 used a phenomenological approach, as described in Chapter Two, to examine more closely the attitudes toward mathematics of the participants and the experiences that have influenced the development of those attitudes. This study utilized journals and interviews to capture and describe experiences that have influenced the participants’ attitudes toward mathematics.
Participants

The participants in this study were 33 university students enrolled in one section of a mathematics methods course for elementary education majors at a major research university in the southeastern United States during the fall semester, 2004. Students enrolled in this course typically are juniors and seniors who are working toward state certification as elementary school teachers of kindergarten through grade 6. Thirty-two of the participants were females and one was male. Twenty-three of the participants were between the ages of 18 and 22, six were between the ages of 23 and 27, one was between the ages of 28 and 32, two were between the ages of 33 and 37, and one was over 37 years of age. The researcher taught the course. It was necessary to use an intact group due to university scheduling. The class met once a week for three hours.

Description of Course

This course is the first of two mathematics methods courses that elementary education majors must complete. The methods course utilizes constructivist instructional methods such as the use of hands-on manipulatives, cooperative group work, problem solving, and the use of calculators. There is also an emphasis on the use of children’s literature in the teaching of elementary school mathematics. The course syllabus (Appendix C) states the following purpose for the course:

The purpose of this course is to provide opportunities for preservice teachers to examine their understanding of various mathematics topics and to construct a vision of mathematics that considers the goals and assumptions of the current reform movement in mathematics education. Content, methods, and materials for
teaching elementary school mathematics will be examined with a focus on Problem Solving, Whole Number concepts, and Rational Number concepts. In this course, preservice teachers were engaged in a variety of teaching/learning activities. These included lectures, discussions, cooperative learning activities, question and answer sessions, student demonstrations/explanations, and role-playing. Preservice teachers were expected to present results and problem solutions to their peers.

The methods course used the text *Elementary School Mathematics: Teaching Developmentally, Second Custom Edition*, by John A. Van de Walle (2004). This edition was taken from *Elementary and Middle School Mathematics: Teaching Developmentally, Fifth Edition* by John A. Van de Walle (2004). The course covered the first 17 chapters of the textbook. The Table of Contents for the textbook is found in Appendix D. Students were also required to purchase a manipulatives kit which included a book of teaching activities called *Hands On Teaching (HOT) Strategies for Using Math Manipulatives* by Carol Thornton & G. Lowe-Parrino, ETA, 1997. The kit contained such manipulatives as Pattern Blocks, Base Ten Blocks, Color Tiles, Fraction Tower Cubes, Tangrams, PopCubes, Geoboards, Fraction Circles, Two-Color Counters, Coins, GeoReflectors, Angle Rulers, Spinners, Number Cubes, and Factor Blocks.

**Procedure**

Each participant completed the Attitudes Toward Mathematics Inventory (Appendix E) at the beginning of the semester and again during week 12 of the 15-week semester. This allowed the researcher to measure each participant’s initial attitudes toward mathematics and to assess any changes that may have taken place during the first
11 weeks of the semester. Scores were determined for each of the four attitudinal components measured by the ATMI: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics, as well as a composite attitude score. In addition, demographic information including age, gender, previous mathematics coursework, and previous education coursework was collected.

The ATMI was also administered during week one and week twelve to students in two other sections of the mathematics methods course for the purpose of making comparisons in results. Two different instructors taught these methods course sections. The first instructor is an Assistant Professor of Mathematics Education. After receiving her Ph.D. in 1998, she held a faculty position in the Mathematics Department at a university in the Rocky Mountain region. During her tenure there, she taught mathematics content and pedagogical content courses and was fundamentally involved in the reformation of the undergraduate teacher preparation programs. Although this was her first time teaching the methods course at this university, she had previously taught this methods course in the same state in which this study took place. These classes were taught intermittently over a period of six years before she moved to the Rocky Mountain region. She was a doctoral student at the time.

The second instructor received a B.S. in Mathematics Education in 1993 and an M.B.A. in 2000. She is currently pursuing a Ph.D. in Mathematics Education. She has taught high school mathematics for five years in both urban and suburban schools. She has also worked with elementary school students as a private tutor. Although this was her first time teaching the methods course, she observed the researcher’s class each week before teaching her own class. However, she did not try to model her teaching style after
that of the researcher. When asked about this, she said that she had used some of the researcher’s course content, but as an experienced teacher, she “had [her] own [teaching] style, and it would have been difficult for [her] to change that.”

The researcher and the other two instructors all used the same textbook and manipulatives kit. Although each instructor was responsible for the content of her own course, all three classes covered the same content material and took the same final examination. The two other instructors were asked not to give their classes any written assignments that would involve reflection on their attitudes toward mathematics.

Throughout the semester, participants in the researcher’s class submitted reflective journal entries as part of their course assignments. The journals were graded only for completeness, with grammar and spelling errors ignored. Journal entries were submitted by email, and the researcher responded to each entry by email. Rose (1989) cited teacher response as an important benefit of journal writing. “As the teacher writes back to the students, students realize the teacher hears and cares” (p. 26). Examples of the researcher’s responses are found in Appendix F.

The two preservice teachers with the lowest initial scores on the ATMI and the two with the highest scores were each asked to participate in an individual interview where their attitudes toward and experiences with mathematics were further explored. These Experiences with Mathematics Interviews took place between week six and week eight of the semester. This use of purposeful sampling allowed “information-rich cases” to be studied in depth (Patton, 2002, p.46).

After participants had completed the second ATMI, individual interviews were conducted with four preservice teachers who showed significant positive changes in
attitude. In addition, three preservice teachers who experienced negative changes in attitude also participated in individual interviews. The method that was used to determine which participants were interviewed is described in the Data Analysis section that follows. These Changed Attitudes Interviews focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. All interviews were conducted in a private conference room. Interviews took place approximately one month after the completion of the methods course and submission of final grades.

The decision to interview these participants after the completion of the course was based on findings from the first pilot study. The Changed Attitudes Interview protocol was used with 2 participants in the pilot study who were interviewed six months after the completion of the course. In addition, they were also asked the following question:

- Would your answers have differed any if you had been interviewed before the end of the course? If your attitudes had changed in a negative way, would you have been open about it if interviewed before the end of the course?

Both of the interviewees said that their answers would not have differed if they had been interviewed before the conclusion of the methods course. However, both recommended that any participants whose attitudes had changed in a negative direction be interviewed after the conclusion of the semester. They both acknowledged that securing the participation of those participants would be more difficult after the course had ended, but both believed that interviewees with negative attitude changes would be better able to put their experiences in the methods course into perspective after some time had elapsed. As one of the interviewees explained:
[A student] might not like a particular class, so it’s easier to think, ‘Oh, I hate math,’ because they’re in that class and that’s all they can see. Whereas if they wait until after they’re out of that class, they might think, ‘Well, that class is over; it wasn’t that bad, looking back.’ Then they might have more of a positive view of math.

Both participants focused their responses on this notion of allowing time to pass rather than on the response anticipated by the researcher that students might feel uncomfortable discussing the course with the instructor before their final grades had been submitted. They both believed that interviews with those who experienced positive attitude changes could be conducted either during or after the conclusion of the methods course.

The researcher kept a reflective journal during the methods course. This journal provided a detailed account of what took place during each class, as well as the researcher’s impressions of each class. This perspective was valuable when analyzing interviewees’ references to class activities. In an effort to provide reliability of this account, a doctoral student who has taught this mathematics methods course several times also took field notes during two of the classes. The observer, without the researcher’s knowledge, randomly chose which classes to attend. One of the observations took place during weeks two to six of the semester and the other took place during weeks seven to eleven of the semester.

In order to establish an observer protocol, the observer attended one class during the second pilot study and took field notes. A comparison was made between the observer’s account and that of the researcher, and guidelines were established. The observer protocol (Appendix G) asked the observer to record instructional activities and
students’ activities that took place during the class. The observer was also asked to note any observations that might reflect students’ attitudes toward mathematics, especially value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics. The researcher and the observer agreed that it would be beneficial for the observer to move to a different location in the classroom approximately every forty-five minutes. This allowed the observer to spend time taking notes in each area of the classroom during a three-hour class.

Instruments

The Attitudes Toward Mathematics Inventory (ATMI)

The ATMI was used to assess preservice elementary teachers’ attitudes toward mathematics. The ATMI contains 40 items (Appendix E). Participants were asked to indicate their degree of agreement with each statement using a Likert-type scale, from strongly disagree to strongly agree. The authors of the ATMI tested the instrument for internal consistency and construct validity. They administered the ATMI to 544 high school students in Mexico City. The students represented all grade levels and mathematics levels. The alpha reliability coefficient was .97 (Tapia, 1996). A factor analysis identified students’ self-confidence, motivation, enjoyment, and value of mathematics as underlying dimensions of students’ attitudes toward mathematics. Table 2 lists some of the survey items that correspond to each factor.
Table 2

Survey Items Grouped by Factors

Self-Confidence:

- Mathematics makes me feel uncomfortable.
- I have a lot of self-confidence when it comes to mathematics.

Value:

- Mathematics is a very worthwhile and necessary subject.
- I believe studying mathematics helps me with problem solving in other areas.

Motivation:

- I am willing to take more than the required amount of mathematics.
- The challenge of math appeals to me.

Enjoyment:

- I get a great deal of satisfaction out of solving a mathematics problem.
- I like to solve new problems in mathematics.


The ATMI was later administered to 262 middle school students from a private, bilingual school in Mexico City, with an alpha reliability coefficient of .95 (Tapia and Marsh, 2000). Because these samples of middle school and high school students from Mexico were so different from the sample in this study, the ATMI’s reliability with preservice elementary teachers was also determined. Cronbach’s Coefficient Alpha was calculated using the data obtained in the first pilot study (n=31). An alpha coefficient of .98 was found using this sample, indicating a high degree of internal consistency.
Because the ATMI was written for high school students, two of the items were inappropriate for university students. Following the suggestion of the ATMI’s author (M. Tapia, personal communication, December 14, 2002) these two items were changed as follows: “High school math courses would be very helpful no matter what I decide to study” was changed to “Math courses would be very helpful no matter what grade level I teach,” and “I would like to avoid using mathematics in college” was changed to “I would like to avoid teaching mathematics.”

Journal Prompts

Participants were given prompts for each journal entry. Prompts and corresponding due dates were included in the course syllabus (Appendix C), which the participants received during the first class of the semester. The researcher had found that providing participants with all of the prompts at once allowed them to think ahead about which of their experiences best applied to each prompt. The prompts were developed by the researcher, with the following exceptions:

- Item #4: Describe in detail one experience from your past that is particularly memorable and influential in your attitudes about mathematics. Where were you? Who was there? What was said? What did you do? How did you feel? (Davidson and Levitov, 2000, p. 18).

- Items #6: What do you think are the qualities of the best mathematics teacher you have ever had? (Stallard and Thompson, 2004)

Eight journals were assigned over the course of the semester. Five of these related directly to the purpose of this study and were analyzed using methods that are described
in the Data Analysis section that follows. The remaining three journal prompts did not relate directly to the purpose of this study, but they did relate to the purpose of the methods course. Therefore, participants responded to them as well, but these entries were not analyzed unless they contained information relevant to the study. Journal prompts and their designated purposes can be found in Table 3.

Experiences with Mathematics Interviews

Individual interviews were used to explore more deeply the attitudes toward and experiences with mathematics of those preservice teachers with the highest or most positive attitude scores and those with the lowest or most negative attitude scores. A standardized open-ended interview format was used. The same interview protocol that was used successfully in the first pilot study was used again, with one change. The following question was omitted:

Complete: I enjoy or feel positive about mathematics because …

and/or

Complete: I do not enjoy or I feel negative about mathematics because …

This question was omitted from the interview protocol in order to use it as a journal prompt. This change was made in order to allow all participants to reflect on these attitudes rather than just those with the most extreme attitudes toward mathematics.

The Experiences with Mathematics Interview protocol (Appendix H) contained nine questions. The first question, “Why did you decide to become a teacher?” was included as a way of ‘breaking the ice’ before asking participants to focus on their memories and to relive experiences. Four questions asked the participant to reflect on his
Table 3

*Journal Prompts and the Order in Which They Were Assigned*

<table>
<thead>
<tr>
<th>Prompts related to study</th>
<th>Prompts related to methods course</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Discuss any feelings (positive or negative) that you have about taking this course. What are you hoping to gain from the course?</td>
<td>5. Many students have low self-confidence when it comes to mathematics. What will you do as a teacher to boost the self-confidence of your students regarding mathematics?</td>
</tr>
<tr>
<td>2. What are your memories of learning mathematics in elementary school (attitudes, success, etc.)? What can you, as a future teacher, learn from these experiences?</td>
<td>6. What do you think are the qualities of the best mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?</td>
</tr>
<tr>
<td>3. Complete each of the following. Explain your responses. Why do you think you feel this way? I enjoy or feel positive about mathematics because … and/or … I do not enjoy or I feel negative about mathematics because …</td>
<td>7. What do you think are the qualities of the worst mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?</td>
</tr>
</tbody>
</table>

Table continued on the next page
Table 3 (Continued)

**Journal Prompts**

<table>
<thead>
<tr>
<th>Prompts related to study</th>
<th>Prompts related to methods course</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. Describe in detail one experience from your past that is particularly memorable and influential in your attitudes about mathematics. Where were you? Who was there? What was said? What did you do? How did you feel?</td>
<td></td>
</tr>
<tr>
<td>8. Discuss the use of reflective journals in this course. What benefits, if any, did they provide? What, if any, were the drawbacks?</td>
<td></td>
</tr>
</tbody>
</table>

or her own experiences as a student in a mathematics classroom at various levels of schooling. Two questions related directly to feelings about the methods course.

**Changed Attitudes Interviews**

In addition, individual interviews were conducted with four preservice teachers who showed the greatest positive change in attitude and three who experienced a negative change in attitude. These interviews focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. The
*Changed Attitudes Interview* protocol (Appendix I) contained 11 questions. Participants were asked how they felt about the use of manipulatives, cooperative learning, problem solving, and journals in the methods course and also in teaching mathematics in general.

The *Changed Attitudes Interview* protocol was used successfully with two participants in the first pilot study who were interviewed six months after the completion of the course. It was also used with three participants in the second pilot study who were interviewed immediately following the completion of the methods course and submission of final grades. No interview protocol changes were made as a result of the pilot studies.

*Final Examination for Mathematics Methods Course*

The final examination for the mathematics methods course was a 50-item multiple-choice instrument that included questions about both mathematics content and pedagogy. The test was a departmental exam, and all students who were enrolled in any section of the course took the same final exam. The final exam was used as the measure of course achievement rather than the final course grade in an effort to minimize bias. The test was a multiple-choice instrument, so grading was not subjective. In addition, the test was not written by the researcher, so use of the final exam as a measure of achievement provided validity and reliability. A Mathematics Education faculty member who has taught the methods course for many years oversaw the writing of the departmental exam. All methods-course instructors were invited to share opinions about and contribute problems to the test. Thus the final exam was a collaboration of several professionals with expertise in the field of mathematics education.
Exam questions were based primarily on the content of the textbook. The distribution of exam questions from specific textbook chapters can be found in Table 4. Descriptions of specific test items are found in Appendix J. As a security measure, two similar forms of the final exam were used in the methods course so that each participant would have a different form than the classmate sitting on either side. To determine the reliability of the final examination, a Kuder-Richardson formula 20 (KR-20) coefficient was calculated using the software program SAS. A KR-20 coefficient of 0.71 (n=17) was found for Exam Form A, and a KR-20 coefficient of 0.73 (n=16) was found for Exam Form B, indicating a relatively high degree of reliability.
### Table 4

**Content of Methods Course Final Examination**

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Topic</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Developing Understanding in Mathematics</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Teaching Through Problem Solving</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Building Assessment Into Instruction</td>
<td>2</td>
</tr>
<tr>
<td>9</td>
<td>Developing Early Number Concepts and Number Sense</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>Developing Meanings for the Operations</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>Helping Children Master the Basic Facts</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>Whole-Number Place-Value Development</td>
<td>4</td>
</tr>
<tr>
<td>13</td>
<td>Strategies for Whole-Number Computation</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Computational Estimation with Whole Numbers</td>
<td>4</td>
</tr>
<tr>
<td>15</td>
<td>Developing Fraction Concepts</td>
<td>10</td>
</tr>
<tr>
<td>16</td>
<td>Computation with Fractions</td>
<td>9</td>
</tr>
<tr>
<td>17</td>
<td>Decimal and Percent Concepts and Decimal Computation</td>
<td>6</td>
</tr>
</tbody>
</table>

\[n = 50\]

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**Data Analysis**

**Surveys**

Scores for each participant on each of the four attitudinal components, as well as a composite attitude score, were calculated at both the beginning and after the twelfth week of the semester. Possible scores on the ATMI range from 40 to 200. The author of the ATMI provided scoring guidelines (Tapia and Marsh, 2000). Most of the items,
such as *Mathematics is important in everyday life*, use anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree. However, 11 items were reversed items, so the anchors were also reversed. An example of a reversed item is *I am always under a terrible strain in a math class*. Reversed items use anchors of 1: strongly agree, 2: agree, 3: neutral, 4: disagree, 5: strongly disagree. The score is the sum of the ratings. Therefore, a higher score reflects more positive attitudes than a negative score.

The ATMI contains 10 items dealing with Value, 10 with Enjoyment, 15 with Self-Confidence, and 5 Motivation. Because there are unequal numbers of items for each attitude factor, the average score per attitude factor was also found in order to make comparisons more easily. These average per-item scores range from one to five. These scores were used for statistical analyses to answer research questions #1-3 using the software program, SAS. Question #1 asked:

What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?

For question #1, only the scores from the beginning of the semester were used. Descriptive statistics were computed for participants’ composite attitude scores, their scores on each of the four attitudinal components being measured, and on each individual survey item. These statistics included means, standard deviations, and measures of skewness and kurtosis.
Question #2 looked at the pre-course and post-course survey scores to determine if preservice elementary teachers’ attitudes toward mathematics changed during the methods course. Question #2 asked:

To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course? To what do students whose attitudes toward mathematics were altered attribute this change?

Because pre-course and post-course scores are not independent, a repeated measures t-test was conducted using composite survey scores to determine if a significantly significant change in attitude occurred. Each participant’s change score, which was their post-course score minus their pre-course score, was calculated. Change scores could range from –160 to 160, where a negative change score represented a negative change in attitude and a positive change score represented a positive attitude change. Those with change scores greater than one standard deviation above or below the mean change score were considered for individual interviews. These interviews examined to what these preservice teachers attributed this change.

Question #3 asked:

What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

A Pearson correlation coefficient was found in order to determine this relationship. The composite attitude score was the independent variable and the methods course final examination grade was the dependent variable. An alpha level of 0.05 was used to indicate whether the obtained correlation was statistically significant.
Journals

Question #4 asked:

What do preservice elementary school teachers’ reflective journal entries reveal about their attitudes toward mathematics and the experiences that have influenced the development of those attitudes?

Analysis of the qualitative aspects of the study involved looking for patterns. Hycner (1985) provided guidelines for the phenomenological analysis of interview data, and his methods were utilized in this study. Although the guidelines were written for analysis of interview data, they are easily adaptable for the analysis of journal data as well. After reading a journal entry for a sense of the whole, units of general meaning were delineated. These units were recorded using the computer software program Ethnograph. When a journal expressed multiple themes, these themes were analyzed separately. A more extensive description of Hycner’s guidelines is found in Appendix K.

Once units of meaning had been identified for each journal entry for a given prompt, units of meaning from all journal entries responding to that prompt were examined. Units of meaning relevant to the research questions were then clustered and common themes identified from the data. Themes were labeled using words that were introduced by the participants themselves whenever possible, and frequencies of themes were noted. When excerpts from journal entries were cited, no names or other means of identification were given. Any names of people, schools, etc. that were included were replaced by pseudonyms.

In an effort to provide reliability, a graduate student who was familiar with Hycner’s guidelines repeated the coding process independently on a sample of 18
journals. A stratified random sample of responses to this prompt was chosen using subgroups based on the participants’ ages and lengths of response. Table 5 shows how these samples were selected. Journal One was randomly selected for double coding. The researcher and the coder independently identified both units of meaning and common themes from these journals. Prior to collaboration, a comparison of identified units of meaning for the 18 journals produced an overall 71.6% inter-rater reliability. Differences were categorized into five groups. After collaboration between the researcher and the coder, 100% agreement was reached. A sample of this process is shown in Appendix L.

Table 5

Stratified Random Sampling of Journals For Double Coding

<table>
<thead>
<tr>
<th>Age Bracket</th>
<th>Average Length of Journal Responsea</th>
<th>Groups</th>
<th>Number Randomly Chosen From Each Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional</td>
<td>Long</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>College Age</td>
<td>Medium</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>(ages 18-22)</td>
<td>Short</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Nontraditional</td>
<td>Long</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>College Age</td>
<td>Medium</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>(ages over 22)</td>
<td>Short</td>
<td>6</td>
<td>3</td>
</tr>
</tbody>
</table>

aShort responses ranged from 70 to 100 words, Medium from 145 to 206 words, Long from 216 to 370 words

The graduate student who coded the sample journals also served as the classroom observer described previously. She was extremely qualified to participate in both capacities. She is an experienced mathematics teacher who was completing a doctoral
program in Elementary Education with a cognate in Mathematics Education at the time of this study; she graduated in August 2005. She had taught the elementary mathematics methods course several times and was therefore very familiar with the content and nature of the course.

Five journal entries from Pilot Study I were used for training and determining inter-rater reliability between the researcher and the coder in identifying units of meaning. For this training, the researcher and the coder determined common themes together. Prior to collaboration, a comparison of identified units of meaning for five journals produced an 83% inter-rater reliability. After collaboration between the researcher and the coder, 100% agreement was reached. A sample of this process is shown in Appendix L.

In investigating and describing how people experience a phenomenon, it is important for a researcher to utilize the process of epoche. This involves first identifying, and then putting aside, any personal biases and preconceptions. Therefore, this researcher attempted to record personal biases and preconceptions prior to identifying units of meaning in the journals. Sitting alone in a quiet setting, I contemplated my own life-experience, focusing on personal experiences that might influence my interpretations of the data. I then attempted to view the data without the influence of these preconceived notions. This record of the researcher’s possible personal biases and preconceptions is found in Appendix M.

Due to the confidential nature of reflective journals, there was concern about potential bias in preservice teachers’ responses if they were aware that their journals were being used as part of a research study. Therefore, they were not asked to sign consent
forms for the journals until the end of the semester. Although they were aware of their participation in the study from the beginning of the semester when they signed consent forms for the survey, they were not aware until the end of the semester that the journals would also become a part of the study since journal writing was a course assignment. All participants signed consent forms to allow their journals to be used.

Interviews

Interviews were used to answer question #5. Question #5 asked:

What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most extreme (either positive or negative) attitudes?

Interviews were also used to answer the second part of question #2. Question #2 asked:

To what do preservice teachers whose attitudes toward mathematics were altered attribute this change?

The interviews were audio taped and later transcribed. Hycner’s guidelines were again used to identify common themes. After listening to the tape and reading the transcription of an interview for a sense of the whole, units of general meaning were delineated. Units of meaning relevant to the research questions were then delineated and clustered and common themes identified. Once a summary had been written for each individual interview, a second meeting was scheduled with each participant. A discussion of agreement or disagreement with the researcher’s findings allowed each participant to make any necessary corrections or additions. Once any needed modifications had been made, themes common to multiple interviews were identified, as were any themes that
were unique to a single interview or a minority of interviews. The use of surveys, reflective journals, and interviews allowed for triangulation of the data.

Limitations of the Study

1. The relatively small sample size could limit the quantitative elements of the study.
2. The use of an intact group could limit generalizability to the entire population.
3. The researcher’s role as instructor of the methods course could limit the validity of the qualitative elements of the study.
4. Possible biases and preconceptions (Appendix M) could affect the researcher’s judgment.
CHAPTER FOUR
RESULTS

The purpose of this study was to examine the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course. The study focused on the following attitudes: value, enjoyment, motivation, and self-confidence. Quantitative methods were used to measure these attitudes. Qualitative methods were used to explore these attitudes and the experiences that have led to the development of these attitudes. The study sought to determine the extent to which preservice teachers’ attitudes toward mathematics changed during the methods course. The study also examined the correlation between preservice teachers’ initial attitudes toward mathematics and their achievement in the methods course. This chapter will present the researcher’s findings in addressing the research questions.

Question 1: Initial Attitudes Toward Mathematics

Question #1 asked:
What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?
Survey scores for each participant on each of the four attitudinal components, as well as a composite attitude score, were calculated at the beginning of the semester. Possible scores on the ATMI range from 40 to 200. There are 10 items dealing with Value, 10 with Enjoyment, 15 with Self-Confidence, and 5 with Motivation. Because there are unequal numbers of items for each attitude factor, the average score per attitude factor was also found in order to make comparisons more easily. These average per-item scores ranged from one to five, with one indicating the most negative attitude and five indicating the most positive attitude. These scores were used for statistical analyses to answer research question 1 using the software program SAS. Descriptive statistics were computed for participants’ composite attitude scores, their scores on each of the four attitudinal components being measured, and on each individual survey item. These statistics included means, standard deviations, and measures of skewness and kurtosis.

Participants’ initial survey scores were highest or most positive for Value of Mathematics, with a mean score of 3.96 on the 5-point scale ranging from strongly disagree to strongly agree. A score of one represents the most negative attitude, a score of three represents a neutral position, and a score of five represents the most positive attitude. The lowest or most negative scores were for Motivation, with a mean score of 2.55. Results from the initial survey using raw scores are found in Table 6. Results from the initial survey using average scores per attitude factor are found in Table 7. The individual survey item results are found in Table 8. Post-course individual survey items are found in Appendix N.
Table 6

*Initial Attitudes Toward Mathematics: Mean Raw Scores on the Attitudes Toward Mathematics Inventory*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>39.64</td>
<td>6.40</td>
<td>-0.46</td>
<td>-0.49</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>27.94</td>
<td>9.97</td>
<td>0.28</td>
<td>-0.73</td>
</tr>
<tr>
<td>Self- Confidence</td>
<td>44.45</td>
<td>16.28</td>
<td>0.09</td>
<td>-1.06</td>
</tr>
<tr>
<td>Motivation</td>
<td>12.76</td>
<td>4.53</td>
<td>0.45</td>
<td>-0.54</td>
</tr>
<tr>
<td>Composite</td>
<td>124.79</td>
<td>33.83</td>
<td>0.11</td>
<td>-0.70</td>
</tr>
</tbody>
</table>

*Note.* Value and Enjoyment scores range from 10 to 50, Self-Confidence from 15 to 75, Motivation from 5 to 25, Composite from 40 to 200.

Table 7

*Initial Attitudes Toward Mathematics: Mean Per-Item Scores on the Attitudes Toward Mathematics Inventory*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>3.96</td>
<td>0.64</td>
<td>-0.46</td>
<td>-0.49</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2.79</td>
<td>1.00</td>
<td>0.28</td>
<td>-0.73</td>
</tr>
<tr>
<td>Self- Confidence</td>
<td>2.96</td>
<td>1.09</td>
<td>0.09</td>
<td>-1.06</td>
</tr>
<tr>
<td>Motivation</td>
<td>2.55</td>
<td>0.91</td>
<td>0.45</td>
<td>-0.54</td>
</tr>
<tr>
<td>Composite</td>
<td>3.12</td>
<td>0.85</td>
<td>0.11</td>
<td>-0.70</td>
</tr>
</tbody>
</table>

*Note.* Per item scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.
### Table 8

*Means and Standard Deviations on Items from the Attitudes Toward Mathematics Inventory*

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value of Mathematics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Mathematics is a very worthwhile and necessary subject.</td>
<td>4.39</td>
<td>0.56</td>
<td>-0.13</td>
<td>-0.89</td>
</tr>
<tr>
<td>2. I want to develop my mathematical skills.</td>
<td>4.24</td>
<td>0.66</td>
<td>-0.31</td>
<td>-0.66</td>
</tr>
<tr>
<td>3. Mathematics helps develop the mind and teaches a person to think.</td>
<td>4.18</td>
<td>0.73</td>
<td>-0.30</td>
<td>-0.99</td>
</tr>
<tr>
<td>4. Mathematics is important in everyday life.</td>
<td>4.12</td>
<td>0.82</td>
<td>-0.96</td>
<td>1.02</td>
</tr>
<tr>
<td>5. Mathematics is one of the most important subjects for people to study.</td>
<td>3.61</td>
<td>0.97</td>
<td>-0.43</td>
<td>-0.71</td>
</tr>
<tr>
<td>6. Math courses would be very helpful no matter what grade level I teach.</td>
<td>4.24</td>
<td>0.75</td>
<td>-1.38</td>
<td>3.16</td>
</tr>
<tr>
<td>7. I can think of many ways that I use math outside of school.</td>
<td>4.00</td>
<td>0.94</td>
<td>-0.98</td>
<td>0.44</td>
</tr>
<tr>
<td>8. I think studying advanced mathematics is useful.</td>
<td>3.24</td>
<td>1.09</td>
<td>-0.36</td>
<td>0.01</td>
</tr>
<tr>
<td>9. I believe studying math helps me with problem solving in other areas.</td>
<td>3.73</td>
<td>0.98</td>
<td>-0.69</td>
<td>-0.40</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 8 (Continued)

*Individual Survey Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value of Mathematics (Continued)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. A strong math background could help me in my professional life.</td>
<td>3.88</td>
<td>0.86</td>
<td>-0.71</td>
<td>0.29</td>
</tr>
<tr>
<td>Enjoyment of Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I get a great deal of satisfaction out of solving a mathematics problem.</td>
<td>3.18</td>
<td>1.04</td>
<td>-0.39</td>
<td>-0.56</td>
</tr>
<tr>
<td>12. I have usually enjoyed studying mathematics in school.</td>
<td>2.64</td>
<td>1.34</td>
<td>0.47</td>
<td>-0.73</td>
</tr>
<tr>
<td>13. I like to solve new problems in mathematics.</td>
<td>2.91</td>
<td>1.10</td>
<td>0.04</td>
<td>-0.17</td>
</tr>
<tr>
<td>14. I would prefer to do an assignment in math than to write an essay.</td>
<td>2.42</td>
<td>1.60</td>
<td>0.51</td>
<td>-1.45</td>
</tr>
<tr>
<td>15. I really like mathematics.</td>
<td>2.82</td>
<td>1.24</td>
<td>0.47</td>
<td>-0.59</td>
</tr>
<tr>
<td>16. I am happier in a math class than in any other class.</td>
<td>2.06</td>
<td>1.06</td>
<td>0.88</td>
<td>0.40</td>
</tr>
<tr>
<td>17. Mathematics is a very interesting subject.</td>
<td>3.03</td>
<td>1.07</td>
<td>-0.22</td>
<td>-0.54</td>
</tr>
</tbody>
</table>

Continued on the next page
<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Enjoyment of Mathematics (Continued)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I am comfortable expressing my own ideas on how to look for</td>
<td>2.88</td>
<td>1.17</td>
<td>0</td>
<td>-1.02</td>
</tr>
<tr>
<td>solutions to a difficult problem in math.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I am comfortable answering questions in math class.</td>
<td>2.88</td>
<td>1.24</td>
<td>-0.17</td>
<td>-1.15</td>
</tr>
<tr>
<td>20. Mathematics is dull and boring.*</td>
<td>3.12</td>
<td>1.05</td>
<td>0.09</td>
<td>-0.14</td>
</tr>
<tr>
<td><strong>Self Confidence with Mathematics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. Mathematics is one of my most dreaded subjects.*</td>
<td>2.76</td>
<td>1.46</td>
<td>0.32</td>
<td>-1.28</td>
</tr>
<tr>
<td>22. When I hear the word mathematics, I have a feeling of dislike.*</td>
<td>2.79</td>
<td>1.24</td>
<td>0.43</td>
<td>-0.87</td>
</tr>
<tr>
<td>23. My mind goes blank and I am unable to think clearly when working with mathematics.*</td>
<td>3.36</td>
<td>1.19</td>
<td>-0.65</td>
<td>-0.60</td>
</tr>
<tr>
<td>24. Studying mathematics makes me feel nervous.*</td>
<td>3.00</td>
<td>1.27</td>
<td>0</td>
<td>-1.19</td>
</tr>
<tr>
<td>25. Mathematics makes me feel uncomfortable.*</td>
<td>3.15</td>
<td>1.28</td>
<td>-0.30</td>
<td>-1.14</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 8 (Continued)

*Individual Survey Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>26. I am always under a terrible strain in a math class.*</td>
<td>3.06</td>
<td>1.34</td>
<td>-0.20</td>
<td>-1.09</td>
</tr>
<tr>
<td>27. It makes me nervous to even think about having to do a mathematics problem.*</td>
<td>3.09</td>
<td>1.31</td>
<td>-0.27</td>
<td>-1.15</td>
</tr>
<tr>
<td>28. I am always confused in my mathematics class.*</td>
<td>3.24</td>
<td>1.12</td>
<td>-0.23</td>
<td>-0.68</td>
</tr>
<tr>
<td>29. I feel a sense of insecurity when attempting mathematics.*</td>
<td>3.03</td>
<td>1.31</td>
<td>-0.15</td>
<td>-1.21</td>
</tr>
<tr>
<td>30. Mathematics does not scare me at all.</td>
<td>2.58</td>
<td>1.23</td>
<td>0.36</td>
<td>-0.92</td>
</tr>
<tr>
<td>31. I have a lot of self-confidence when it comes to mathematics.</td>
<td>2.70</td>
<td>1.10</td>
<td>0.21</td>
<td>-1.01</td>
</tr>
<tr>
<td>32. I am able to solve mathematics problems without too much difficulty.</td>
<td>2.97</td>
<td>1.07</td>
<td>-0.26</td>
<td>-0.94</td>
</tr>
<tr>
<td>33. I expect to do fairly well in any math class I take.</td>
<td>3.18</td>
<td>1.07</td>
<td>-0.22</td>
<td>-1.24</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 8 (Continued)

*Individual Survey Items*

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self Confidence with Mathematics (Continued)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34. I learn mathematics easily.</td>
<td>2.82</td>
<td>1.13</td>
<td>0.38</td>
<td>-0.58</td>
</tr>
<tr>
<td>35. I believe I am good at solving math problems.</td>
<td>2.85</td>
<td>1.00</td>
<td>-0.07</td>
<td>-0.51</td>
</tr>
<tr>
<td><strong>Motivation with Mathematics</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>36. I am confident that I could learn advanced mathematics.</td>
<td>2.85</td>
<td>1.28</td>
<td>-0.18</td>
<td>-1.22</td>
</tr>
<tr>
<td>37. I plan to take as much mathematics as I can during my education.</td>
<td>1.94</td>
<td>0.79</td>
<td>0.52</td>
<td>-0.04</td>
</tr>
<tr>
<td>38. The challenge of math appeals to me.</td>
<td>2.39</td>
<td>1.06</td>
<td>0.63</td>
<td>-0.21</td>
</tr>
<tr>
<td>39. I am willing to take more than the required amount of mathematics.</td>
<td>2.03</td>
<td>1.21</td>
<td>1.06</td>
<td>0.33</td>
</tr>
<tr>
<td>40. I would like to avoid teaching mathematics.*</td>
<td>3.55</td>
<td>1.00</td>
<td>-0.33</td>
<td>-0.94</td>
</tr>
</tbody>
</table>

Note. © Martha Tapia. ATMI used with permission of author. Scoring for most items uses anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree.

*Scoring for these items is reversed and uses anchors of 1: strongly agree, 2: agree, 3: neutral, 4: disagree, 5: strongly disagree. Therefore, on all items, scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.
Question 2: Changed Attitudes Toward Mathematics

Question #2 asked:
To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course? To what do students whose attitudes toward mathematics were altered attribute this change?

Change Scores

Pre-course and post-course scores are not independent, so a repeated measures t-test was conducted using composite survey scores to determine if a significantly significant change in attitude occurred. Each participant’s change score, which was their post-course score minus their pre-course score, was calculated. Change scores could range from –160 to 160, where a negative change score represents a negative change in attitude and a positive change score represents a positive attitude change. An alpha level of 0.05 was used to determine whether the results were statistically significant.

The mean change score for the 33 participants was 17.03 (SD = 17.59). The median change score was 15, and there were four modes: 7, 11, 15, and 20, each with a count of 2. The change scores were slightly positively skewed (Sk=0.29). The kurtosis was –0.46, indicating that the distribution was platykurtic. The mean per item change score was 0.43 on a five-point scale. Scores for all four components increased, with Self-Confidence having the largest per-item change score. Per item change scores for all components are found in Table 9. A repeated measures t-test was used to test the null hypothesis that the mean change score in the population was zero. Because 

\[ t = 5.561 > 2.04 \ (t_{\text{crit}}), \text{ and } p < 0.0001, \text{ the null hypothesis was rejected.} \]
Table 9

*Change Scores Per Attitude Factor: Mean Per Item Scores*

<table>
<thead>
<tr>
<th>Attitude Factor</th>
<th>Pre-Course Survey</th>
<th>Post-Course Survey</th>
<th>Change Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>3.96</td>
<td>4.19</td>
<td>0.23</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2.79</td>
<td>3.28</td>
<td>0.49</td>
</tr>
<tr>
<td>Self-Confidence</td>
<td>2.96</td>
<td>3.48</td>
<td>0.52</td>
</tr>
<tr>
<td>Motivation</td>
<td>2.55</td>
<td>2.98</td>
<td>0.43</td>
</tr>
<tr>
<td>Composite</td>
<td>3.12</td>
<td>3.55</td>
<td>0.43</td>
</tr>
</tbody>
</table>

*Note.* Per item scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.

The validity of the repeated measures t-test depends on the assumptions of independence and normality. Although the pre-course and post-course survey scores were dependent or repeated measures, the change scores were independent. The distribution of change scores was slightly positively skewed. However, because n (33) > 20, a repeated measures t-test is relatively robust to violations of the normality assumption. The effect size, $d = \frac{X_{\text{diff}}}{S_{\text{diff}}}$, was 0.968, indicating a large effect size. In summary, it was possible to reject the null hypothesis of a mean change score of zero ($t(33) = 5.561$, $p < 0.0001$). There was a statistically significant positive attitude change.

The ATMI was also administered during week one and week twelve to students in two other sections of the mathematics methods course for the purpose of making comparisons in results. Two different instructors taught these methods course sections. The mean composite initial survey score for the first comparison class was 140.2. The mean change score for the 24 participants in the first comparison class who completed
both surveys was 1.0 ($SD = 12.75$). The median change score was 0, and there were two modes, 0 and 7, each with a count of 3. The change scores were slightly positively skewed (Sk=0.44). The kurtosis was 0.63, indicating that the distribution was leptokurtic. A repeated measures $t$-test was used to test the null hypothesis that the mean change score in the population was zero. Because $t = 0.384 < 2.07$ ($t_{crit}$), and $p = 0.7044$, the null hypothesis was not rejected.

The mean composite initial survey score for the second comparison class was 140. The mean change score for the 31 participants in the second comparison class who completed both surveys was 1.48 ($SD = 13.08$). The median change score was -2, and the mode was -3, with a count of 4. The change scores were moderately positively skewed (Sk=1.16). The kurtosis was 1.82, indicating that the distribution was leptokurtic. A repeated measures $t$-test was used to test the null hypothesis that the mean change score in the population was zero. Because $t = 0.631 < 2.04$ ($t_{crit}$), and $p = 0.5325$, the null hypothesis was not rejected. In summary, it was not possible to reject the null hypothesis of a mean change score of zero in either of the comparison classes. Neither comparison class demonstrated a statistically significant attitude change.

*Changed Attitudes Interviews*

Statistical analysis revealed that six participants had positive change scores greater that one standard deviation above the mean change score. This reflected a change score of at least 35 points. These significant positive change scores ranged from 36 to 58. The four participants with the greatest positive change scores were interviewed in order to explore to what these participants attributed their positive attitude change. In addition,
six participants had negative change scores greater than one standard deviation below the mean change score. This reflected a change score less than -0.56. These negative change scores ranged from -12 to -1. The four participants with the greatest negative change scores were also asked to participate in interviews. Three of the four agreed to be interviewed. The fourth participant did not respond to the researcher’s requests for an interview. All of these interviews took place four to six weeks after the completion of the methods course and submission of final grades.

‘Amelia’

Amelia’s change score was 58, the highest in the class, indicating the greatest positive attitude change. Her score on the pre-course ATMI was 97 out of a possible 200 points. This represented a mean response of 2.4 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 155, representing a mean response of 3.9 per item. Her scores increased in all four components: Value increased by 7 points, Enjoyment by 16 points, Self-Confidence by 26 points, and Motivation by 9 points.

Amelia began by saying that she believed that her attitudes toward mathematics had improved. She explained that in previous mathematics classes, she had been taught how to do mathematics, but she had not always understood the underlying concepts:

I’m a lot more comfortable in teaching math and math itself…. [Previous teachers] said, “Ok, this is how you do it,” but they never said why. Now that I grasped it in your class so well, I’m very excited to teach it to other kids now. That’s how [my attitude] changed. I [previously thought], ‘I hate math, I don’t want to teach it,’ and now that I’m excited; I’m like, ‘OK, it makes sense to me,’
so I know I can make it make sense to the children.

When asked which aspects of the methods course she thought had affected her attitude toward mathematics, Amelia first mentioned the journals and the opportunity for reflection that they provided:

The journals, actually, had a big impact because [journal writing] made you sit back and actually think about … the way you were taught, and do you want to teach that way, and so on and so forth, and that gave me a chance to [reflect] with the prompting of the questions.

Amelia also said that the manipulatives that were used in the course had positively affected her attitude:

And also the use of the manipulatives, knowing how to use them, and being able to be comfortable to show someone else how to use them. Because I had people sitting next to me [saying], ‘I don’t understand,’ and I was able to explain it to them, which made me comfortable; if I can explain it to an adult, I surely can explain it to a child. I think those [journals and manipulatives] are the two that really stuck out to me that made me say, ‘You know what? I think I can do this,’ as opposed to at the beginning of the class where I was [thinking], ‘No, that’s not happening.’

Amelia said that she believed that manipulatives would be useful for mathematics students at all levels:

I think all the way through high school you should use [manipulatives] because me, being even a college student, it helps me out a lot to see it in front of me … Like I said, it helped me to learn how to teach [mathematical concepts] to myself
… It gave me a different view on [mathematics] using the manipulatives.

When asked about the use of cooperative learning, Amelia said that her experience as a substitute teacher had helped her to understand the benefits cooperative learning provides:

I’m all about cooperative learning. Substituting, I change the seats around because if they were not in groups, I didn’t like it. I believe you can learn from your peers, and even if you might be [more advanced] than your other peer, that peer can still learn from the lower…. I think it helps, especially with the lower ones. [The teacher] can’t be everywhere all the time…. having someone that may be a little bit more advanced helps to show them … and they can explain maybe a little bit different than I can; a child’s perspective to it as opposed to mine.

Amelia also found the use of cooperative learning in the methods course to be beneficial:

In the actual methods class, I thought it helped a lot … even being adults [some people] didn’t get it, and it’s a little bit more fun, a little bit more interactive than just sitting there and hearing a lecture all the time. It gave us a break and let us use manipulatives with someone else so that we could see how it would be with the child.

Amelia said that she “hated problem solving, …especially word problems,” and that she had “always had a hard time” with them. She did appreciate the value of putting a computation problem “into a context that [children] can relate back to.” She said that, “It helps a whole lot more than putting 30 + 80. Putting it into word problem solving, solving it out … helps the kids a lot.” As for problem solving in the methods course, Amelia said that “those parts were hard where we had to actually do the [problem
solving].” She did benefit from class discussions regarding how children might approach problems:

I [thought], ‘Oh, a child would get this.’ By you teaching us the methods in the methods class, [I thought], ‘Oh, you know, if you do relate it, it might help this way,’ and you showed us a way to relate it. So I learned a lot, actually, for problem solving.

Amelia said that “journals get overlooked too much in math” and are used more for English. She recognized the benefits of journal writing as a form of assessment:

The students being able to reflect on how they think they’re doing in math or just put down their thoughts, anything within a journal, gets a better view for the teacher because sometimes you don’t know if a child’s struggling. I mean, you can see it here and there, but I think journals help a lot… You [as a teacher] get a feel for your students, where they’re at, how they feel, and you just get a different insight than you would just sitting there teaching … You really get an insight into what they’re thinking, what background they come from, as far as math and their attitudes… So I’m for journals all the way around. I love them.

At this point in the interview, the researcher showed Amelia her pre- and post-course survey scores and the change scores for each attitude component. Viewing these scores confirmed Amelia’s belief that her attitudes toward mathematics, especially her self-confidence, had improved:

Seriously, that class was a great class, and I really thought I was going to hate it going in, and coming out I’m so much more … confident about teaching math. I’m ready to get in there and do it!
Jennifer’s change score was 45, the second highest in the class, indicating the second most positive attitude change. Her score on the pre-course ATMI was 113 out of a possible 200 points. This represented a mean response of 2.8 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 158, representing a mean response of 4.0 per item. Her scores increased in all four components: Value increased by 6 points, Enjoyment by 9 points, Self-Confidence by 24 points, and Motivation by 6 points.

Jennifer said that she believed her attitude toward mathematics had “totally changed” [in a positive way]. She explained that she had never been a strong mathematics student. When beginning a new mathematics course, she would tell herself, “Well, I’m not good at math so I’ll settle for a ‘C’.” Then she “had a great teacher” for Social Science Statistics. She “ended up getting an ‘A’ in that course for the first time,” and her self-confidence began to improve. She thought, “OK, maybe I’m good at math.” As a result, Jennifer began the methods course believing that if she “tried really hard and studied, it would be possible to get an ‘A’:”

… coming into here [methods course], I still was kind of uneasy, but now after [the methods course], I felt like, ‘All right, I can do math, no question about it.’ I’m even willing to get up and teach kids math when before I would say that was the one subject that I did not want to teach. I [thought], ‘Give me a co-teacher because I don’t want to teach that.’ But now I feel like I could step in there and actually teach math.
When asked which aspects of the course she thought had affected her attitudes toward mathematics, Jennifer first mentioned the format of the classes. She appreciated the copies of overhead transparencies used in class that the instructor made available for students to purchase through a local copying service:

In math class normally you are looking up, writing, looking up, writing. With the packet … I could sit and really pay attention, fill in the blanks, … it just worked much better than saying, ‘Chapter one; you need to read this and then we’ll come in and do math problems.’ That’s what I’m used to doing [in math classes], like [a teacher says], ‘This is what you should be reading, we’ll just go over the homework and then learn new examples,’ where this is more hands-on and you feel like you can actually pay attention without having to look up, writing, look up, writing, look up, writing.

Jennifer also said that the journals had influenced her attitude change. She explained that journal writing provided an excellent means of communication between students and teacher:

They [journals] made me feel like you really care about our math experience and that [students] could be more open about, like ‘I don’t understand this,’ or ‘I’ve had a problem with this in the past.’ It was a way outside of class that [a student] could communicate to [the teacher] even if you were shy about certain things or you knew where we were all coming from at the beginning of the course.

Jennifer especially appreciated knowing that the instructor was reading and responding to the journals:

You actually care about where we’re coming from; why do we feel this way.
Maybe if I had sent them and you didn’t reply back, I might feel like you were just doing them for, you know, extra points. But the fact that I knew that you were reading every single one of them and you had something to say back [made me think], ‘Well, OK. The line of communication is open. You’re not just a teacher who taught us math. You are someone who cared about where we were coming from and how we’re progressing’. It made me [think], ‘She’s taking time to read this, so I need to take time to sit down and write something that’s meaningful.’

When asked about the use of manipulatives, Jennifer said that she thought it was “a great idea” to use them in the elementary school classroom. She had found that using manipulatives was very effective during her internship. Some of her students “weren’t quite getting it,” so she used manipulatives to help them understand. Jennifer also found the use of manipulatives very helpful to her in the methods course:

Oh, I really liked [manipulatives]…. I’m a visual learner, so when I can move things around and do hands-on visuals, then I can actually see what I’m doing. Like with fractions, cause I really dislike fractions, [manipulatives] made it that much easier for me to understand…. Like with the fractions, using the pattern blocks with fractions; that made so much sense, like if you can’t fit four of them in there than it can’t be ¼ of that main object [unit]…. You can actually see the reasoning behind it.

Jennifer said that she thought using cooperative learning in the classroom was “fine” because you “just turn to the person next to you.” However, she had reservations about the use of cooperative learning for assignments or for studying together outside of
class. She explained that she had benefited from this type of cooperative learning in the methods course because she had a classmate with whom she worked well:

When I’m in other classes where I don’t know anyone, I really dislike it because they don’t pull their part…. Sometimes I really like it, but I think it’s because I had my one main person [to work with]. I know we work well together. I know we both won’t settle for anything less than an ‘A.’ The fact that I had [classmate’s name], I know that we will work well together… when it’s stuff like [an assignment] or studying together, knowing that that person will be there to study with you, just having the extra support.

Jennifer said that problem solving was “important because you have to use it throughout your whole life, not just in math.” She thought that problem solving should be included “in every single subject.” She believed that her problem-solving skills had improved as a result of the methods course:

That was my problem before. If it didn’t work this time, then I would think, ‘Alright, I’ll just wait.’ But now I [think,] ‘If it can’t work this way, let’s turn around and try it this way.’ I pick something else that I know and try to apply it to that.

When asked about the use of journal writing in teaching mathematics, Jennifer said that she thought it was important:

In mathematics you don’t normally think about journaling. When you think about journaling, you think English and things along that line. But I think it’s important though, like if you don’t understand something and you’re too afraid to say something about it [in class], then you can write it in your journal. Or you can
write, “I’ve had a really hard time in math, but this semester I’m really trying to do good,” and things along that line…. I really enjoyed [the journals]…. It was something I looked forward to doing.

At this point in the interview, the researcher showed Jennifer her pre- and post-course survey scores and the change scores for each attitude component. When asked if there was anything else she would like to add about her attitude change or to what she attributed this change, Jennifer said:

Just that, from the [methods] course, so many kids may just decide that they can’t do math, and it just takes going about things differently, like maybe changing learning styles or setting up study groups and things along those lines, to change an attitude…. I can finally say, ‘Hey, I can do this.’ I may be 23, but now I’m finally realizing that [math] is not that hard. If I really apply myself, I have to do the [review] exercises, I have to have a study group before the test. So that’s how my attitude has changed. Before, I thought, ‘Oh, just do the homework and show up.’ I know now that I have to say, ‘OK, it’s Sunday night. Let’s get together to study so we can do good.’... Everyone that we work with all started making ‘A’s on their tests, so it’s just a positive thing because not only are you doing that for yourself, but also for the person next to you. Like, it’s a good part of a friendship.

‘Erin’

Erin’s change score was 44, the third highest in the class, indicating the third most positive attitude change. Her score on the pre-course ATMI was 86 out of a possible 200 points. This represented a mean response of 2.2 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score
was 130, representing a mean response of 3.3 per item. Her scores increased in all four components: Value increased by 8 points, Enjoyment by 14 points, Self-Confidence by 20 points, and Motivation by 2 points.

Erin believed that her attitude toward mathematics had improved since the start of the methods course. She attributed this change primarily to the use of manipulatives and the focus on conceptual understanding in the course:

I know [my attitude] changed after the class because a lot of it was I was not very confident in [math] … I did have a lot more self-confidence at the end of the semester, definitely… I think it was the teaching of the concepts that helped a lot, too ‘cause so many times before with math it was like, ‘formula, ok.’ But when you have to understand, it makes it a lot easier…. I found myself very visual with a lot of things and we worked with manipulatives so that helped a lot. And later on in my math career when I started to go downhill with it, it was very much like there was no hands-on. It was like, an overhead and teacher ditto…. Also because I had someone [classmate] in there that I knew it also helps with that process so we were able to get together and I could even further my understanding of it.

Erin said that the use of manipulatives in teaching mathematics was “absolutely necessary” because “it’s such a hands-on thing and by doing that it really helps to cement in what you’ve been learning about.” She reinforced her feeling that the use of manipulatives in the methods course was “very helpful … probably the number one thing that helped” her in the course because she was a “visual learner.”

When asked about the use of cooperative learning in teaching mathematics, Erin said that it is “a really good thing just because some kids are at different levels so when
they get together they are able to teach each other, which is great.” She found the use of cooperative learning in the methods course helpful to her. She explained that sometimes she “didn’t understand a concept or something and getting together with other people helped a lot.”

Erin said that problem solving was one of her “main struggles.” She remembered that there was “a lot” of problem solving in the methods course. She found it “hard at first,” but once she “got the concept down, it was real easy because we would always use manipulatives.”

Erin believed that journal writing was useful in teaching mathematics:

I think it’s good just because it’ll help you [teacher] relate to your students better and, especially if you do math problems within the journaling, you’ll be able to see if they’re [students] struggling in a subject and you’ll be able to help out with them.

She also shared her views on the use of journal writing in the methods course:

In the course, I thought it was good because you [instructor] were able to see how we came to feel about certain subjects in math by the questions that you asked, and it was very good for me because I had forgotten about some things and having to think about it, why my attitudes were a certain way, I was [thinking], ‘Oh, yeah. THAT’S why I don’t enjoy math.’

At this point in the interview, the researcher showed Erin her pre- and post-course survey scores and the change scores for each attitude component. Erin seemed to be aware that her attitudes had improved. She responded, “I did have a lot more self-
confidence at the end of the semester, definitely.” When asked why she thought her self-confidence had increased, Erin said:

I felt a lot more confident in math, like I just understood it. Understanding’s a big part of it because, definitely. With my past experiences with math, not understanding it is very discouraging so [I would think,] ‘Hmm, I don’t really care. I don’t enjoy it.’ I’d just sit through the class, wait for it to end.

When asked if there was anything else she would like to add about her attitude change or to what she attributed this change, Erin smiled and said, “I like math a lot more!”

‘Tessa’

Tessa’s change score was 41, the fourth highest in the class, indicating the fourth most positive attitude change. Her score on the pre-course ATMI was 90 out of a possible 200 points. This represented a mean response of 2.3 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 131, representing a mean response of 3.3 per item. Her scores increased in all four components: Value increased by 9 points, Enjoyment by 10 points, Self-Confidence by 20 points, and Motivation by 2 points.

Tessa said that she was sure that her attitude toward mathematics had improved since the start of the methods course:

Well, I know for a fact that it did change ‘cause I know in my previous years, math was a dreaded subject, [I was] very intimidated by it. I don’t like it, I don’t want to have anything to do with it… But now after I took the course, the way that we used the manipulatives; it was just so much easier for the kids to grasp now. If we would’ve had that back then, I know that math would have been one of
my favorite subjects. I know for a fact. So, I do know that my attitude has changed and I’m thankful for it ‘cause I know I can take my positive attitude back to the classroom and I know that’s a big help.

Tessa believed that the use of manipulatives in the methods course had positively affected her attitude toward mathematics. She also felt less pressure in this course than she had in previous mathematics courses because she was able to understand concepts and not fall behind. She thought that this positively affected her attitudes as well:

I know there were a couple [of things that affected attitude]. The manipulatives were definitely one … Those really helped out. And there wasn’t a lot of pressure in the class. It was very, not laid-back, but it wasn’t like, ‘you have to learn this in order to learn this.’ ‘Cause I know in my previous math classes, like in high school [teachers said], ‘Well, if you don’t get this concept, then you’re definitely not going to get that,’ and that’s how all math is, but I got it the first time [in the methods course] so it was easier to get one concept and go to the next.

When asked about the use of manipulatives in mathematics classrooms, Tessa said that she liked “the idea of having an overhead set as well as a student class set.” She felt that it had helped her in the methods course and that it would help children to see the teacher using the manipulatives on the overhead projector while they modeled a problem using their own manipulatives. She said that “the kids could see it and they can physically have it in front of them as well as seeing it on an overhead.” Tessa also felt that she had benefited from using the manipulatives on the tests. She found that when she used the manipulatives, she “could just do the problem, and it was a piece of cake. It was a lot easier.”
Tessa supported the use of cooperative learning in mathematics classrooms, but she also felt that “it’s very important that the kids have independent work as well as group or partner work.” At first Tessa was a bit uncomfortable with the cooperative learning activities in the methods course. She didn’t know many of her classmates and felt “a little shy in the beginning.” However, she soon realized that “the classroom was very relaxed and there was not a lot of pressure; it was ok to ask my neighbor for help.” She eventually felt very comfortable asking a classmate for help:

Towards the end, if I didn’t get something, my neighbor did, or the group that we were working with did, then I could [say], ‘Wait, how did you get that?’ and I wasn’t intimidated, I wasn’t scared to ask them the answer or to show me how they got it and then I could try another one by myself if that was the case, but I know [cooperative learning] definitely helped out in the course.

As she was remembering her discomfort with cooperative learning activities at the beginning of the methods course, Tessa recalled some of the feelings she was experiencing at the time and how they changed during the semester:

I came in there [methods course] very hesitant and very nervous and so I was all high strung and everything, but then I was [thinking], ‘Oh, it’s not going to be bad, it’s ok! It’s fine, it’s just math class, it’s OK.’ That’s how I felt towards the end. I was like, ‘Yea, I’m going to math class! What can I learn now with these manipulatives?’

When it came to problem solving in the methods course, Tessa felt very “hesitant” and uncomfortable about not being able to solve problems by herself. It helped her to know that if she could not solve the problem herself, she could work with her partner.
She also felt more comfortable about problem solving due to something she had learned in the methods course:

From the class, I learned there’s not just one way of doing something, and that’s how we used to be taught in our younger years. There are obviously definite answers for some questions, but there are different ways of going about to get the answer…. From the beginning, I was [thinking], ‘Oh, I don’t know how to get it,’ … but by the end of the class I was very surprised, I was [thinking], ‘Oh, well I could do it this way, or I could do it this way,’ and as a teacher I get to be able to express that to the students that there are different ways to solving a problem.

Tessa said that at the beginning of the course and in past courses when she had trouble solving problems, she felt “frustrated.” By the end of the methods course, she was feeling much more confident about her problem-solving abilities:

I was frustrated ‘cause that was the only way that I knew how to do that problem and if I couldn’t get it, then I felt dumb or I felt stupid or I felt that I wasn’t good in math, but at the end [of the methods course], I was [thinking], ‘Oh, I got it!’ and then ‘Oh, I could do it this way or this way!’ and I was [thinking], ‘Oh, you know what? I can do math!’ I would tell my mom all the time, ‘Mom, my math class is going so good!’ ‘cause she knows that I’ve had a really big problem with it all through the years so it definitely has changed.

Tessa said that she “enjoyed the journals.” She remembered that in her education classes, she had been encouraged to use reflection as a teacher. She recognized that the journals had allowed her to use reflection relating to mathematics:

It [journal writing] allows me to grasp my thoughts, grasp my feelings, and not
only think about them, but put them down, not necessarily on paper, but on the computer physically. It led me to think of other aspects of math that I didn’t think about before…. The journals were great. I did like the journals a lot.

At this point in the interview, the researcher showed Tessa her pre- and post-course survey scores and the change scores for each attitude component. These scores supported Tessa’s belief that her attitudes had improved, especially self-confidence. She responded, “Yeah, that one probably went up the highest. And I feel it, too, ‘cause I am a lot more confident about math and teaching as well.”

‘Stephanie’

Stephanie’s change score was -12, the lowest in the class, indicating the most negative attitude change. Her score on the pre-course ATMI was 141 out of a possible 200 points. This represented a mean response of 3.5 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 129, representing a mean response of 3.2 per item. Her scores for the four attitude components changed as follows: Value decreased by 10 points, Enjoyment increased by 1 point, Self-Confidence decreased by 1 point, and Motivation decreased by 2 points. It should be noted that changes in Enjoyment, Self-Confidence, and Motivation were too small to be either statistically or practically significant.

Stephanie said that she believed her attitude towards mathematics had improved since the start of the methods course. Her first thoughts were of the after-school program she runs and how she has already been able to apply what she learned in the methods course:
I definitely think my attitude has changed about math. The biggest thing, I guess, for me is with the after-school thing, is trying to help the people who are helping [the students] with their homework understand that [teaching math] is not the way it used to be … One of the biggest things that I use from your class is the base ten rods. Even when I’m helping the kids with their homework, I’ll draw [base ten blocks] and I’ll ask them, ‘Do you recognize that? Do you do that in class?’ and they do, and it always helps them get it. It’s really awesome…. I was really fearful about teaching math, but I think that the manipulatives helped, and the book also…. and the reflections were really, really helpful.

When asked if there was anything else she would like to add about the use of manipulatives in teaching mathematics or in the methods course, Stephanie said that she used “a lot of it to help the kids [in after-school program] with their homework.” She has found that the manipulatives “really helped [her students] make that connection” between multiplication and repeated addition. She recalled discussing manipulatives with her sister and “telling her about all the manipulatives and how we have one for fractions and the [fraction] circles, and they make everything so hands-on and it’s really awesome.” Stephanie later mentioned that she “liked that [instructor] had the overhead [manipulatives] so you could show us how to do it as we were doing it.”

Stephanie thought that the use of cooperative learning in mathematics classrooms was “really great. It’s really good for skill building.” She felt that the cooperative learning activities in the methods course were “good. We were learning how to use the manipulatives.” Stephanie made it clear that she did not like cooperative learning when it involved assignments:
I just don’t like when we have to collaborate and turn stuff in … someone ends up always doing more, namely me, and I really don’t like that. I’m taking ESOL online, I’m doing most of the work for my group. I absolutely hate it.

When asked about the use of problem solving in teaching mathematics and in the methods course, Stephanie just said, “I definitely feel like I’m going to use stuff that I used in the class and the problem solving that we talked about.”

Stephanie said that she found the journals “really helpful.” She added, “I’ve even gone back… I go back and read them sometimes and they’re really helpful. They made me think about a lot of stuff that I probably wouldn’t have thought about unless you prompted me.”

At this point in the interview, the researcher showed Stephanie her pre- and post-course survey scores and the change scores for each attitude component. Stephanie was astonished that her score had decreased, and she said once again that she thought her attitude toward mathematics had improved since the start of the methods course. She looked at her responses on the post-course survey and observed that she had not answered ‘strongly agree’ to any of the survey items. She said, “I’m just thinking that, maybe that day, I didn’t feel like I would ‘strongly agree.’ … because I didn’t write ‘strongly agree’ for anything.” Stephanie then reminded the researcher that Stephanie’s mother had passed away during week 10 of the semester, which was only a few weeks before the participants completed the post-course survey. She suggested that perhaps she was not feeling overly positive about anything during that time.

When asked if there was anything else that she would like to add about her attitude change or to what she attributed this change, Stephanie said:
I just want you to know that I really do use this stuff and I’m trying to train people who work with my after-school program. They’re not elementary ed. majors so they really don’t know everything that I know. I even told my boss, ‘I teach a math training course.’ Because people are helping them [students in after-school program], but they don’t know the right thing to do and they’re just confusing them.

Stephanie also added something concerning the journals:

When I sit home and I’m writing my reflections and I’m thinking about what I want to say, that’s the time when my emotions aren’t playing any part in it because I have the computer and I can type it and I can write the thing and say, ‘Oh, I don’t want to say that.’

‘Shelly’

Shelly’s change score was -10, the second lowest in the class, indicating the second most negative attitude change. Her score on the pre-course ATMI was 155 out of a possible 200 points. This represented a mean response of 3.9 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 145, representing a mean response of 3.6 per item. Her scores for the four attitude components changed as follows: Value decreased by 6 points, Enjoyment decreased by 4 points, Self-Confidence decreased by 2 points, and Motivation increased by 2 points. It should be noted that possible change scores ranged from –160 to 160, so these changes were too small to be of statistical or practical significance.

Shelly was unsure when asked how she thought her attitude toward mathematics had changed since the start of the methods course:
I don’t know. My attitude about math, I think, is constantly changing, all the
time, and sometimes it might just be that day or certain subjects or topics that I
have in my head. It’s certain categories or something that to this day still just rub
me the wrong way. I can’t get them down. I don’t know; I think a lot of it has to
do with the teachers that I’ve come across because everybody has such different
teaching styles.

Shelly said that she had done well in the methods course and that she appreciated the
organized format of the course:

I thought of [the course] as very organized … There were no surprises, you didn’t
throw any surprises at us. You told us things in particular and it was really clearly
stated of how we could go about it and how we could teach it and I just really
enjoyed it…. And I remember everything that you did with me and I’ll know how
to use that with other kids and then maybe they’ll have a better attitude about
math, too, because I wasn’t taught the way that you taught or showed me. I had a
negative attitude about math for a very long time.

Shelly said that she “loved” using the manipulatives in the methods course and
that she was already thinking about how she would use manipulatives with her future
students:

Even when I did that mini-lesson plan that we had to do for your class, I just was
thinking of so many ways I could use manipulatives, and I think that every math
problem, like I want to try to use a manipulative, for the visual and kinesthetic
learners. Any math problem that somehow provides an example, a hands-on
example, I think would probably be the best way to go. I think that’s great.
Shelly felt that the use of cooperative learning in teaching mathematics was “very important.” She added, “anything where you’re involved with other people and figuring things out together, especially with peers, you can learn from their perspective.”

When asked about the use of cooperative learning in the methods course, Shelly said:

As long as that’s not a constant thing, I think that it wouldn’t ever bring my attitude down because I know that a lot of people, especially with math, they do like to go back and work on their own and do their own work and get their own answer like with problem-solving and skill practice. They want to figure it out for themselves and usually if they can’t get it, then cooperative learning is important coming on that end of the deal. But then also you go back and have some independent or individual learning … I don’t like to start out doing a problem by myself if it’s major or important or just for play or fun. I just like to have someone show me and show me and show me again. Eventually I do want to do it and I do want to get the right answer and then I also do want to be able to show someone else so they’ll know how.

Shelly viewed the use of problem solving in teaching mathematics as “good” and important for children because problem solving “is going to help you advance or think deeper, and that’s important for teachers to be able to make their kids do that.” However, she thought that for a child, “it could be a turn-off.” Shelly said that she sometimes found word problems to be “intimidating.” Although she considers herself a “critical thinker,” Shelly doesn’t really like word problems:
I like the basic arithmetic, multiplying, straight numbers, and I don’t really like word problems. I don’t know why I don’t. I don’t know if it’s because I think there’s a hidden trick or clue that I’m going to forget or skip, and I’m just going to mess the whole thing up.

Shelly felt that she had benefited from the reflection that the journal writing in the methods course had provided:

They [journals] make you not forget your own little history, your little pattern of life, like your personal math diary that you thought you were never going to have, but it’s good. It reminds you of the ups and downs and the positives and negatives, the things that are important…. Everybody needs time to reflect.

At this point in the interview, the researcher showed Shelly her pre- and post-course survey scores and the change scores for each attitude component. Shelly was surprised to learn that her attitude scores had decreased:

I’m surprised…. When I think of that and what you’re saying, I really think that it probably would have gone the other way. I do and I think that it has to do with the way that you’ve taught me how to teach children which may have been different than the way that I learned so I just might see it differently now in my head and the whole visual aspect, and then the presentation of it. I don’t know. I think that you’ve cleared up a few things, even though we only did some basic and simple math for pretty young children. I don’t know. I’ve picked up a lot from your class and I think that my attitudes would’ve gotten better just because a lot more makes sense now and that’s just kind of surprising to hear that it went the other direction.
When asked if there was anything else that she would like to add concerning her attitude change or to what she attributed this change, Shelly responded:

I just really wish you could have taught all my math classes, I really do. You actually remind me of one of my other teachers that I wrote about in my journals; she taught Algebra, Geometry all through high school. You kind of resemble her, I don’t know why, in a way. If I could have just had you two, I probably would have gone through Calculus, I think. It’s not that I’m turned away or intimidated by those upper level subjects. As I said before, when I take Math II, I’m taking it with you. I have to. This will probably be my last math class for the rest of my life … I hate the feeling I get when I go into a math class and I get, ‘Uhhh, it’s math, so I’m a little nervous.’ And you just don’t know what’s expected. You just never know how it’s going to be. But at least with you I know how it’s going to be, and I feel confident, and I feel like I’m kind of interested about doing it.

‘Yezania’

Yezania’s change score was -5, indicating a negative attitude change. Her score on the pre-course ATMI was 80 out of a possible 200 points. This represented a mean response of 2.0 per survey item, with 1 representing the most negative response and 5 the most positive response. Her post-course ATMI score was 75, representing a mean response of 1.9 per item. Her scores for the four attitude components changed as follows: Value decreased by 1 point, Enjoyment decreased by 4 points, Self-Confidence increased by 1 point, and Motivation decreased by 1 point. It should be noted that these changes were too small to be either statistically or practically significant.
Yezania said that she thought her attitudes toward mathematics had improved in some ways and not in others:

Yes [I think my attitudes changed] because I liked all the manipulatives we did.

See, when I was growing up, and I was in elementary school, we didn’t have any of those [manipulatives]… I’m a visual learner so math was just always [disgruntled noise]. You know, they would write numbers and that was it. And I was thinking, ‘what’s going on?’ So that’s why I’ve even postponed taking College Algebra because I’m so scared. So yes, and no, because I’m still kind of nervous when it comes to math, I’m not secure of myself, but it was fun. Let’s put it that way.

Yezania thought that the use of manipulatives in teaching mathematics was “awesome.” She is the director of an after-school program where she has used manipulatives with her students:

I even used them with my kids in after-school programs, and they loved it. They were doing a problem on the worksheet; they were not getting it. Once I took out manipulatives, they were like [noise indicating speed], and they knew how to do it. So I think they’re awesome.

Yezania felt that manipulatives had helped her “a lot” in the methods course as well, “especially with those word problems ‘cause I’m not good with word problems. I would have to draw it out. So I would use my little circles … fraction circles.”

Yezania thought that in teaching mathematics, “you need a lot of cooperative groups because there are strong learners and then there’s weak learners so maybe together they’ll kind of help each other out.” She felt that maybe she would have done
better in the methods course and benefited more from the cooperative learning activities if she had not been sitting with her friends: “In the math course, it was interesting, I think, because we did too much talking instead of actually doing the work. So, you know, I’m being honest. Sometimes you get kind of sidetracked.”

Yezania “really had a rough time” with problem solving in the past. She “learned a lot of new ways to solve” problems in the methods course, which she said “was good for” her. She explained that she was a “very visual” learner, so she benefited from learning problem-solving strategies that used “a lot of writing and drawing:”

I learned a lot of new things to make it easier on me and a lot of new ways to, like I told you, in my after-school program I have to help kids with their homework.

It’s very frustrating when I don’t like math to help them do math. So I’ve learned a lot of new ways to teach them and to teach myself.

When asked about the journal writing in the methods course, Yezania said that she “loves writing,” especially her “own opinions and everything.” She concluded that she “loved ” the journals and was disappointed when she took her second mathematics methods course and there were no journals assigned.

At this point in the interview, the researcher showed Yezania her pre- and post-course survey scores and the change scores for each attitude component. The researcher explained that although Yezania’s overall score had only decreased five points, her original score had been quite low, with a mean score of 2.0 per item, with 1 representing the most negative response and 5 representing the most positive response. Yezania said that she believed that these results could have been related to the distractions she had mentioned earlier involving sitting with her friends in class: “I think it did [affect the
scores]. Especially those problems, remember, like the compare stuff [meanings of operations], like sometimes I wouldn’t be grasping it, but I would be too involved in [chitchat noises] so I wouldn’t grasp it too well.”

Yezania stressed that even though her attitude towards mathematics had not improved and her score had decreased, she still felt that she had “learned a lot even though.” She added that she had learned a lesson about paying attention in class:

Yeah, I learned a lot in this [methods course] as now I’m taking College Algebra so I already have this attitude that I have to pay attention, grasp everything that the teacher’s [doing]. I’m always writing, whatever she’s doing, I’m writing it down.

Question 3: Relationship Between Initial Attitudes and Score on Final Examination

Question #3 asked:

What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

A Pearson correlation coefficient was found using the software program, SAS, in order to determine the relationship between initial attitudes toward mathematics and achievement in the methods course. Achievement was measured using the methods course final examination. The departmental test is a 50-item multiple-choice instrument that includes questions about both mathematics content and pedagogy. Information about the authors and content of the final exam is found in Chapter Three (pp. 80-82) and in Appendix J. The use of the final examination as a measure of achievement provided validity and reliability to the results. A reliability coefficient of 0.71 (n=17) was found for
Exam Form A and a coefficient of 0.73 (n=16) was found for Exam Form B, indicating a relatively high degree of reliability.

The composite attitude score was used as the independent variable and the methods course final examination grade was used as the dependent variable. An alpha level of 0.05 was used to indicate whether the obtained correlation was statistically significant. A statistically significant Pearson Correlation Coefficient of $r = 0.5321$ was found, indicating a moderately strong positive correlation ($p = 0.0014 < 0.05$, $n = 33$).

**Question 4: Journals**

**Question #4 asked:**

What do preservice elementary school teachers’ reflective journal entries reveal about their attitudes toward mathematics and the experiences that have influenced the development of those attitudes?

Analysis of the qualitative aspects of the study involved looking for patterns. Hycner (1985) provided guidelines for the phenomenological analysis of interview data, and his methods were utilized in this study. After reading a journal entry for a sense of the whole, units of general meaning were delineated. Hycner defined units of meaning as “those words, phrases, non-verbal or para-linguistic communications which express a unique and coherent meaning” (Hycner, 1985, p. 282). These units were recorded using the computer software program Ethnograph. When a journal expressed multiple units of meaning, these were analyzed separately.

Once units of meaning had been identified for each journal entry for a given prompt, units of meaning from all journal entries responding to that prompt were
examined. Units of meaning relevant to the research questions were then clustered and common themes identified from the data. Themes were labeled using words that were introduced by the participants themselves whenever possible, and frequencies of themes were noted. When excerpts from journal entries were cited, no names or other means of identification were given. Any names of people, schools, etc. that were included were replaced by pseudonyms.

*Journal 1: Feelings At Beginning of Course*

The first journal entry asked participants to discuss any feelings, positive or negative, that they had about taking the methods course. Responses were analyzed and positive, negative, and neutral themes were identified. Some of the journal entries expressed multiple themes, and these themes were analyzed separately. Therefore, frequencies may total more than 33. Initially, 19 distinct units of meaning associated with positive feelings about the course and 14 units associated with negative feelings about the course were identified. As themes emerged, those representing similar concepts were combined. For example, the following excerpts were initially categorized, respectively, as ‘Apprehensive about Course’ and ‘Nervous about Course.’

- “I am very apprehensive about taking this course, considering my math skills aren’t the greatest.”
- “I am nervous because I wasn’t always great at math.”

They were both later counted as two instances of ‘Nervous, Worried, Apprehensive about Course.’ The following themes, along with their respective percentages of all comments made for this prompt, were identified for Journal One: positive feelings about course (17.5%), negative feelings about course (11.7%), mixed feelings about course
(3.9%), positive attitudes and experiences not related to course (19.5%), negative attitudes and experiences not related to course (29.9%), and beliefs expressed (17.5%). Table 10 shows the themes that were identified related to the methods course.

The following journal excerpts are representative of data responses for each of these themes:

**Positive Feelings about Course**

- “My feelings about taking this course are positive even though math is not my strongest subject.”
- “When I was signing up for classes over the summer this was the class that I was most looking forward to.”
- “I am for the most part very excited about this course.”
- “I am finding the kit of manipulatives intriguing.”
- “So I come into this class with some confidence.”
- “Not only did I think I would do well but I knew that I would be interested.”

**Negative Feelings about Course**

- “I can honestly say that I had some apprehension about taking this course, as mathematics has not been a favorite subject of mine.”
- “I was a tad anxious about this class because any class with the word ‘math’ has always made me a little nervous.”
- “I am a little nervous because math has always been the subject that I have struggled the most with.”
- “When I got into the school of education and saw that I had to take two more math classes, my heart was broken.”
Table 10

*Feelings about Methods Course at Beginning of Course*

<table>
<thead>
<tr>
<th>Feelings</th>
<th>Frequency(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>Feel positive, look forward to</td>
<td>11</td>
</tr>
<tr>
<td>Excited about course</td>
<td>6</td>
</tr>
<tr>
<td>Like manipulatives kit</td>
<td>5</td>
</tr>
<tr>
<td>Confident</td>
<td>3</td>
</tr>
<tr>
<td>Interested</td>
<td>2</td>
</tr>
<tr>
<td><strong>Negative Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>Nervous, worried, apprehensive</td>
<td>14</td>
</tr>
<tr>
<td>Dislike of mathematics</td>
<td>4</td>
</tr>
<tr>
<td><strong>Mixed Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>Both positive and negative feelings</td>
<td>6</td>
</tr>
</tbody>
</table>

\(^a\)Total frequency of 51. Total frequency of 27 positive feelings came from 21 of the 33 participants. This represented 17.5% of all comments made for this prompt. Total frequency of 18 negative feelings came from 15 of the 33 participants. This represented 11.7% of all comments made for this prompt. Total frequency of 6 mixed feelings came from 6 of the 33 participants. This represented 3.9% of all comments made for this prompt.

- “At the beginning of summer I didn’t want to think about taking this course at all. Just the idea of math was enough for me to dislike the course.”

*Mixed Feelings about Course*

- “I would have to say that I currently have very mixed emotions about this course.”
• “For me, taking this math course is going to be both positive and negative.”

Some participants expressed attitudes toward mathematics that were not specific to the methods course. Tables 11 and 12 summarize the positive and negative themes that were identified and the frequencies with which these themes were cited. The journal excerpts that are given for each theme are representative of data responses given.

Seventeen participants expressed twenty-seven beliefs (17.5% of all comments made for this prompt) about mathematics, teaching mathematics, and learning mathematics while responding to Journal One. The following are representative of these beliefs:

• “Everything in the world is made up by some mathematical equation.”

• “With fine [math] instruction, you can learn anything.”

• “[Using the textbook everyday] gets boring for the children.”

• By including manipulatives and other hands-on activities, [students] will be able to interact with math instead of just acquiring new information for memorization.”

• “So many people do not like [math classes].”

• “Some people have more of a natural interest and feeling for math than others.”

• “Once children get a concept, it is such a self esteem booster.”

• “If a teacher has a negative attitude towards the subject, the students will recognize this and develop a bias attitude towards the subject as well.”

Journal One also asked the participants what they were hoping to gain from the course. Table 13 summarizes all of the themes that were identified in addressing this question.
Table 11

Positive Attitudes and Experiences Expressed in Journal One: Feelings About Course

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Attitudes Toward Mathematics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likes, enjoys</td>
<td>10</td>
<td>“Math has always been my favorite subject.”</td>
</tr>
<tr>
<td>math</td>
<td></td>
<td>“I enjoy math at the elementary level.”</td>
</tr>
<tr>
<td>Does well</td>
<td>6</td>
<td>“Math is one of my strongest subjects.”</td>
</tr>
<tr>
<td>Confidence</td>
<td>1</td>
<td>“I know that I can do math, it just takes time and a good teacher.”</td>
</tr>
<tr>
<td><strong>Positive Attitudes Toward Teaching Mathematics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wants to teach</td>
<td>4</td>
<td>“I look forward to teaching math in elementary school.”</td>
</tr>
<tr>
<td>math</td>
<td></td>
<td>“Just last week I taught my nine year-old sister long division. Good times.”</td>
</tr>
<tr>
<td><strong>Positive Experiences with Mathematics Classes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>3</td>
<td>“When I was in elementary school, I would get really happy when it was time to work in groups and use manipulatives to learn.”</td>
</tr>
<tr>
<td>Great teachers</td>
<td>2</td>
<td>“I had great mathematics teachers as a child.”</td>
</tr>
<tr>
<td>Math came</td>
<td>1</td>
<td>“In math [class], the teacher could usually show me once how to do something, and I would just get it.”</td>
</tr>
<tr>
<td>Loved geometry</td>
<td>1</td>
<td>“I remember algebra, which was OK, and geometry, which, for some reason, I loved.”</td>
</tr>
</tbody>
</table>

*aTotal frequency of 30 came from 15 of the 33 participants. This represented 19.5% of all comments made for this prompt.*
### Table 12

**Negative Attitudes and Experiences Expressed in Journal One: Feelings About Course**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Negative Attitudes Toward Mathematics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not good at it</td>
<td>12</td>
<td>“I am horrible at math.”</td>
</tr>
<tr>
<td>Don’t like/hate</td>
<td>8</td>
<td>“I do not like math.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I dread the idea of doing anything concerning math.”</td>
</tr>
<tr>
<td>Not interested</td>
<td>2</td>
<td>“I am not particularly interested in [math].”</td>
</tr>
<tr>
<td>Intimidated</td>
<td>2</td>
<td>“I am intimidated by math and all of its subtopics.”</td>
</tr>
<tr>
<td><strong>Negative Attitudes Toward Teaching Mathematics</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worried about teaching math</td>
<td>6</td>
<td>“I wonder how I am going to teach a subject that I am not very good at.”</td>
</tr>
<tr>
<td>Methods not same as book</td>
<td>1</td>
<td>“Whenever I try to help others I know what I am doing but my methods are usually not the same as the book describes.”</td>
</tr>
<tr>
<td>Fractions</td>
<td>1</td>
<td>“I tried to teach a lesson on fractions to 1st graders. The lesson was a flop, the kids were LOST.”</td>
</tr>
<tr>
<td><strong>Negative Experiences with Mathematics Classes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school and college</td>
<td>6</td>
<td>“I got into high school and sort of forgot the basics and instead memorized formulas.”</td>
</tr>
<tr>
<td>Struggled</td>
<td>5</td>
<td>“I was never the best math student.”</td>
</tr>
<tr>
<td>General</td>
<td>3</td>
<td>“I have had good and bad experiences [with math classes], unfortunately more bad than good.”</td>
</tr>
</tbody>
</table>

*Total frequency of 46 came from 24 of the 33 participants. This represented 29.9% of all comments made for this prompt.*
### Table 13

**Themes from Journal Prompt: What Do You Hope to Gain From the Course?**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching strategies and tools</td>
<td>24</td>
<td>“I [hope to gain] a better understanding of the strategies used to teach math well.”</td>
</tr>
<tr>
<td>Learn to like and appreciate</td>
<td>13</td>
<td>“My main goal in this class is to try and appreciate math, not only for my sake, but for my future students as well.”</td>
</tr>
<tr>
<td>Help students</td>
<td>11</td>
<td>“I do not want [my students] to have the same fear [of math that] I do.”</td>
</tr>
<tr>
<td>Help students</td>
<td>11</td>
<td>“I don’t want to make my students dread math.”</td>
</tr>
<tr>
<td>Gain better understanding of math</td>
<td>10</td>
<td>“I am hoping that through this course I will learn more about math.”</td>
</tr>
<tr>
<td>Make math enjoyable, fun</td>
<td>9</td>
<td>“I am excited to learn how to make math fun for my students.”</td>
</tr>
<tr>
<td>Gain confidence with math</td>
<td>9</td>
<td>“I am hoping to learn and feel confident that I can do math after completing this course.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 13 (Continued)

*Themes from Journal Prompt: What Do You Hope to Gain From the Course?*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Be a good teacher</td>
<td>6</td>
<td>“I am hoping I can come away from this course with the ability to become a good math teacher.”</td>
</tr>
<tr>
<td>Accommodate diff. learning</td>
<td>5</td>
<td>“I want to learn different methods of teaching the same types of problems so that I can use these techniques in classes with students who learn differently and at different speeds.”</td>
</tr>
<tr>
<td>Help students see math as relevant</td>
<td>4</td>
<td>“I want them to see it as a tool, as something that can positively affect their lives.”</td>
</tr>
<tr>
<td>Make math interesting</td>
<td>3</td>
<td>“I want to be able to make [math] as interesting to them as possible.”</td>
</tr>
<tr>
<td>Learn to use manipulatives</td>
<td>1</td>
<td>“I hope to gain [knowledge of] how to use all the manipulatives from our kit.”</td>
</tr>
</tbody>
</table>

*Total frequency of 95 came from all of the 33 participants. This represented 100% of all comments made for this prompt.*
Journal 2: Memories of Mathematics in Elementary School

The second journal entry asked participants to reflect on their memories of learning mathematics in elementary school. Initially, 19 distinct units of meaning associated with positive memories and 25 units associated with negative memories were identified. As themes emerged, those representing similar concepts were combined. For example, the following excerpts were initially categorized, respectively, as ‘Negative Memory about Word Problems’ and ‘Negative Memory about Fractions.’

- “I remember feeling challenged by word problems because I never knew where to start.”
- “I can remember not enjoying fractions.”

They were both later counted as two instances of ‘Negative Memory about Learning Specific Topics.’

The following themes, along with their respective percentages of all comments made for this prompt, were identified for Journal Two: positive memories of mathematics in elementary school (34.2%), positive memories of mathematics teachers in elementary school (9.7%), enjoyed mathematics more after elementary school (1.3%), negative memories of mathematics in elementary school (32.3%), negative memories of elementary school teachers (3.2%), began to struggle after elementary school (3.2%), negative memories of mathematics teachers after elementary school (2.6%), general memories of elementary school (5.8%), neutral attitudes (1.3%), and beliefs expressed (6.4%). Those journal entries reflecting positive memories of elementary school mathematics are summarized in Table 14. Those journal entries reflecting positive memories of elementary school mathematics teachers are summarized in Table 15.
## Table 14

**Positive Memories of Mathematics in Elementary School from Journal Two**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific topics, especially mult. facts</td>
<td>11</td>
<td>“We would have to name all of the times tables under a certain amount of time. We earned stickers on our name card… It was a large boost of confidence after receiving a new sticker.”</td>
</tr>
<tr>
<td>Good at it; successful</td>
<td>8</td>
<td>“I always remember looking forward to math because I was good at that subject.”</td>
</tr>
<tr>
<td>Enjoyed it</td>
<td>5</td>
<td>“In elementary school I remember enjoying math so much.”</td>
</tr>
<tr>
<td>Unit related to real-life application</td>
<td>4</td>
<td>“We did a unit where we learned about money. We created a school store….I loved it and still to this day remember doing well at it and having fun with it.”</td>
</tr>
<tr>
<td>General positive memories</td>
<td>4</td>
<td>“I have many fond memories of learning math at the elementary level.”</td>
</tr>
<tr>
<td>Positive attitude toward math</td>
<td>3</td>
<td>“All during elementary school I had a really positive attitude towards math.”</td>
</tr>
<tr>
<td>Parental involvement</td>
<td>3</td>
<td>“My parents were chaperones for this [math-related] event and I remember being so happy that I could share this experience with them.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 14 (Continued)

*Positive Memories of Mathematics in Elementary School from Journal Two*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doing well</td>
<td>3</td>
<td>“I was retaining the procedures quickly and effectively and this gave me a lot of confidence.”</td>
</tr>
<tr>
<td>increased confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manipulatives</td>
<td>3</td>
<td>“I couldn’t wait to get my hands on the blocks, pennies and geometric shapes. In class, each of us would get our own manipulatives.”</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>3</td>
<td>“In elementary school I remember enjoying math so much…Often, we would work in groups to solve tough word problems.”</td>
</tr>
<tr>
<td>groups</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fun</td>
<td>2</td>
<td>“When I was in elementary school, math was fun.”</td>
</tr>
<tr>
<td>Games</td>
<td>2</td>
<td>“I remember in first grade, we played a game called Around the World … This served as a source of encouragement to me.”</td>
</tr>
<tr>
<td>Motivated</td>
<td>2</td>
<td>“I always wanted to get good grades and be looked up to.”</td>
</tr>
</tbody>
</table>

*Total frequency of 53 came from 21 of the 33 participants. This represented 34.2% of all comments made for this prompt.*
Table 15

*Positive Memories of Mathematics Teachers in Elementary School from Journal Two*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Took time for</td>
<td>4</td>
<td>“My teacher would take the time to explain something until everyone understood what was going on.”</td>
</tr>
<tr>
<td>Made math</td>
<td>2</td>
<td>“I loved this teacher because she made learning math and science so interesting.”</td>
</tr>
<tr>
<td>Patient,</td>
<td>2</td>
<td>“I know that I would not have been able to [be successful] without the patient supportive help from my teacher, ‘Mrs. W.’ I will never forget her.”</td>
</tr>
<tr>
<td>Encouraging</td>
<td>2</td>
<td>“I remember my teachers being extremely encouraging towards all of us.”</td>
</tr>
<tr>
<td>Taught math in</td>
<td>2</td>
<td>“My teachers would teach us in many different ways. Some days we would use dittos and have drill and practice and the next we would be using M&amp;Ms to count with.”</td>
</tr>
<tr>
<td>Made math</td>
<td>1</td>
<td>“One of the reasons I did so well was because my teachers …applied [lessons] to real life situations.”</td>
</tr>
<tr>
<td>Encouraged</td>
<td>1</td>
<td>“The teachers always encouraged lots of group work during math, which I think is wonderful.”</td>
</tr>
<tr>
<td>Great at</td>
<td>1</td>
<td>“I always had very good teachers who were great at explaining things.”</td>
</tr>
</tbody>
</table>

*Total frequency of 15 came from 7 of the 33 participants. This represented 9.7% of all comments made for this prompt.*
Although Journal Two asked about memories of elementary school mathematics, two participants said that they began to like mathematics more once they were out of elementary school:

- Loved algebra: “I enjoyed math more when I got to middle school or high school because I love to do algebra.”
- Started working and succeeding: “I didn’t start to like [math] until I was in college and really started applying myself. I got pleasure from earning good grades on tests.”

Those journal entries reflecting negative memories of elementary school mathematics are summarized in Table 16. In addition, the following negative memories of mathematics teachers in elementary school were each mentioned once:

- Teachers not compassionate: “I had go to Catholic School and some of the nuns were not too compassionate for some of the students.”
- Teacher mostly used dittos: “[My second grade teacher’s] idea of math class was assigning a bunch of mindless dittos that taught nothing more than simple addition and subtraction.”
- Teachers not excited about math: “As I remember back to my elementary days of math there are no teachers that taught math that I recall being excited about math.”
- Teacher bitter: “I had a teacher that would mark down our grade if we would ask questions when we did not understand because she was bitter and did not want to be bothered.”
### Table 16

**Negative Memories of Mathematics in Elementary School from Journal Two**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific topics, especially</td>
<td>11</td>
<td>“We did many drills for our times tables. If you didn’t pass your two’s and three’s then you didn’t move on. That put pressure because if you didn’t move up then everyone knew, that made me feel dumb.”</td>
</tr>
<tr>
<td>multiplication facts</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Struggled with math</td>
<td>7</td>
<td>“I remember excelling in all my other subjects, except math in which I struggled.”</td>
</tr>
<tr>
<td>General negative memories</td>
<td>5</td>
<td>“So as you can see all my main memories of learning math are bad.”</td>
</tr>
<tr>
<td>Did not understand</td>
<td>4</td>
<td>“I remember crying in front of the teacher because it was so hard for me just to get an understanding of math.”</td>
</tr>
<tr>
<td>Stressful</td>
<td>3</td>
<td>“[Struggling with math] was a very new and incredibly stressful thing for me to comprehend.”</td>
</tr>
<tr>
<td>Low test scores</td>
<td>2</td>
<td>“I can recall memories of receiving my Stanford Achievement scores in elementary school and always placing in the average or low percentile in math.”</td>
</tr>
<tr>
<td>Felt stupid, less smart</td>
<td>2</td>
<td>“I remember feeling less smart when people around me … just ‘got it’ so easily.”</td>
</tr>
<tr>
<td>Hated math</td>
<td>2</td>
<td>“I remember that I hated doing [math].”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 16 (Continued)

*Negative Memories of Mathematics in Elementary School from Journal Two*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency$^a$</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boring</td>
<td>2</td>
<td>“I can remember as a child, not really having any interest in math. I found it boring.”</td>
</tr>
<tr>
<td>Games</td>
<td>2</td>
<td>“We played a game called ‘Around the World’ in which we competed to see who could answer the fastest. I dreaded these parts of math.”</td>
</tr>
<tr>
<td>Not relevant or needed</td>
<td>2</td>
<td>“I remember [thinking] what was the purpose of me doing this when I don’t need it later in life.”</td>
</tr>
<tr>
<td>Teachers did not help</td>
<td>2</td>
<td>“I remember not understanding anything and not having teachers that would go back and help.”</td>
</tr>
<tr>
<td>Only one way to solve problem</td>
<td>2</td>
<td>“I remember not being taught several ways to work out problems.”</td>
</tr>
<tr>
<td>Drill work</td>
<td>2</td>
<td>“The drill, drill, drill made me hate math for a little while.”</td>
</tr>
<tr>
<td>Moved to a new school</td>
<td>1</td>
<td>“Math had always been one of my lesser subjects, but it got even worse in 3rd grade [when] I transferred to a new school.”</td>
</tr>
<tr>
<td>Homework</td>
<td>1</td>
<td>“I hated the homework…The problems were a lot more difficult than the easy ones we did in class.”</td>
</tr>
</tbody>
</table>

$^a$Total frequency of 50 came from 16 of the 33 participants. This represented 32.3% of all comments made for this prompt.
• Teacher would yell: “I remember that my teacher used to yell at the class, and when she yelled, a lock of her hair would fall over her forehead and a vein in her neck would stand out.”

Five participants said that they liked mathematics in elementary school, but that they began to struggle with it and dislike it once they reached middle school or high school:

• “Once I went to middle school I was totally lost when it came to math.”
• “I can clearly remember unpleasant math experiences in middle school and beyond.”
• “I did not really start to dislike math until the 7th grade.”
• “When I got to high school, it got a bit harder and I started to shut down from wanting to learn more math.”
• “Unfortunately, along the way, math became one of my most hated subjects.”

Although Journal Two asked about memories of elementary school mathematics, four participants mentioned negative memories of teachers after elementary school:

• “In high school I had one teacher that said that there was no way I would make it in school because I did not do well in math.”
• “In high school, I had an extremely rigid, math teacher. She made math class so tense it was hard to feel at ease. Thus, she created a difficult learning environment.”
• “In my Algebra 2 class [I had] a HORRIBLE teacher.”
• “I took College Algebra here at [university], and my teacher was HORRIBLE!!!

He never helped, and every time you would ask for help he would make you feel stupid.”

Some of the participants’ memories of elementary school mathematics were neither positive nor negative. These are found in Table 17.

Table 17

*General Memories of Mathematics in Elementary School from Journal Two*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Worksheets</td>
<td>4</td>
<td>“I don’t really remember too much about elementary math; what I do remember is worksheets and ditto sheets and lots of them.”</td>
</tr>
<tr>
<td>Manipulatives</td>
<td>4</td>
<td>“My memories early on are using manipulatives such as bottle tops and pieces of felt.”</td>
</tr>
<tr>
<td>Teacher would</td>
<td>1</td>
<td>“The teacher would show how to do the problem on the board and explain; you would read about it in your textbook; then you would do problems in class and also as homework.”</td>
</tr>
</tbody>
</table>

*Total frequency of 9 came from 7 of the 33 participants. This represented 5.8% of all comments made for this prompt.*

In addition, two participants expressed neutral attitudes toward mathematics in elementary school:

• “I believe my basic attitude [was] that math was something I needed to do … it wasn’t particularly painful, but it wasn’t particularly enjoyable either.”
• “I did not dread math -- but I did not look forward to it either. It was simply something that I had to do.”

Journal Two also asked participants what they, as future teachers, had learned from these experiences. Table 18 summarizes their responses.

While discussing their memories of elementary school mathematics, 9 participants expressed 10 beliefs about mathematics, teaching mathematics, and learning mathematics. The following are representative of these beliefs:

• “[History] is mostly memorization. Math problem solving is a more complex thought process.”

• “Parental involvement is important when teaching a child any subject. If the student doesn’t have a good support system then it’s going to be ten times more difficult for the child.”

• “Kids tend to have their own language and can better explain things to each other.”

• “With the right amount of teacher support most students are capable of not only using the four basic operations of mathematics, but also higher-level math.”

• “Research says that dancers are strong in math and I believe it to be true.”

• “I believe that if you make math fun students are more apt to pay attention in class and more likely to remember what you have taught them.”
Table 18

*Themes from Journal Prompt Two: What Did You Learn as a Future Teacher?*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide extra help when needed</td>
<td>9</td>
<td>“If a student needs extra help, I think it is important to stay after school to help them.”</td>
</tr>
<tr>
<td>Make math fun</td>
<td>8</td>
<td>“As a future educator, I want to be the type of teacher that makes math fun.”</td>
</tr>
<tr>
<td>Make math interesting</td>
<td>7</td>
<td>“As a future teacher, I want to try to make mathematics more interesting for my students than it was for me, if possible.”</td>
</tr>
<tr>
<td>Foster positive attitudes toward math</td>
<td>7</td>
<td>“I hope as a teacher that I will make an impact on [my students] and that they will love to do math.”</td>
</tr>
<tr>
<td>Build students’ confidence</td>
<td>6</td>
<td>“I will try to make them feel good about themselves when they have success …It brings out confidence.”</td>
</tr>
<tr>
<td>Help students feel comfortable</td>
<td>6</td>
<td>“I want my students to feel comfortable in my classroom. I feel once they are then they will be able to meet their full potential.”</td>
</tr>
<tr>
<td>Make math relevant</td>
<td>5</td>
<td>“As a teacher I must try to help my students understand that math is something they are going to need in their lives at all times.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 18 (Continued)

*Themes from Journal Prompt Two: What Did You Learn as a Future Teacher?*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help students</td>
<td>5</td>
<td>“I need to help my children in the future become successful in everything that I can because they will then feel successful!!!”</td>
</tr>
<tr>
<td>Understand</td>
<td>4</td>
<td>“I think this will make me a better teacher because I not only know a way to teach multiplication, but I understand the process behind the lesson.”</td>
</tr>
<tr>
<td>Accommodate</td>
<td>3</td>
<td>“As a teacher I will try my hardest to teach math in a way that all children, with different learning styles will learn.”</td>
</tr>
<tr>
<td>Various types of strategies and assessment</td>
<td>3</td>
<td>“I want [students] to know that there is more than one way to do something.”</td>
</tr>
<tr>
<td>Use</td>
<td>2</td>
<td>“I think using manipulatives is going to be a great asset and I cannot wait to learn how to apply them to math.”</td>
</tr>
<tr>
<td>Encourage group work</td>
<td>2</td>
<td>“I’m definitely going to encourage group work in math.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 18 (Continued)

Themes from Journal Prompt Two: What Did You Learn as a Future Teacher?

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not use too many</td>
<td>2</td>
<td>“I do not want to have the students complete as many worksheets as I worked on because I believe it is redundant.”</td>
</tr>
<tr>
<td>Integrate math with other subjects</td>
<td>2</td>
<td>“As a teacher, I plan on integrating math with literature and all of the other subjects.”</td>
</tr>
<tr>
<td>Ask colleagues for help</td>
<td>1</td>
<td>“If I don’t remember or can’t do a problem, I will ask my fellow teachers for some help.”</td>
</tr>
</tbody>
</table>

*Total frequency of 72 came from all of the 33 participants. This represented 100% of all comments made for this prompt.*

Journal 3: Feelings about Mathematics

The third journal entry asked participants to complete the following statements: I enjoy or feel positive about mathematics because … and/or … I do not enjoy or I feel negative about mathematics because …. Participants were also asked to explain why they thought they felt this way. Initially, 32 distinct units of meaning associated with positive feelings and 53 units associated with negative feelings were identified. As themes emerged, those representing similar concepts were combined. For example, the following excerpts were initially categorized, respectively, as ‘Negative Feelings about Mathematics: Intimidated’ and ‘Negative Feelings about Mathematics: Scared.’
• “I am very intimidated by math and all of its procedures.”

• “I would describe myself as being scared [of mathematics].”

They were both later counted as two instances of ‘Negative Feelings about Mathematics: Scared, Nervous, Intimidated.’

The following themes, along with their respective percentages of all comments made for this prompt, were identified for Journal Three: positive feelings about mathematics (14.8%), experiences associated with positive feelings about mathematics (13.4%), positive experiences with teachers at specific grade levels (3.8%), experiences that improved attitudes toward mathematics (1.9%), negative feelings about mathematics (22.5%), mixed feelings about mathematics (1.9%), experiences associated with negative feelings about mathematics (23.0%), negative experiences at specific grade levels (7.2%), want to improve own attitudes toward mathematics (4.8%), want to develop positive attitudes toward mathematics in future students (1.9%), and beliefs expressed (4.8%).

Table 19 shows the identified themes that reflected positive feelings about mathematics. Table 20 shows the experiences that participants associated with positive feelings about mathematics.
Table 19

*Positive Feelings About Mathematics from Journal Three*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finds mathematics enjoyable, fun</td>
<td>10</td>
<td>“I really enjoy learning new things about math.”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I do enjoy mathematics most of the time.”</td>
</tr>
<tr>
<td>Finds mathematics useful, relevant</td>
<td>7</td>
<td>“I know that math is an integral part of our everyday lives.”</td>
</tr>
<tr>
<td>Feelings related to the methods course</td>
<td>5</td>
<td>“I like the approaches that we are learning in this class.”</td>
</tr>
<tr>
<td>Likes constancy of mathematics</td>
<td>4</td>
<td>“I have always liked math because it has a certain way to solve problems, and if you do it right, you will always get the right answer.”</td>
</tr>
<tr>
<td>Has learned how to approach math</td>
<td>4</td>
<td>“I feel positive about mathematics because I now know how to approach the subject.”</td>
</tr>
<tr>
<td>Feels confident about mathematics</td>
<td>1</td>
<td>“If I had to complete a [mathematics] problem I think I would feel confident to do it.”</td>
</tr>
</tbody>
</table>

*Total frequency of 31 came from 19 of the 33 participants. This represented 14.8% of all comments made for this prompt.*
Table 20

Experiences Associated with Positive Feelings About Mathematics from Journal Three

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive experiences with</td>
<td>8</td>
<td>“I enjoy or feel positive about mathematics because I have had good teachers to help me along the way.”</td>
</tr>
<tr>
<td>math teachers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Success with mathematics</td>
<td>5</td>
<td>“I enjoy and feel positive about mathematics because math has always been my best subject.”</td>
</tr>
<tr>
<td>Mathematics came easily</td>
<td>5</td>
<td>“I enjoy or feel positive about mathematics because it has always been so easy to me.”</td>
</tr>
<tr>
<td>Positive experience in elem. school</td>
<td>4</td>
<td>“At one point in time [elementary school], I truly enjoyed math and it made sense to me.”</td>
</tr>
<tr>
<td>Feels confident about math</td>
<td>3</td>
<td>“During the CLAST [test] I could not wait for the math sections for a stress relief and a confidence boost…. It all comes back to confidence.”</td>
</tr>
<tr>
<td>Positive experience in college</td>
<td>2</td>
<td>“I think I feel positive about mathematics because the first math class I took when I came to college I actually understood and passed.”</td>
</tr>
<tr>
<td>Enjoyed parental involvement</td>
<td>1</td>
<td>“… any time I didn’t understand a lesson, [my dad] was always able to give me the extra help I needed.”</td>
</tr>
</tbody>
</table>

*Total frequency of 28 came from 18 of the 33 participants. This represented 13.4% of all comments made for this prompt.*
While describing their positive feelings about mathematics, four participants remembered experiences that improved their attitudes toward mathematics. The following journal excerpts are representative of the five comments with which this theme was identified:

- “They [mathematics teachers] have made me enjoy math because they helped me build my confidence. They made math fun and exciting.”
- “The years that I made good grades in math have boosted my confidence especially in college.”

In addition to the experiences associated with positive feelings listed in Table 20, there were some references to positive experiences with teachers at specific levels of schooling. Table 21 lists the different grade levels and the frequency with which positive memories were cited.

Table 21

*Positive Experiences with Teachers at Specific Levels of Schooling*

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Frequency(^a)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>4</td>
</tr>
<tr>
<td>Middle School</td>
<td>0</td>
</tr>
<tr>
<td>High School</td>
<td>1</td>
</tr>
<tr>
<td>College</td>
<td>3</td>
</tr>
</tbody>
</table>

\(^a\)Total frequency of 8 came from 6 of the 33 participants. This represented 3.8% of all comments made for this prompt.
The following journal excerpts are examples of data responses at each level of schooling:

- **Positive experiences in elementary school.** “I feel positive about mathematics because I have had good teachers. I loved my elementary school teachers because they made learning math fun.”

- **Positive experiences in high school.** “I think the reason why I like math the way I do is from my algebra one teacher in high school. She made it fun and I could understand everything.”

- **Positive experiences in college.** “I had a wonderful teacher that made learning fun. He always made sure we knew what was happening and offered any help if we needed any.”

Table 22 shows the identified themes that reflected negative feelings about mathematics. Table 23 shows the experiences that participants associated with negative feelings about mathematics.
Table 22

**Negative Feelings About Mathematics from Journal Three**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative attitude</td>
<td>8</td>
<td>“I cringe at the word mathematics and feel negative about mathematics.”</td>
</tr>
<tr>
<td>Feels intimidated, nervous, fearful</td>
<td>8</td>
<td>“I began to fear [math] at an early age, and not much was done to ever change that.”</td>
</tr>
<tr>
<td>Does not enjoy mathematics</td>
<td>6</td>
<td>“I do not really enjoy math.”</td>
</tr>
<tr>
<td>Lacks confidence with math</td>
<td>5</td>
<td>“I feel negative about mathematics because I have very little confidence in myself.”</td>
</tr>
<tr>
<td>Not good at mathematics</td>
<td>4</td>
<td>“I’ve convinced myself that I am not good at math.”</td>
</tr>
<tr>
<td>Feels frustrated with math</td>
<td>4</td>
<td>“I feel negative about mathematics because when I get stuck on a problem or concept I get frustrated.”</td>
</tr>
<tr>
<td>Does not see need for advanced mathematics</td>
<td>3</td>
<td>“I am not in any job that I need more than the basics, such as adding, subtracting, multiplying, dividing, and fractions.”</td>
</tr>
<tr>
<td>Views math as unneeded</td>
<td>3</td>
<td>“I always thought why do I have to learn math. I won’t need it later in life.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 22 (Continued)

*Negative Feelings About Mathematics from Journal Three*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tries to avoid mathematics</td>
<td>3</td>
<td>“I do not do math unless I absolutely have to.”</td>
</tr>
<tr>
<td>Does not like nature of math</td>
<td>3</td>
<td>“I do not enjoy or appreciate that math is a growing or continuing process by adding new concepts to the old ones.”</td>
</tr>
</tbody>
</table>

*Total frequency of 47 came from 14 of the 33 participants. This represented 22.5% of all comments made for this prompt.

Four participants expressed mixed feelings about mathematics. The following excerpts are representative of these responses:

- “I have very mixed feelings when it comes to mathematics.”
- “I feel both positive and negative about math in different situations.”

In addition, two participants expressed neutral feelings about mathematics. The following excerpt is representative of these responses:

- “Up to this point, I have felt neither negative nor positive about mathematics.”
Table 23

Experiences Associated with Negative Feelings About Mathematics from Journal Three

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Struggled with mathematics</td>
<td>13</td>
<td>“I feel negative about mathematics because of the fact that throughout all of my schooling, math was the one and only class I really struggled at.”</td>
</tr>
<tr>
<td>Disliked ‘traditional’ teaching methods</td>
<td>8</td>
<td>“My past teachers never used manipulatives. It was strictly read the book and do the problems on the board.”</td>
</tr>
<tr>
<td>Bad teachers</td>
<td>8</td>
<td>“I have had some bad teachers that have made me not like math because I never learned anything from them.”</td>
</tr>
<tr>
<td>Felt stupid</td>
<td>4</td>
<td>“I struggled a lot and sometimes I felt like I was dumb or stupid.”</td>
</tr>
<tr>
<td>Negative experiences with tests</td>
<td>4</td>
<td>“When I studied really hard for the test and still did below average, I immediately began to doubt myself.”</td>
</tr>
<tr>
<td>Have always disliked math</td>
<td>2</td>
<td>“Growing up I really disliked math and anything to have to deal with it. My mind would shut off when given a math problem.”</td>
</tr>
<tr>
<td>Felt frustrated, traumatized</td>
<td>2</td>
<td>“When my parents would help me with my math homework I would cry … I would get so frustrated.”</td>
</tr>
</tbody>
</table>

Continued on the next page
<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nonspecific negative experiences</td>
<td>2</td>
<td>“I feel negative about mathematics because I have had some negative experiences that have turned me off of math.”</td>
</tr>
<tr>
<td>Did not enjoy</td>
<td>2</td>
<td>“Naturally because I struggled with [math], I did not enjoy it.”</td>
</tr>
<tr>
<td>Problem with pacing of courses</td>
<td>2</td>
<td>“As soon as I was caught up with what we were learning, the class had already moved on to a new topic.”</td>
</tr>
<tr>
<td>Brother’s success with math</td>
<td>1</td>
<td>“The fact that [math] always seemed to come very easy to my brother did not help me much either.”</td>
</tr>
</tbody>
</table>

<sup>a</sup>Total frequency of 48 came from 22 of the 33 participants. This represented 23.0% of all comments made for this prompt.

In addition to the experiences associated with negative feelings listed in Table 23, there were some references to negative experiences at specific levels of schooling. Table 24 lists the different grade levels and the frequency with which negative memories were cited.
Table 24

*Negative Experiences at Specific Levels of Schooling*

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Frequency$^a$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary School</td>
<td>2</td>
</tr>
<tr>
<td>Middle School</td>
<td>3</td>
</tr>
<tr>
<td>High School</td>
<td>7</td>
</tr>
<tr>
<td>College</td>
<td>3</td>
</tr>
</tbody>
</table>

$^a$Total frequency of 15 came from 11 of the 33 participants. This represented 7.2% of all comments made for this prompt.

The following journal excerpts are examples of data responses at each level of schooling:

- **Negative experiences in elementary school.** “I do not enjoy and feel slightly negative about mathematics. I know it stems partially from my experiences as an elementary student.”

- **Negative experiences in middle school.** “As I got into middle high, my math classes used less and less manipulatives and more lecturing became popular. Hands-on activities and working with groups rarely, if ever happened.”

- **Negative experiences in high school.** “I feel negative about mathematics because I made bad grades at the high school level.”

- “The only thing I feel negatively about as far as mathematics is that all through high school I was looked at as a nerd because I was good at mathematics.”
• Negative experiences in college. “When I entered [university] I was upset to learn I needed more math. I took the two easiest maths possible, failed them both. I had to retake my math classes for forgiveness.”

While describing their feelings about mathematics, seven participants said that they wanted to improve their negative attitudes toward mathematics. The following journal excerpts are representative of the ten comments with which this theme was identified:

• “I feel that I am open to new ideas and want to change my opinion about math.”

• “The new way of teaching sounds like it will be more inviting to the students and to myself… I think that my opinion of math will soon change.”

• “I am looking forward to making how I feel about math change for the better.”

• “If I am going to teach math I need to have a positive attitude about it. I believe now is the time to turn my attitude toward math around.”

In addition, four participants said that they wanted to encourage the development of positive attitudes toward mathematics in their future students by making mathematics fun and enjoyable for them. The following journal excerpt is representative of those responses with which this theme was identified:

• “I want to find a way to make math more fun for students like me whose favorite subject may not be math.”
While discussing their feelings about mathematics, 8 participants expressed 10 beliefs about mathematics, teaching mathematics, and learning mathematics. The following are representative of these beliefs:

- “Too much math and/or bad instruction can turn you away from enjoying it.”
- “Children are able to recognize when [teachers] are uncomfortable with a subject. I feel that when they do recognize this, it in turn makes them uncomfortable and that much harder to teach.”
- “Schools should focus more on practical mathematics, and then for those children who love math and want to learn more, they can take special electives to learn it.”

*Journal 4: Memorable Experience with Mathematics*

The fourth journal entry asked participants to describe in detail one experience from their past that was particularly memorable and influential in their attitudes about mathematics. The following themes, along with their respective percentages of all comments made for this prompt, were identified for Journal Four: positive memories (56.8%) and negative memories (43.2%). Table 25 shows the frequencies of experiences that reflected positive and negative memories and the grade levels at which these experiences occurred.

While describing a memorable experience that influenced their attitudes toward mathematics, eight participants recalled one special teacher or private tutor whose individual help and encouragement positively affected their attitudes toward mathematics. The following journal excerpts are representative of these experiences:
Table 25

*Memorable Experiences that Influenced Attitudes toward Mathematics*

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Positive Memory or Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>8</td>
</tr>
<tr>
<td>Middle school</td>
<td>4</td>
</tr>
<tr>
<td>High School</td>
<td>7</td>
</tr>
<tr>
<td>College</td>
<td>1</td>
</tr>
<tr>
<td>No specific grade level</td>
<td>1</td>
</tr>
<tr>
<td><strong>Negative Memory or Experience</strong></td>
<td></td>
</tr>
<tr>
<td>Elementary school</td>
<td>4</td>
</tr>
<tr>
<td>Middle school</td>
<td>5</td>
</tr>
<tr>
<td>High school</td>
<td>6</td>
</tr>
<tr>
<td>College</td>
<td>0</td>
</tr>
<tr>
<td>No specific grade level</td>
<td>1</td>
</tr>
</tbody>
</table>

<sup>a</sup>Total frequency of 37. Total frequency of 21 positive memories came from 21 of the 33 participants. This represented 56.8% of all comments made for this prompt. Total frequency of 16 negative memories came from 16 of the 33 participants. This represented 43.2% of all comments made for this prompt. Together these represented 100% of the comments for this prompt.

An experience I had in math was when I was in elementary school. I remember [teacher’s name] was the nicest teacher ever. I remember every time she told us to get out our math books I would feel embarrassed because I knew we were about to start something that I wasn't very good at. I knew [teacher’s name] could tell that math made me uncomfortable because I was so eager with all the other
subjects and I clammed up when it came to math. One day she took me aside and said, "[student’s name], I can tell you are uncomfortable with math time but I know that you are smart and I believe that you can really achieve a lot if you put your mind to it. I want to help you succeed, and I will do whatever it takes to help you get there." After [teacher’s name] said that, I knew that there was no reason for me to feel uncomfortable because I was smart and if she had that much faith in me I must really be something.

When I was in the seventh grade … I had a wonderful math teacher named [teacher’s name] She was teaching us … about addition and subtraction using negative numbers. This was a new concept for me. Before that concept, I understood all of mathematics without a problem. But, those pesky negative numbers kept throwing me off. So, one afternoon when I was particularly frustrated, [teacher’s name] pulled me out of class and handed me a laminated slip of paper. It was a number line that she said I could use when doing my homework as well as tests. I thought that was incredibly considerate of her, especially since she made it for me without my having to ask her for it. So, I used that number line for the rest of the year until I felt comfortable adding and subtracting negative numbers without it. It definitely built my trust in Math teachers.

My most memorable experience occurred during the summer of my 7th grade year. I had a decent year in prealgebra, but my mom insisted that I attend summer school with Mrs. S…. That summer I was introduced to the fun and
exciting side of math. I enjoyed every day in my math class. Everyday we received challenging logic problems to solve and great rewards whether we got the correct answer or just attempted it. Mrs. S. was the most influential math teacher I have ever had. She single handedly opened my eyes to math.

One experience that was memorable to me was when I was in high school trying to pass the [county test required for graduation]…. [The teacher] took time to help students individually so that they would understand the concepts. He gave me practice worksheets so I could get the concept better. He said motivational things to keep our head up like you can do it, just keep trying. He never said anything to keep us down. He knew that math wasn't my skill but he took time and devotion to help me so that I could graduate. Even though I hate math with a passion he made me understand how to do it and made me feel confident when I did the test…. I walked in on the test and felt good about every answer I did because of his teaching skills.

Four participants recalled experiences that they said changed their attitudes toward mathematics in a positive way. Three of these involved a special teacher or tutor. The following journal excerpts are representative of these experiences:

One of my past memories that was memorable and influential in having turned a negative attitude of math into a positive one was when I decided to go to a math tutor. I was in high school at the time and had a math teacher that would call on me knowing that I did not know the answer. I was making a "D" in her class and
she suggested I find a tutor. I did and she was GREAT!!! Not only did she help me with what I was currently doing but she would help get me started on the next day’s work so when the teacher asked questions I was the first one to put up my hand and was able to know what I was talking about. She told me several times that going to the tutor had definitely helped my grades improve. This made me feel great inside!

At the end of tenth grade, I had an extremely influential experience, which changed my attitudes about mathematics. During tenth grade, I had a math tutor that I went to once a week. Even though I had a tutor and worked extremely hard I was barely squeaking by with a C-. Needless to say, I thought my tenth grade geometry teacher was terrible. I honestly think she found pleasure out of torturing her students. As I was preparing for the final, my math tutor could tell my ego had been battered and bruised. Before I left her house, she told me, “[Name], you know this material and you will do well on the exam.” She also reminded me to take a deep breath before I start taking the exam and to skip over the problems that I do not know how to solve. Her confidence in me gave my math self esteem a much needed boost. The following day I took the exam and her advice. A couple of days later I received my exam results, which showed I made a B-. I was so elated, because I finally made a satisfactory grade in geometry.

Six participants recalled negative experiences involving individual teachers. The following journal excerpts are representative of these experiences:
I remember I was in 4th grade, and this really mean lady was my math teacher. She retired the next year, so I think that she was bitter and tired of teaching. I had always had a difficult time in math. One time she called on me during a lesson on fractions, and I had no idea what the answer was... so in front of the whole class she said that I was not listening and following directions, so I could not go to reward that week. I began to cry because I felt that the teacher just did not like me, and I was embarrassed because I was listening, but I just could not understand the concept she was trying to teach. That even affects me today because I think that since that class I have really disliked math.

An experience from my past that is particularly memorable and influential in my negative attitudes about mathematics would have to be a statement from my 7th grade teacher. That year I was a part of a class that combined math and science in a two-hour block. I can clearly remember my teacher explaining to us that he hated math and was not going to teach it because he liked science better. Although we touched on math before tests and final grades, we quickly brushed through it and I clearly remember not learning too much. I also remember the effort that our teacher did put into math was accompanied by yelling and frustration when we weren't getting it correct or we were producing poor scores.... I remember feeling confused about the importance of math. If an adult didn't like math and even professed to never use it, then it must not really matter.
The one memory I can think of that left an impression on me was kind of weird. I was in high school in an algebra 2 class. It was the worst math class ever. I wasn't understanding anything…. When [the teacher] went to start writing on the board, with his back towards the class, almost the entire class started to play cards and do other things. When he did turn around he did notice that the class was doing other things and he didn't even care. He let it continue on. Unfortunately for me, I can’t concentrate when there are other things going on. So for the rest of the year I got nowhere…. I suffered the rest of the year. I almost failed. Luckily I got a tutor and that helped me, somewhat!!!!

Three participants recalled experiences involving individual teachers that they said changed their attitudes toward mathematics in a negative way. The following journal excerpts are representative of these experiences:

In 11th grade I had what has to be the worst math teacher ever… I gave up in that class because she would not take time to help me with the problems I was having…. The teacher was an older woman and I think that part of the problem was that she could not truly control the class…. The teacher would write on the board the page numbers she wanted us to look over. She would then sit at her desk and grade papers. She would have us read and work on problems. She never went over the class work/homework that we did; she would just hand it back with red marks all over it. If you tried to ask her for help she would just do the sample problem on the board and think that everyone understood from that point on. She did not try and explain things in different ways, she did not take time to work with
anyone individually. She just was not a good math teacher. I got a “D” in that class, the worst grade I had ever gotten… I felt dumb and that I was not important enough for her to help me. From that moment on I disliked math.

In high school I took AP Calculus so I could get out of taking one math class in college. I absolutely hated that class because the teacher never did anything. We would always do homework for other classes. So a few months before the final exam, the teacher decided to start teaching so we knew a little bit for the final. I asked him a question about one of the skills and he told me I didn't have to understand why it was done the way it was, just memorize the steps. Things like that turn me off to math.

While describing a memorable experience that influenced their attitudes toward mathematics, four participants recalled situations in which they experienced feelings of success with mathematics. The following journal excerpts are representative of these experiences:

One experience that stands out for me was middle school geometry and algebra. There is not one particular event, but just the fact that finally there were two parts of math that I "got" and I felt confident about. I really loved solving equations, as they felt like puzzles to me. I am not sure why this particular math came easier to me than others, or if it was just that I loved my teacher [teacher’s name]. ( I had him for both subjects).…. I liked that the rules and applications connected in my brain and that things finally "clicked" for once in math…. I remember actually
thinking that I might like math, and perhaps could be "good" at it. Alas, then came trigonometry, which had me stumped again.

One math experience I had that gave me one of the best feelings in the world took place when I was a sophomore in high school taking geometry. When the semester first started, I was struggling a little bit and failed my first test…. My mom asked [geometry teacher from different high school] to tutor me…. I worked really hard and by the second test I made a B and by the next one, an A. From there on out, I made 100's and beyond. At the end of the semester, I had a 104% in the class. To me, it was a great feeling because I had worked so hard and it felt so good to know the material as well as I did and to complete the class with an A.

One memory that is particularly memorable to me is getting my first A in mathematics last semester in statistics. I studied really hard for this test…. I can clearly remember seeing the 95% at the top of the paper. I was screaming inside. This was the first time in my whole life that I received an A on a math test. I kept it in the whole time during class, and as soon as I got out I called my mom as soon as I could to tell her the news. She was so proud of me, and I was so proud of myself. It was a turning point in my math career. For the rest of the semester I continued to make A's on all of my tests. It was amazing.
Three participants recalled memorable experiences involving changing schools.

One of these was a positive experience and the other two were negative experiences.

The following journal excerpts reflect these experiences:

… I was in fourth grade. At the time I lived in New York…. I was upset because I was moving to Florida. This also happened to be my last day of long division, which meant a test…. I remember that I had to force myself to focus on the test and not the move…. It was two months before I was placed back into school. I remember how scared I was, not just because I was in a new school, but also because I did not know how behind I would be. I ended up being ahead…. I even tutored one of the girls. I know that you are wondering how this affected my attitude toward mathematics. At first, it made me really dread mathematics. However, I then felt confident after I learned that I was ahead. In addition, it was a great way to make friends. I felt pretty confident that day.

Probably my most memorable experience involving mathematics occurred when I was in the sixth grade…. I had missed the first term of sixth grade [family was caring for ill relative in another state]…. I had few problems merging back into my other subjects, but math was a different story…. I was not only seven or eight weeks behind, but I was completely in a fog about the new concept [prealgebra]. My teacher was a man, and I had always had women teachers before. I still remember how intimidated I felt when he called me up to the front of the class to stand beside his desk so that he could give me individual instruction while the rest of the class worked on the class assignment…. How did this influence my attitude
about math? Oddly enough, I don't think it affected my attitude toward math at all – once I had managed to grasp the concept, I had no trouble working the problems. I think it probably affected my attitude towards male teachers: I tended to see them in my following years of school as being impatient and intimidating.

Five participants recalled memorable experiences that involved the use of tricks, drill exercises, and games for learning basic facts. Four of the five recalled positive experiences, and the fifth memorable experience was negative. All of the positive experiences mentioned the positive recognition that the participant received for being successful with the drills and games. The following journal excerpts, beginning with the negative experience and followed by two excerpts that are representative of the positive experiences, reflect this theme of using tricks, drill exercises, and games for learning basic facts:

I would say my most memorable experience involving mathematics would have to be from third grade…. For some reason, I just could not grasp the concept of multiplication, and I failed quiz after quiz on the material. I think it was mainly because there was no logic to it, just memorization. What I hated most of all was that the tests were timed, which just gave way to more anxiety (i.e. more failure). As if class was not already horrible enough for me, my teacher decided to call my parents and tell them about the difficulty I was having…. The following afternoon after school, my dad was waiting for me with a load of blank worksheets he had made for me to practice multiplying. I sat there and practiced over, and over, and
over until it was nighttime. At the time (and for several weeks afterward) I resented and hated my dad for making me do that, but I must say, I never failed another test.

One experience that I can recall very well that had an early influence on my math life was in the first grade. When I was very young I really enjoyed math…. [We] usually played a game called "around the world." What would happen was each student would go up against the other in friendly competition and compete to solve a math problem first…. One day I went up against each student and won. I was only the second person in my class to do so. I got a certificate and lots of encouragement…. I did not always win. The teacher made the atmosphere fun and comfortable. I was so proud of myself. This early exposure really gave me confidence in math. Later on is when it all changed.

When thinking back about my past experiences with math, one of my favorite memories was when I learned my times tables in the fourth grade…. In my class we had this game that we played called the clock game and we would compete against other classes…. Due to the game we played I was very motivated to learn [times tables] quickly. I made sure to practice them as my homework along with what we did in class during math. This experience with multiplication facts, and the game that we played showed me that math could be fun, and I was capable of knowing my times tables if I just took the time to practice them and give them
attention. My teacher was very impressed with my knowledge, and I ended up being the best in class at the game. This made me happy and also proud of myself, considering that I did not like math very much.

The impact of a teacher’s recognition was also noted in another participant’s journal. She was recalling a memorable experience from middle school:

… One day Mr. M. [teacher from the previous year] came by and said hi to the class as school was letting out. The next day, Mrs. H. [current teacher] told me that Mr. M told her that I was the best student he'd ever had. That itself is a huge complement, but considering that he had taught for almost forty years, this was the nicest thing that has ever been said about me. I almost cried I was so touched…. Knowing that a teacher recognizes me as such is one of the best feelings in the world.

Four participants recalled negative experiences where they felt stupid or not very smart. The following journal excerpts are representative of these experiences:

I have a younger brother who has always been very good at math while I have always seemed to struggle…. One evening I was at home doing homework at the counter as usual and I asked my dad to take a look at my homework …. [As] he began trying to talk himself through it to understand the problem … my younger brother who was sitting next to me doing his homework as well, looked over and said "Oh that's easy, you just do this."… My dad said to me, "Wow maybe you
should just have your brother help you with your math homework from now on, you won't have to wait for me to get home." I felt so incredibly stupid that my YOUNGER brother not only knew more than me but could figure out something he wasn't even learning at the time. From then on I think I resigned in my head that I would never be good at math.

I remember sitting in my sixth grade math class going over some new math problems. The teacher was instructing in front of the classroom using the overhead. After doing several problems, she started calling on people randomly to give answers to some problems…. I had no clue as to what the answer was. I was still trying to understand the problem, and before I knew it, I was being asked to give answers. I just shrugged my shoulders and said I didn't know. It made me feel so stupid for the rest of the day. I felt like it was my fault and that I should know these things. Now that I look back on it, I really see that the teacher made a big mistake by just assuming that we would all grasp the concept after a few example problems.

Two participants recalled memorable experiences involving being placed into a more advanced class. One of these was a positive experience and the other was a negative experience. The following journal excerpts reflect these experiences:

I remember being tested for “gifted” the summer after 2nd grade. For some reason, I didn't focus well that day, and didn't do too well. After my teachers recommended I be retested the whole next school year, I was re-tested, and the
psychologist that gave the test said I should have already been in the “gifted program.” I think this, combined with the fact that my mom and her two sisters were math majors, and one of them used to be a math teacher, really made me want to excel in Math.

My most memorable math event was when I was in the [name of program] in middle school…. I really think this program changed my view on math [negatively]. I was always good in math and when I was in 5th grade I had to take a portion of the PSAT to prove that I knew enough about math to be one of the few to be in a special program offered at only 2 or 3 middle schools in the county. I took it and did very well. I opted to be in this program…. I understood bits and pieces of the class but my mind was in other places. We spent two hours everyday working on these items…. I had a personal issue with my teacher so that didn't help the situation either.

*Journal 8: Use of Reflective Journals in the Methods Course*

The eighth and final journal entry asked participants to discuss the use of reflective journals in the methods course. They were asked about the benefits, if any, as well as any drawbacks related to the journals. Initially, 97 distinct units of meaning associated with benefits of the journals and 8 units associated with drawbacks of the journals were identified. As themes emerged, those representing similar concepts were combined. For example, the following excerpts were initially categorized, respectively, as ‘Provides Means for Informal Communication’ and ‘Allows for Personal Dialogue.’
• “[The journals] let [the instructor] know what we were thinking without having to write a formal paper.”

• “[The journals] are a great way to dialogue more personally with someone, especially a professor.”

They were both later counted as two instances of ‘Good Means of Personal Communication.’ The following themes, along with their respective percentages of all comments made for this prompt, were identified for Journal Eight: benefits of journal writing (89.2%), drawbacks of journal writing (3.9%), comments about the methods course (2.5%), and beliefs expressed (4.4%). Table 26 shows the identified themes that reflected benefits of reflective journal writing in the methods course.

Although the overwhelming majority of identified units of meaning focused on benefits of the reflective journals, eight participants also mentioned drawbacks in addition to benefits. These drawbacks represented 3.9% of the comments made for this prompt. The following are representative of these comments:

• “On the other hand, there was one drawback to doing these journals. It was depressing having to relive my sophomore year in high school.”

• “Perhaps the only reason [the journals] have not been helpful is because they’ve prompted me to realize that I have been lacking very much in the area of good math teachers and role models my entire school career, which makes me feel quite uneasy about teaching math myself.”

• “The only drawback was that a few of the journal topics seemed a little repetitive.”
<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opportunity to reflect on future teaching</td>
<td>26</td>
<td>“The reflection in its entirety has gotten me to really think about how I am going to teach my own students.”</td>
</tr>
<tr>
<td>Opportunity to reflect on past experiences</td>
<td>26</td>
<td>“I think that [the journals], really help us, as students, to look back on our past math experience and see what we can learn from them.”</td>
</tr>
<tr>
<td>Reflection on attitude toward mathematics</td>
<td>20</td>
<td>“The reflective journals in this class have given me a lot of insight about my attitudes toward mathematics.”</td>
</tr>
<tr>
<td>Reflection on good and bad teaching</td>
<td>12</td>
<td>“The journals helped me to remember what I liked and what I didn’t like about the ways I was taught math.”</td>
</tr>
<tr>
<td>Reflection on specific plans as future teacher</td>
<td>9</td>
<td>“I learned not to be like my bad teacher, but I learned to be willing to help and reach out to children that need help.”</td>
</tr>
<tr>
<td>Liked, loved, enjoyed journals</td>
<td>9</td>
<td>“I absolutely loved the use of reflective journals for this class.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 26 (Continued)

**Benefits of Reflective Journal Writing in the Methods Course**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plans as future teacher regarding students’ math attitudes</td>
<td>9</td>
<td>“[The journals] helped me to see that as a teacher I would have to be sensitive to the fears [regarding mathematics] of my students.”</td>
</tr>
<tr>
<td>Journals were a great idea</td>
<td>8</td>
<td>“I thought the use of reflective journals was a great idea.”</td>
</tr>
<tr>
<td>Realized teachers’ impact on students’ attitudes</td>
<td>6</td>
<td>“From these reflections and my own experiences I can see that the teacher plays an extremely important role in shaping a student’s attitude toward math.”</td>
</tr>
<tr>
<td>Helpful, beneficial</td>
<td>5</td>
<td>“I think doing the reflective journals has been beneficial to me.”</td>
</tr>
<tr>
<td>Reflection on struggles with mathematics</td>
<td>5</td>
<td>“I was actually provoked to go back into my past and to figure out where it all went wrong with math.”</td>
</tr>
<tr>
<td>Reflection on future teaching methods</td>
<td>5</td>
<td>“After I reflected on [a previous teacher’s methods], I made a point to remember to do those same approaches and math tricks when I become a teacher.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 26 (Continued)

Benefits of Reflective Journal Writing in the Methods Course

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comments about researcher’s responses</td>
<td>4</td>
<td>“Your responses allowed me to know that I am not the only person out there with horror stories about math.”</td>
</tr>
<tr>
<td>Negative at first, but appreciated later</td>
<td>4</td>
<td>“These [journals] seemed tedious in the beginning. However, after I did the first two I realized the immense benefits of reflective dialogues.”</td>
</tr>
<tr>
<td>Reflection about mathematics</td>
<td>4</td>
<td>“[The journals] made me think about math in a different way.”</td>
</tr>
<tr>
<td>Reflection about making math class fun</td>
<td>4</td>
<td>“As I reflected on the best teacher I had, I remembered what he did to make math fun and I want to use those same strategies when I teach.”</td>
</tr>
<tr>
<td>Plan to use journals with future students</td>
<td>4</td>
<td>“I think that I will use something like this in my classroom so children can express their fears or their joys about math and it will just be between me and the student.”</td>
</tr>
<tr>
<td>Journals make you think</td>
<td>3</td>
<td>“[Journals] make you think about things that I would not have thought about.”</td>
</tr>
<tr>
<td>Reflection on methods course</td>
<td>3</td>
<td>“[Journal writing] allowed me to reflect on my learning in this class.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 26 (Continued)

**Benefits of Reflective Journal Writing in the Methods Course**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflections on specific teachers</td>
<td>3</td>
<td>“Math started to go downhill for me. That was until I got a math teacher who saw my potential and made me believe … I could do it.”</td>
</tr>
<tr>
<td>Good means of communication</td>
<td>3</td>
<td>“People can be more open through writing than speaking face to face at times.”</td>
</tr>
<tr>
<td>Reflection on importance of students’ understanding</td>
<td>2</td>
<td>“[The journals] showed me that I want to be a good teacher and make sure that [my students] have a good understanding of math.”</td>
</tr>
<tr>
<td>Benefits of reflection</td>
<td>2</td>
<td>“I learned so much more from the journals because they required reflection.”</td>
</tr>
<tr>
<td>Realized commonalities</td>
<td>2</td>
<td>“I also think that the reflective journals helped me to see that my concerns were not very different from other students in math.”</td>
</tr>
<tr>
<td>Liked e-mail format</td>
<td>1</td>
<td>“This e-mail form was very convenient for me.”</td>
</tr>
<tr>
<td>Wish journals were used by more teachers</td>
<td>1</td>
<td>“Overall I really enjoyed the weekly journals, and I wish more teachers would take the time to do them.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table 26 (Continued)

Benefits of Reflective Journal Writing in the Methods Course

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provided opportunity for</td>
<td>1</td>
<td>“It also brought up discussion. For example, when carpooling with [name] to our internship we would</td>
</tr>
<tr>
<td>sharing of reflection</td>
<td></td>
<td>talk about some of the stuff that were brought up in our journals.”</td>
</tr>
</tbody>
</table>

*aTotal frequency of 181 came from all of the 33 participants. This represented 89.2% of all comments made for this prompt.

• “The only drawback for me is that my memory is not as good as it used to be and I find it hard to recall things that happened when I was in school.”

While discussing the benefits and drawbacks of reflective journal writing, nine participants expressed beliefs about mathematics, teaching mathematics, and learning mathematics. The following are representative of these beliefs:

• “Moving children into a harder subject when they are not ready is damaging to their self-esteem.”

• “Many people have some negative views toward the subject [of mathematics].”

• “So many students don’t like math.”

In addition, five participants made comments regarding the methods course itself. The following are representative of these comments:

• “Your class has also taught me the vast amount of resources that are out there to help me accomplish my goals as a teacher. I never dreamed there were so many..."
things I could do to make math hands on and fun. I hope my students will benefit from my class as much as I have from yours.”

- “I also think that you make this class awesome. The manipulatives that you use are easy to understand. I use many strategies that we have learned to train my employees [at an afterschool program] and help them teach the children. I try to steer them away from traditional algorithms and to use base ten blocks, especially with the little ones. I really am taking so much knowledge away from the course. Thank You.”

- “I have learned so much in this course!!!”

**Journals 5, 6, and 7: Relevant Excerpts**

Although eight journals were assigned over the course of the semester, only journals 1, 2, 3, 4, and 8 related directly to the purpose of this study and were analyzed using methods that are described in chapter 3. The remaining three journal prompts did not relate directly to the purpose of this study, but they did relate to the purpose of the methods course. Therefore, participants responded to them as well, but these entries were not analyzed unless they contained information relevant to the study. The following journal excerpts contained data that was pertinent to the research questions of this study:

**Journal 5: Boosting Confidence of Students**

The fifth journal asked participants how they as future teachers will help boost the confidence of students who have low self-confidence regarding mathematics. Eleven participants responded with comments that related to their own experiences and feelings
of low self-confidence with mathematics. The following are representative of these comments:

- “I can definitely relate to the fact that many students have a low self-confidence when it comes to mathematics.”
- “I know what it is like to not have any confidence in your abilities, and not want to raise your hand because you’re afraid. I believe some teachers do not realize how they can so easily negatively affect their students.”
- “I think that a lot of children have low self-esteem when it comes to math. I was and still sometimes am one of those persons.”
- “I will also try to show my students that math can be done by everyone...not just boys or the smart kids. This was often relayed to me as a child and I know it can be very discouraging.”
- “I wish I had someone to build up my confidence when it came to math because I sure did need it during those times.”
- “I agree with the statement that children grow to have a low self-confidence when it comes to math because I am living proof of those children. I, like many children, grow to either not like mathematics as a whole or become intimidated by it entirely.”

*Journal 6: Qualities of Best Mathematics Teacher*

The sixth journal asked participants to reflect on the qualities of the best mathematics teacher they ever had and the effect this teacher had on them as learners of mathematics. Twenty-one participants responded with comments that were pertinent to
the research questions of this study. The following are representative of these comments:

- “She made me believe in myself.”
- “[Teacher’s name] had such a positive attitude about mathematics that she made me think learning math was exciting.”
- “Honestly, I have never really had a very good mathematics teacher. … This is also why I’m a little anxious about teaching math in my elementary classroom one day because I don’t feel like I had anyone who really modeled for me what a good math teacher is supposed to be.”
- “Math is still one of my least favorite subjects (science is my least favorite!) but she was the first math teacher I had that made me feel like I could handle it all…. She did give me a slightly more positive attitude towards math.”
- “My better mathematics teachers had a good attitude about the subject. They never implied that math was one of the harder subjects and never dreaded teaching it.”
- “She really kept a positive and upbeat attitude, which was visible in all that she did…. She made it possible for me to see math as something exciting and fun.”
- “She would answer any question we had without making us feel stupid.”
- “I had a difficult time with math and I hated it. I had a hard time understanding why math relates to real life. It took me years to realize that we do use math everyday.”

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The seventh journal asked participants to reflect on the qualities of the worst mathematics teacher they ever had and the effect this teacher had on them as learners of mathematics. Seventeen participants responded with comments or experiences that were pertinent to the research questions of this study. The following are representative of these comments and experiences:

- I believe the worst qualities a math teacher can possess are impatience, discouragement, lack of enthusiasm, and inflexibility. Unfortunately, I have had a math teacher who has possessed all these qualities—[teacher’s name]. She is the reason why I have such a strong distaste for math.

- The worst teacher[s] I ever had [were] throughout my elementary school years. I say this because they did not give me the help I needed. They did not show me that they cared and wanted me to do the work on my own. The effect they had on me is the way I feel about math now, that I dislike it…. They made me feel like I was worthless and that they felt they did not have to teach me the material.

- The worst math teacher I ever had was 10th grade geometry with [teacher’s name]. He was a bad teacher because his overall personality was hard to approach. If I didn't understand something, I was scared to ask him…. After Geometry, I was not too excited about Math. I took an easier math course in high school the next year.

- The qualities of my worst math teacher was that she never listened to our worries, and she would never explain things more then once, which hurt a lot of people because it made us feel STUPID!!! Ever since this teacher I disliked
mathematics…. Since this teacher I am scared to ask a question because when we would ask her a question she would embarrass us in front of the whole class making us feel that we were the stupidest person in the world.

- My 11th grade math teacher was the worst. She just would not take the time to work with us to help us understand the problems. She did not use different methods of teaching, it was always the same thing…. I think that our class just gave up. I know most of the students did just as poorly as I did in her class. We stopped asking her questions because she never explained them to us anyways…. This teacher affected me greatly. I did not want to ever have to take another math course again, I hated math.

- She would start everyday with a lecture about some new math strategy and show us examples on the overhead. During the examples, she would call on students to help her out. There was no time for us to process the new information and practice it for ourselves. It was just expected that all of us [would] immediately know what we had just learned. I got called on a few times, [and] when I didn't know the answer, she made me, and others, feel horrible and dumb for not knowing the answer. This obviously had a very negative effect on me and ended up making me feel incompetent…. Overall, the effect was damaging to my self-esteem about mathematics.

While responding to journals 5, 6, and 7, some participants expressed beliefs about mathematics that were pertinent to the research questions of this study. The following are representative of these beliefs:

- “[Math] is a difficult subject to get students excited about.”
• “I think a lot of the time the students come into [math] with a bias against the whole subject.”
• “When a person believes they can do something they have a much more positive outlook on things and will do better overall.”
• “Attitude is key when it comes to learning. You have to keep an open mind and venture from what you are comfortable with.”
• “Teachers that make math difficult and uninteresting make kids hate math.”
• “If you dislike a subject, I really feel that you do not do as well as if you really liked that subject.”

Question 5: Participants with the Most Extreme Attitudes

Question 5 asked:

What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most extreme (either positive or negative) attitudes?

The two preservice teachers with the lowest initial scores on the ATMI and the two with the highest scores were asked to participate in an individual interview where their attitudes toward and experiences with mathematics were further explored. These Experiences with Mathematics Interviews took place between week six and week eight of the semester.

‘Mary’

Mary’s score on the ATMI was 63 out of a possible 200 points. She was one of two participants to score 63, the lowest in the class, indicating the most negative attitude
toward mathematics. This represented an average per item score of 1.58, with 1 representing the most negative attitude and 5 the most positive. Her average scores on the four attitude components were: Value, 2.5; Enjoyment, 1.1; Self-Confidence, 1.4; and Motivation, 1.2.

Mary remembered elementary school mathematics as “pretty tough.” She had a difficult time understanding concepts, especially subtraction. The algorithm confused her, so she would “end up counting on [her] fingers.” When asked if she remembered anything else from elementary school mathematics that might have affected her attitudes toward mathematics, Mary replied:

Just the pressures of trying to understand it and not doing so well. Then going home and bringing C’s, which [parents] didn’t too much like, which brought on more pressure. It was stressful. I remember crying because I could not understand what was going on.

Middle school brought more problems with understanding concepts such as long division. An after-school tutor helped somewhat, but she still had trouble understanding the concepts:

I just could not understand math…. Bringing a ‘C’ home is not good for math, but I was just happy if I could get a ‘C,’ I was happy. I was happy about that. That’s all I got in math was just C’s. If I got a ‘B’ I would throw myself a party!

High school was even harder for Mary. She was in her senior year and needed to pass a standardized test in order to graduate. She had failed the test the year before and was placed in a test-preparation class. The teacher for this course was very helpful to
Mary. He taught her strategies to use on the test and made himself available to her when she needed help:

When I got to the actual test, I felt comfortable and confident because I remembered the different things that he taught us, and I passed it the first semester. But it was hard because you couldn’t use a calculator and just grasping all those things, it was hard. But he took time, even after school he would say, “Come to the library and I’ll help you with these certain problems.”

Mary attended a community college before coming to the university. She passed College Algebra with a ‘C.’ She attended a tutor lab for individual help with that course. She took Statistics three times and Liberal Arts Math twice before she passed those courses. When asked if this had affected her attitude toward mathematics, Mary responded:

Yes, they were already negative, but then they got more [negative], especially when I took statistics. The first time, I just did not understand why did I have to take it. Then they told me I could take Calculus, and I said that was a NO!! I thought I’ll take the simpler one, still horrible, but simpler. The second time with Statistics, the teacher’s tests were all different from what he taught. The third time, the teacher I had was pretty good. He did step-by-step more [which helped] understanding. Then when I got to liberal arts, it was like a mixture of statistics also, but yet it still got confusing in the middle. I went to the math lab and everything, but people can only help you so much because they have different people [working], so you just have to get it on your own and just read. And I’ve read the book thousands of times and couldn’t understand it.

Prior to the start of the methods course, Mary was nervous about the course:
At first I thought, “Oh Lord, how am I going to understand the different strategies to use. I was scared. With all these strategies I’m learning, would I be able to use it when I go into actual [classroom]? If I can’t understand, how am I going to be able to teach?

Mary said that her feelings had changed since the start of the methods course:

Yes, it’s changed because I’m learning different strategies and ways to use it. I never knew that with the subtraction problems, there were different interpretations and stuff like that. Now I get an understanding of how I could break it down for students so they could have a better understanding of it.

When asked what a teacher could do to help students develop a good attitude toward mathematics, Mary said:

I would say more one-on-one time…to see those students who are having the most trouble and … help those students who are not grasping that certain material…. They would have a better understanding of it instead of having them lost like me.

When asked what Mary would like to add concerning her attitudes toward mathematics, she responded:

I’m just glad I don’t have to take any more math…. Math to me is like, “What’s the use of it?” and “Why do I need it?” But now I have to go to the elementary level and teach it to them. That’s one of my biggest fears is the math part, teaching them because I know that I had a very bad understanding [of math] and I don’t want to go in the classroom and have them looking lost like I was.
At the end of the methods course, Mary showed a survey change score of 14 points, indicating a positive attitude change. Her scores increased in all four components: Value increased by 5 points, Enjoyment by 4 points, Self-Confidence by 3 points, and Motivation by 2 points.

‘Lisa’

Lisa’s score on the ATMI was also 63 out of a possible 200 points. She was one of two participants to score 63, the lowest in the class, indicating the most negative attitude toward mathematics. This represented an average per item score of 1.58, with 1 representing the most negative attitude and 5 the most positive. Her average scores on the four attitude components were: Value, 2.9; Enjoyment, 1.3; Self-Confidence, 1.0; and Motivation, 1.2.

Lisa said that she had clear memories of doing well in elementary school reading, and she remembered learning social studies and science. However, she was concerned that she had no memories of elementary school math other than not scoring well on standardized tests:

I don’t remember math. That’s what scares me. The only thing I do remember are the [standardized] tests that we got back and those score sheets that say Low, Average, High. My math was always in the Low column and my reading and everything else was in Average and High.

Lisa’s memories of middle school mathematics focused on a teacher who taught both science and mathematics in a 2-hour block. He repeatedly told the students that he
disliked mathematics and would spend most of the time on science. When they did do mathematics, the teacher would get angry when the students made mistakes:

When we did have [math] tests or we did have assignments, he was so angry when our stuff came out wrong. That’s what I really remember about middle school, just “I don’t like math. I don’t like math.” Hearing teachers saying that. “I don’t like math. I hate math.”

When asked about her attitudes toward mathematics at that time, Lisa said:

I thought it was OK not to like it. If there are teachers who don’t like it, why should I like it? … It just always felt like we were pressed for time in middle school, like we were rushing through the material. Even in 8th grade, it was a better teacher, a lot better, but we just always seemed rushed.

Lisa made good grades in high school math, although she did not believe they were deserved. In ninth grade her Algebra I teacher was “a lot of fun and a nice guy.” However, Lisa remembered that he got off the subject a lot. When they did talk about mathematics, she once again experienced “that rushed feeling:”

I got an ‘A’ in that class, and I don’t think I deserved it. I wasn’t getting the material enough to get an ‘A’. But he was one of those who gave an ‘A’ for effort, gave the whole class an ‘A’, but I didn’t know it well enough to get an ‘A’.

In tenth grade Geometry class, Lisa’s teacher was a permanent substitute teacher who was “a joke.” He gave the class assignments and then sat with his feet up on the desk:

We’d kind of work it out together amongst ourselves. Some students were smarter in it than others, but we didn’t know how to teach each other. So there was a lot of copying. So I got through that class with an ‘A’… didn’t know it at all. It was all
Lisa’s eleventh-grade Algebra II teacher recognized that even though she had good grades from the previous two years, she did not know any basic concepts. This teacher was very helpful to Lisa:

She even said to me, “I don’t understand why you got the high marks that you did if you don’t know these basic concepts.” [She said it] in a very nice way. She spent a lot of time and effort with the class as a whole. She opened her door during lunch periods and mornings and tutoring outside of school. She was amazing. Unfortunately we didn’t have enough time to get through as much time as we wanted to, but she helped with a lot of the basics that I do have now. So that was a good year.

Lisa enrolled in Precalculus her senior year, even though she had already completed the required mathematics credits. However, she was struggling and ended up withdrawing from the course:

The teacher made sure we knew [that the course was not required] right off the bat. She said, “You don’t have to be here if you don’t want to.” And with that being said, I didn’t take the fourth math and I left. I tried. I was there for the first couple of weeks and I was struggling. She was rushing through, saying, “If you don’t know this, you don’t need to be here” type thing. So I left because I didn’t know it.

Lisa said that mathematics in college “wasn’t too fun.” She had to retake her courses and was still trying to complete her mathematics requirements:

I put it off; I put math off. I started with the Finite Math and Liberal Arts Math. I
had never even heard of that. I didn’t know what that was. But it actually worked out better for me because it’s more wording and more stuff I can memorize. I memorize math. It isn’t the best thing to do, I know that now, but that’s a lot of my strategy…. That’s how I approach math. I was never taught another way to do it…. right now I’m struggling with my third math to graduate…. I’ve got two more chances. I’ve got the spring and the summer. Again I saved it for the last…. Two times for taking College Algebra, taking it and then dropping it halfway through. I’m not going to try a third time.

When asked about her feelings prior to the methods course, Lisa said that she put off taking the mathematics methods courses until her last few semesters. She said that she avoids mathematics classes until she “absolutely has to take them.” When asked if her feelings about the methods course had changed since the start of the course, Lisa said:

About the class, yes. About my ability with math, probably not….I’m actually learning things that I didn’t know, and that’s exciting. But it’s kind of scary, too, being 22 years old and learning basic addition and subtraction strategies that I never heard before…. It wasn’t as scary as I thought it was going to be. We’re learning more strategies versus like you’re giving us math problems to do. But even with the “brain teasers” that we’ve had, and I couldn’t do them right off the bat, that still makes me nervous. I feel like I’m supposed to know it and I’m supposed to get it quickly, especially with my kids looking at me for the answer.

When asked what teachers can do to help students develop a good attitude toward mathematics, Lisa said:

Definitely to say that they like [math], to acknowledge that it is difficult for some
people and people think in different ways, but it doesn’t have to be as scary. It’s not bad. Math is not bad. I think the best thing would be to relate it to real life. That way they understand; I’m doing math all the time and it doesn’t have to be scary.

Lisa expressed concern about her struggles with mathematics and about how those struggles would affect her ability to teach mathematics:

I just hope it gets better. That’s what I’m looking forward to. I really want it to get better. I just am really nervous about not knowing enough for my kids [future students]… I just hope it’s not too late. That’s my biggest concern. I’m just concerned. I don’t know how many other people are in my same position. It seems like everyone I talk to says, “Oh, you’re just not a math person,” and if you hear something enough, you are going to believe it.

When asked who had said that to her, Lisa replied:

It was in college. My professor that I just got out of the class [said it]. He said, “You’re not a math person.” He just confirmed it. It’s been something I’ve [always believed]. I remember thinking [since middle school] that no one around me was a math person. I would bring my math book home, and my parents couldn’t touch it. They didn’t know about it. And if the teachers didn’t like teaching it, they must not be math people.

At the end of the methods course, Lisa showed a survey change score of 23 points, indicating a positive attitude change. Her scores increased in all four components: Value increased by 3 points, Enjoyment by 4 points, Self-Confidence by 14 points, and Motivation by 2 points.
‘Hermione’

Hermione’s score on the ATMI was 185 out of a possible 200 points. Her score was the highest in the class, indicating the most positive attitude toward mathematics. This represented an average per item score of 4.63, with 1 representing the most negative attitude and 5 the most positive. Her average scores on the four attitude components were: Value, 4.7; Enjoyment, 4.2; Self-Confidence, 4.9; and Motivation, 4.6.

Hermione remembered elementary school mathematics as “just easy.” She made good grades, but “it didn’t really mean anything” to her because she found most of the mathematics to be so easy. She did remember learning long division and how it helped her better understand the concept of multiplication:

I distinctly remember long division. I remember thinking, ‘Oh times; that’s what times means! Why didn’t they tell me that before?’

Then on the way home from school that day, she remembered helping others:

I remember the day I learned long division. I taught people on my bus and I said, ‘See, this is easy.’

Hermione attended a junior high school rather than a middle school. She remembered doing well in 7th grade Prealgebra honors class:

Our teacher would give back our tests, and she would call your name and you’d get your test. She’d call my name, and she’d say, ‘Perfect score.’ Seventh grade was great.

The next year Hermione was enrolled in an Algebra I honors class. She really thought her teacher was great even though her grade in this course was not as good as in previous years:
I had the best teacher. I didn’t get an ‘A,’ I got like a ‘C.’ But I knew a lot… Then the next year I had [teacher’s name] for Geometry. [Algebra I teacher] had come into the class, and I said ‘hi,’ and then he went away. The next day [Geometry teacher] told me that [previous teacher] said that I was the best student he’d ever had. I was like, ‘Oh my gosh!!’ That’s something that’s really important to me. I want to be a good student.

When asked how she felt about receiving lower grades in mathematics that year, Hermione said that she still felt confident about her mathematics knowledge and abilities:

I did get A’s in elementary math. But when I got C’s in middle school math, I knew more and it felt like I KNEW I was good at math.

In 9th grade, Hermione took a Geometry course at her junior high school. She did well, and this reinforced her feelings of self-confidence with mathematics:

I did really, really good in Geometry…. In Geometry, I got over 100, and I was so happy. I [thought], ‘See, I am good in math,’ and I was all happy.

In high school, Hermione took Algebra II, Precalculus, and the AP [Advanced Placement] Calculus course:

Then I went to Algebra II, and that was tough. I don’t know why. Now it’s so obvious; the unit circle is so obvious. I don’t know what my problem was. I had a really great teacher. [Teacher’s name] was awesome, a great teacher. I also had him for Pace Setter Precalculus. It’s just below AP. You have the test at the end, but you don’t get college credit. I was the only person who passed the test in the Pace Setter class. The Pace Setter class is really, really great. It’s [coursework is done] all in groups and that was another ‘A’ that I got in math. We had this
project … When everyone brought in their project on the day it was due, the class would all vote [for the best project]. Whoever got the highest [number of votes] would get 100 [points], as though they took another test and got 100 on it. Mine won … Then I took AP Calculus. AP Calculus was different. I really liked calculus. Calculus made sense … I didn’t get an ‘A;’ I got a ‘C.’

Hermione retook Calculus I in college. Again she received a ‘C,’ but she felt that this time she really understood the mathematics. She did not feel as confident with Calculus II: I still got a ‘C,’ but now I knew everything, but I still screwed up on the test. Then I took Calc. II and I don’t know how I passed it. I must have gotten 100 on the final, because I had an ‘F’ before the final. Then I took Calc. III and I dropped it because I wanted to get straight A’s, and I did and then I was happy. The thing about calculus is that I think it is really doable. It’s something we could teach [students]. Once they get the concepts, I think everybody is capable of calculus.

Hermione then remembered that she had taken another college mathematics class, Finite Mathematics, which she found extremely easy: I took this class that was so easy, so easy it hurt my brain. Finite Math was just like, remember all that stuff that seemed hard in high school, but you knew it wasn’t hard? Well, here you go…. I was so frustrated, and I went to class everyday because [teacher] took roll, and [I would think], “Why am I here?” It was way too easy. It was so weird because people didn’t know what pi was, like they thought it was rational…. So I took the final, and I went over every problem because if I missed one single problem, I would be so mad at myself. There were
some bonus problems, and I got the highest you could get.

Prior to the start of the methods course, Hermione felt “kind of excited.” When asked if she felt any stress about the course, she said:

No, no…. A lot of people are afraid that they don’t know enough, and I’m afraid they don’t know enough. If I don’t know something, I’m willing to learn it. I’m not afraid. I don’t know how a teacher can be a teacher and be afraid of learning something. It’s counter-intuitive.

When asked what teachers can do to help their students develop good attitudes toward mathematics, Hermione said:

Look at math as a tool, not a chore. So many people hate math. What’s to hate about it? It’s just numbers and operations and things to help you when you need to find the answer to a problem. I don’t know where it starts, but somewhere along the way with people who hate math, they have a bad teacher. You [as a teacher] have to be enthusiastic about what you are doing. You have to want to learn. If you learn in front of the kids and you’re saying, ‘Yeah, we are learning! This is helpful. I can solve things.’ You’re modeling the behavior…. I think math is not the gargantuan task people make it out to be.

At the end of the methods course, Hermione showed a survey change score of –6 points, indicating a negative attitude change. Her scores were still extremely high, the fourth highest in the class However, they did decrease in all four components: Value decreased by 1 point, Enjoyment by 1 point, Self-Confidence by 3 points, and Motivation by 1 point.
Torri’s score on the ATMI was 182 out of a possible 200 points. Her score was the second highest in the class, indicating the second-most positive attitude toward mathematics. This represented an average per item score of 4.55, with 1 representing the most negative attitude and 5 the most positive. Her average scores on the four attitude components were: Value, 4.9; Enjoyment, 4.3; Self-Confidence, 4.6; and Motivation, 4.2.

Torri’s father was in the military, so she moved and changed schools several times. She was in Germany for grades two through four. She noticed a difference in the way mathematics was taught overseas:

I did notice that when I was overseas, we used more manipulatives in class, more hands-on and different techniques to do math. When I came back to the states, it was all ones-place, tens-place, you have to do it that way [focus on algorithm]…. It was a lot more fun until I got [back] over here. …[In Germany, they used] group work, more hands-on stuff, and when I got back here, it was more worksheets, out of the book, things like that.

In 7th grade, Torri’s mathematics teacher suggested to her mother that Torri attend a summer mathematics program that the teacher was conducting for students who needed extra help. Although Torri was doing “pretty well” in pre-algebra, her mother and teacher both thought that she could benefit from the program. At first Torri was not happy about attending this program, but it turned out to be a great experience:

I wasn’t happy at all having to go to summer school for math. When we got there, it wasn’t like regular school. Everything was a different kind of activity. She gave us [activities] like riddles…. It wasn’t all like ‘OK, this is a math problem,
this is how you do it. This is the answer.’ It was, ‘now YOU come up with a way
to do it. Now YOU come up with a way.’ It was always something fun.

By high school Torri had moved again. She took Geometry in 9th grade, Algebra II in 10th
grade, Trigonometry and Analytic Geometry in 11th grade, and Mathematics Analysis in
12th grade. She had trouble with Geometry:

Geometry was not good for me at all… [The teacher] went real fast. I was
[thinking], ‘Uhhhh!! I don’t understand! I’m failing!’ I was really failing. And it
shocked me because up until 8th grade I was doing so good in middle school. Up
until then I was doing really good, and then to get to Geometry and be like, ‘OK, I
don’t understand this.’ And then I went to summer school at another school after
that and she [teacher] kind of touched on Geometry a little bit more then, and then
she helped me understand.

In college, Torri took Finite Mathematics, Statistics, and Precalculus. She sometimes had
trouble understanding the concepts and would get frustrated when the professor would
not adequately explain the mathematics. When that happened, Torri knew that she would
have to figure it out herself:

She [Precalculus Professor] didn’t really explain how to do the work. If the
problem was in the book, she’d rewrite the problem. I’m [thinking], ‘No!! Explain
why that does that!’ I kind of had to teach myself. By that point I was used to
teaching myself. After 9th grade, I kind of got to a point where I thought, ‘If I
don’t understand and my teacher won’t explain it, then I have to figure it out for
myself.’ I got a ‘B’ out of [Precalculus]. That was good.

Torri felt “kind of excited” prior to the start of the methods course. She was looking
forward to taking methods courses that would focus on how to teach different subjects. When asked if she felt any stress prior to the beginning of the course, she replied, “No, not at all.” Torri reflected on her elementary school experiences in Germany as she shared her ideas about helping students develop good attitudes toward mathematics:

[I would] not scare them. Not just be like, ‘OK, this is math. This is how you do it. There is no other way.’ And if you get a wrong answer, not just [say], ‘OK, that was wrong. You’re wrong. This is the right way.’ There are other ways you can get the answer. But that was one reason why I like math because I kind of like being right. So when I got the right answer, I was like, ‘Aha! I got the right answer!’ When I came back here [to the U.S.] there was more emphasis on getting the right answer, like, ‘You did a good job because you got the right answer,’ while in Germany it was more like, ‘Well, you didn’t quite get it, but I see how you tried to do it,’ rather than ‘No, it’s wrong; You’re wrong.’

When asked if there was anything else she would like to share concerning her attitudes toward mathematics, Torri said:

I think I do [have a good attitude toward math]. I just hope that when I start teaching, that I can convey that to my students, a good attitude. That’s the only thing I’m really scared about.

At the end of the methods course, Torri showed a survey change score of 18 points, indicating a positive attitude change. Her scores increased in all four components: Value increased by 1 point, Enjoyment by 7 points, Self-Confidence by 6 points, and Motivation by 4 points.
Reflections from the Researcher’s Journal

The researcher kept a reflective journal (Appendix O: Relevant Excerpts) during the methods course. This journal provided a detailed account of what took place during each class, as well as the researcher’s impressions of each class. The intended purpose of this journal was to provide additional information when analyzing interviewees’ references to class activities. In an effort to provide reliability of this account, an additional observer also took field notes during two of the classes. The researcher’s journal and the observer’s notes added some perspective to these results.

During her interview, Shelly made some comments that indicated that she did not like solving “word problems.” With this comment in mind, the researcher’s journal was examined for relevant information. This search showed that nearly every methods course class included problem-solving activities. However, Shelly referred specifically to “word problems.” This type of problem solving was used during four of the classes. Two of these activities involved the researcher presenting the participants with several word problems and asking them to share their solution strategies with each other. The other two lessons involved recognizing and writing word problems demonstrating different interpretations of the basic operations of addition, subtraction, multiplication, and division.

Shelly also said that she did not think cooperative learning activities should be used all the time because sometimes students like to figure out problems by themselves. The researcher’s journal revealed that cooperative learning was always encouraged, but was usually not required. During several classes, games and interactive activities were used, so participants were required to work cooperatively for these. However, most of the
cooperative learning in the classroom was optional. The observer’s notes reinforced this when she wrote, “some working together, but most working alone,” and “some working alone, some in groups.”

The researcher’s journal and the observer’s notes reinforced Yezania’s comments about her distraction and lack of focus in class. She said that she and her friends sometimes “did too much talking instead of doing the work.” The researcher had noted that the group of four, Yezania and her three friends, were sometimes inattentive. The first mention of this came in the researcher’s journal from week four:

We did number relationships for 10-20 and then I told them that we were going to play the counting game. I think that most of them enjoyed playing that game.

There was a group of four sitting in the back next to [name] that was not really very engaged in the game. It looked like a couple were sort of playing it, but they were also talking about other things. When I came over, the one student sitting closest to the front was not playing at all. When I asked, she said that she was watching the others. I asked if she did not have her blocks with her, and she said that she did, so she took them out.

Another entry concerning this group of participants came in week 11:

I decided to start with a couple of activities while we were waiting for latecomers. The first was Benny’s Cakes [an activity involving fractions]. They worked on them for about 5-10 minutes while I circulated around the room. The group of students who sit [description of where they always sat] was not really engaged--as usual.
The observer made comments in her notes about this group of participants on both of her visits. Because the observer moved to a different part of the room every 45 minutes, she was able to sit near this group for part of each visit. On the first visit, she sat next to Yezania and her friends and wrote, “student trying to look busy but not doing anything.” It is unclear to which student she was referring, but it was either Yezania or one of her friends. On her second visit, the observer again sat next to Yezania and her friends. She noted that students were instructed to model decimals by shading a decimal grid. She observed, “[There were] three students next to me, two did not try it, one did.” It is interesting to note that Yezania was the only one of the friends to have a negative attitude change score.

The researcher’s journal also provided insight in an unexpected manner. Throughout the journals and interviews, many participants related positive experiences and attitudes to teachers who showed care and concern for them. With this in mind, and in light of the large improvement in attitudes toward mathematics that the journal-writing class demonstrated, the researcher examined her journal for instances where she had noted thoughts or actions that reflected her care and concern for participants and their affect. The following excerpts are representative of these. Please note that the data written in brackets reflect the researcher’s personal reactions and thoughts at the time. The first excerpt was written on the first day of classes. Perhaps the researcher’s memories of students in previous classes writing in their journals about how nervous and uncomfortable they felt on the first day prompted these actions and thoughts:

When I first got there, the class was very quiet, not really talking to each other very much. I came in and started talking to those in front very casually about the
heavy traffic on first week of classes, parking situation, etc. [trying to establish rapport and put students at ease]

The next excerpt was from the researcher’s entry for the second class. The researcher had received a couple of journals where students said that they were feeling overwhelmed with the amount of information in the first five chapters:

When I brought this up, approximately 10 students agreed and said that they were feeling the same way. This was a good opportunity for me to point out where in the note packet the review questions were. We spent a few minutes talking about the idea that I wanted them to read all five chapters to get an overview of the philosophy of the course, but that as far as tests were concerned, they would be responsible primarily for things on the review sheet. [I thought that students seemed relieved by that. I remember thinking that this type of communication is another benefit of journals. Something like that might have never come up, but because they were writing that first journal about their concerns about the course, it did come up. This allowed me to address this issue with the whole class and probably alleviate the concerns of several students.]

The following excerpt was from the day of the methods course’s first test. The researcher was sitting in her office before class, and one of the participants came in. She seemed very stressed, and she said that she was nervous about the test, especially since we would be covering new material first. Perhaps as the researcher tried to alleviate the participant’s concerns, the researcher was recalling journals from previous students who talked about the anxiety associated with testing:

I explained that we would do about an hour of new material and then we would
take a long break. During the break, they would have time to ask questions, get refocused, and she seemed to be relieved about that. After she left, I decided that I better go to the classroom early because I figured there would probably be several who were stressed. When I got to the class, I could immediately tell that I was correct. One of them even said, “Can you feel the stress in the air?” and I could. I tried to reassure them. I asked them what they were nervous about. Several of them seemed to be saying the same thing, which was that they had never taken one of my tests before. They were concerned about the format. They pointed out that in the review notes, there were many pages that had five parts to this and six steps to that, and they were afraid that I would ask them to recall all of them. [I remember thinking that this was a valid concern and that as a student I would have felt the same way.] Because I felt that so many of them were feeling this way, and I wanted them to not be focused on that while we were covering new material, I actually got out a copy of the test. I told them that I would not tell them the actual questions, but I went through the short answer section and gave a general idea … name 2 or 3 of 7 steps, etc. They seemed relieved that they wouldn’t have to name all of them. They also seemed concerned that they would have to write long essays and I assured them that they wouldn’t. They did seem very relieved at that point, so I decided to go ahead and start the new material at about 9:15.

The researcher’s journal was intended to provide additional information
when analyzing interviewees’ references to class activities. As it turned out, the journal provided a great deal more. It provided the researcher with valuable insights into her own teaching and interactions with her students. The researcher, as well as the participants, realized the benefits of reflection as a result of this study. As one participant said in a journal, “I see the benefits of reflection and I am thankful for it. Sometimes you forget how much you can learn from yourself and your experiences, but reflection helps you to see the whole picture.”
CHAPTER FIVE

OVERVIEW, CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

This chapter contains four sections. The first section presents an overview of the study. The second section summarizes the research findings of this study and examines the conclusions derived from these findings. This section is organized according to research question. The third section discusses implications and recommendations for practice. The fourth section focuses on implications and recommendations for future research.

Overview of Study

The importance of developing self-confident, motivated students who value and enjoy mathematics has been well established (McLeod, 1992; NCTM, 1989, 2000; NRC, 1989), but the means for doing so are not as clear. Although results are not always consistent, studies have shown that children typically begin school with positive attitudes toward mathematics, but these attitudes tend to become less positive as they get older. By the time students reach high school, their attitudes toward mathematics have frequently become negative (McLeod, 1992). Although many students value and enjoy mathematics and are motivated and confident in their abilities to do mathematics, there are still too many who do not feel this way. Negative attitudes toward mathematics are “thought to plague learners at every level of schooling” (Sherman and Christian, 1999, p.95).
Studies have also shown that many preservice elementary school teachers have negative attitudes toward mathematics (Rech et al., 1993; Cornell, 1999; Philippou and Christou, 1998). This should be a concern for teacher educators because teachers with negative attitudes toward mathematics are unlikely to cultivate positive attitudes in their own students (Hungerford, 1994; Philippou and Christou, 1998; Sherman and Christian, 1999). This study explored the use of reflection, through reflective journals, as a tool for teacher educators seeking to both understand how attitudes toward mathematics are formed and to improve these attitudes.

The purpose of this study was to examine the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course. The study focused on the following attitudes: value, enjoyment, motivation, and self-confidence. Qualitative methods were used to explore these attitudes and the experiences that have led to the development of these attitudes. The study sought to determine the extent to which preservice teachers’ attitudes toward mathematics changed during the methods course. The study also examined the correlation between preservice teachers’ initial attitudes toward mathematics and their achievement in the methods course. The intent of the study was to answer the following research questions:

1. What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?
2. To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course? To what do preservice teachers whose attitudes toward mathematics were altered attribute this change?

3. What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

4. What do preservice elementary school teachers’ reflective journal entries reveal about their attitudes toward mathematics and the experiences that have influenced the development of those attitudes?

5. What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most extreme (either positive or negative) attitudes?

The participants in this study were 33 university students enrolled in one section of a mathematics methods course for elementary education majors at a major research university in the southeastern United States during the fall semester, 2004. The researcher taught the course; an intact group was used due to university scheduling. The class met once a week for three hours. This course is the first of two mathematics methods courses that elementary education majors must complete and utilizes constructivist instructional methods, such as the use of hands-on manipulatives, cooperative group work, problem solving, and the use of calculators. Children’s literature in the teaching of elementary school mathematics was also emphasized.

Participants’ attitudes toward mathematics were measured using The Attitudes Toward Mathematics Inventory (ATMI), (Tapia, 1996) which contains 40 items (see Appendix E). Participants were asked to indicate their degree of agreement with each
statement using a Likert-type scale, from strongly disagree to strongly agree. Possible scores on the ATMI range from 40 to 200. There are 10 items dealing with Value of Mathematics, 10 with Enjoyment, 15 with Self-Confidence, and 5 with Motivation. Because there are unequal numbers of items for each attitude factor, the average score per attitude factor was also found in order to make comparisons more easily. These average per-item scores ranged from one to five. Descriptive statistics were computed for participants’ composite attitude scores, their scores on each of the four attitudinal components being measured, and on each individual survey item.

Each participant completed the ATMI at the beginning of the semester and again during week 12 of the 15-week semester. This allowed the researcher to measure each participant’s initial attitudes toward mathematics and to assess any changes that may have taken place during the first 11 weeks of the semester. The ATMI was also administered during week one and week twelve to students in two other sections of the mathematics methods course for the purpose of making comparisons in results. Two different instructors taught these methods course sections. The researcher and the other two instructors all used the same textbook (Appendix D) and manipulatives kit. Although each instructor was responsible for the content of her own course, all three classes covered the same content material and took the same final examination. The two other instructors were asked not to give their classes any written assignments that would involve reflection on their attitudes toward mathematics.

Eight reflective journals were assigned over the course of the semester. Five of the journal prompts (Table 3) related directly to the purpose of this study and were analyzed using Hycner’s guidelines for the phenomenological analysis of data (Appendix
This involved reading the journal for a sense of the whole, then identifying small units of meaning. Similar units of meaning were clustered and common themes were identified. When a journal expressed multiple themes, these themes were analyzed separately. The remaining three journal prompts did not relate directly to the purpose of this study, but they did relate to the purpose of the methods course. Therefore, participants responded to them as well, but these entries were not analyzed unless they contained information relevant to the study. Journal entries were submitted by email, and the researcher responded to each entry by email (see Appendix F for sample responses by students and the instructor).

The two preservice teachers with the lowest initial scores on the ATMI and the two with the highest scores were each asked to participate in an individual interview where their attitudes toward and experiences with mathematics were further explored. These Experiences with Mathematics Interviews (Appendix H) took place between week six and week eight of the semester.

After participants had completed the second ATMI, a repeated measures t-test was conducted using composite survey scores to determine if a significantly significant change in attitude had occurred. Those participants with change scores greater than one standard deviation above or below the mean change score were considered for individual interviews. These interviews were conducted with four preservice teachers who showed the greatest positive changes in attitude and three preservice teachers who experienced negative changes in attitude. These Changed Attitudes Interviews (Appendix I) focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. These interviews took place approximately one
month after the completion of the methods course and submission of final grades. All interviews were analyzed using Hycner’s guidelines (Appendix K).

The departmental final examination was used to determine the relationship between participants’ initial attitudes toward mathematics and their achievement in the methods course. The final examination was a 50-item multiple-choice instrument that included questions about both mathematics content and pedagogy. The composite attitude score was the independent variable and the methods course final examination grade was the dependent variable.

Summary of and Conclusions from Research Findings

*Research Question One: Initial Attitudes Toward Mathematics*

Participants had a mean composite survey score of 3.12 on the 5-point scale, with a score of one representing the most negative attitude, a score of three representing a neutral position, and a score of five representing the most positive attitude. Therefore, the mean composite score reflected attitudes that were just above the neutral position. The average initial survey scores were highest or most positive for Value of Mathematics, with a mean score of 3.96. Value was the only component with a mean score above the neutral position of 3.0. The mean scores for Self-Confidence and Enjoyment were 2.96 and 2.79, respectively. The lowest or most negative scores were for Motivation, with a mean score of 2.55. These preservice teachers, as a whole, valued mathematics and viewed it as important, but they did not enjoy mathematics or feel self-confident or motivated about mathematics.
Table 8 (pages 93-97) lists the mean rating for each individual survey item, grouped by attitudinal component. The highest-scoring item for the Value of Mathematics component was also the highest-scoring item for the entire survey: *Mathematics is a very worthwhile and necessary subject.* The mean rating for this item was 4.39, indicating a positive attitude. The lowest-scoring Value of Mathematics item, *I think studying advanced mathematics is useful,* had a mean rating of 3.24. Six of the 10 Value item ratings were at least 4.0. All Value item ratings reflected at least somewhat positive attitudes.

In the Self-Confidence component, the highest-scoring item, *My mind goes blank and I am unable to think clearly when working with mathematics,* had a mean rating of 3.36. Because this item was stated from a negative perspective, a response of *strongly agree* was scored as one point, and a response of *strongly disagree* was rated as five points. Therefore, a mean rating of 3.36 represents slightly positive attitudes. The lowest-scoring Self-Confidence item, *I have a lot of self-confidence when it comes to mathematics,* had a mean rating of 2.70. This represents attitudes that are somewhat negative, indicating that, as a whole, participants believed that they did not have a great deal of self-confidence with mathematics. Seven of the items had mean scores below the neutral position of 3.0, and seven items had mean scores above 3.0.

The highest-scoring item for Enjoyment, *I get a great deal of satisfaction out of solving a mathematics problem,* had a mean rating of 3.18. This item reflected an attitude slightly above the neutral position, indicating that these preservice teachers did not particularly enjoy mathematics problem solving. The lowest-scoring item for Enjoyment, *I am happier in a math class than in any other class,* had a mean rating of 2.06,
indicating a negative attitude. These future elementary school teachers did not especially enjoy mathematics classes. Seven of the 10 Enjoyment items had mean scores less than the neutral position of 3.0, reflecting negative attitudes concerning liking and enjoying mathematics.

The statement, *I would like to avoid teaching mathematics*, was the highest-scoring item for Motivation, with a mean score of 3.55. Because this item was stated from a negative perspective and the scoring was reversed, a mean score of 3.55 represents moderately positive attitudes. It is noteworthy that these future elementary school teachers will most likely all be teaching mathematics at some point in their careers, yet as a whole, they had only moderately positive attitude scores about teaching mathematics. The lowest-scoring item for Motivation, *I plan to take as much mathematics as I can during my education*, had a mean score of 1.94, which represents a negative attitude. The mean score for this item was the lowest on the entire survey, reflecting the most negative attitudes. Participants, as a whole, were not interested in taking any more mathematics courses than were required. It should be noted that, at this point in their education, most of the participants had fulfilled their mathematics requirements for graduation, so perhaps this result is not surprising.

Researchers have found that many preservice elementary school teachers at the university have negative attitudes toward mathematics (Christian, 1999; Cornell, 1999; Hungerford, 1994; Philippou and Christou, 1998; Rech et al., 1993). This study confirms these findings. The NCTM (1989, 2000) established goals related to affective factors. One of these goals was that mathematics students learn to value mathematics. The participants of this study, as a whole, demonstrated that they valued mathematics. They
viewed mathematics as worthwhile, useful, and necessary. This finding should be encouraging to those in the field of mathematics education. These results indicate that perhaps mathematics educators have had some success in achieving this goal. Furthermore, it is promising that these preservice teachers valued mathematics, as perhaps they will be more likely to pass on this positive aspect of mathematics to their future students.

Unfortunately, results from the other three attitude components in this study offer a more pessimistic view. Another goal of the NCTM (1989, 2000) was that students develop confidence in their own mathematical ability. Results from this study indicate that this goal has not been met with these participants. In fact, mean scores for the components of Self-Confidence, Enjoyment, and Motivation were all below the neutral position of 3.0. The composite survey mean score was 3.12, but if the Value items were removed, the composite mean score for the Self-Confidence, Enjoyment, and Motivation items would be 2.8, reflecting somewhat negative attitudes. These findings should be disappointing to mathematics educators, especially when one considers that these participants will soon be teaching mathematics in classrooms of their own. If they do not feel self-confident or motivated about mathematics and do not enjoy doing mathematics, they could pass these negative attitudes on to their future students.

Research Question Two: Changed Attitudes Toward Mathematics

A repeated measures t-test was conducted using composite survey scores to determine if a statistically significant change in attitude occurred. Each participant’s change score, which was their post-course score minus their pre-course score, was
calculated. Change scores could range from -160 to 160, indicating a negative or positive change in attitude, respectively. The mean change score for the 33 participants was 17.03 ($SD = 17.59$), and the median change score was 15. This represented a statistically significant positive change in attitude. The change scores ranged from -12 to 58, with a change score of zero representing no change in attitude. Twenty-seven of the 33 participants, or 82%, had positive change scores. Negative change scores were small in magnitude and therefore lacked practical significance. Mean survey scores for all four attitude components increased, with Self-Confidence having the largest per-item change score (Table 9). It should be noted that comparisons between mean pre-course survey item scores (Table 8) and mean post-course survey item scores (Appendix N) indicate that post-course scores increased on every survey item. The following survey items are among those whose mean scores increased by greater than 0.5 on the five-point scale, indicating more positive responses to the items:

- I like to solve new problems in mathematics.
- I really like mathematics.
- I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.
- I am comfortable answering questions in math class.
- Mathematics does not scare me at all.
- I have a lot of self-confidence when it comes to mathematics.
- I am able to solve mathematics problems without too much difficulty.
- The challenge of math appeals to me.
• When I hear the word mathematics, I have a feeling of dislike.*

• I am always under a terrible strain in a math class.*

• It makes me nervous to even think about having to do a mathematics problem.*

• I am always confused in my mathematics class.*

The ATMI was also administered during week one and week twelve to students in two other sections of the mathematics methods course in order to make comparisons in results and to determine if the methods course alone would lead to attitude changes. Two different instructors taught these methods course sections. These classes also used collaborative group work, problem solving, and manipulatives, but participants were not asked to reflect on their attitudes toward and experiences with mathematics. Neither comparison class demonstrated a statistically significant attitude change. The mean change score for the 24 participants in the first comparison class was 1.0 ($SD = 12.75$), and the median change score was zero. Change scores ranged from -25 to 33; 10 of the 24 participants, or 42%, had positive change scores. The mean change score for the 31 participants in the second comparison class was 1.48 ($SD = 13.08$), and the median change score was -2. The change scores ranged from -21 to 35; 14 of the 31 participants, or 45%, had positive change scores.

It is interesting to note that the participants in the journal-writing class demonstrated significant positive attitude changes, with a mean change score of 17.03,

*Scoring for these items is reversed and uses anchors of 1: strongly agree, 2: agree, 3: neutral, 4: disagree, 5: strongly disagree. Therefore, on all items, scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.
while the comparison groups had mean change scores of only 1.0 and 1.48, which reflect very small attitude changes. Both comparison classes had some participants with large positive change scores, but in both cases these accounted for less than half of the class. The positive attitude changes that took place in the journal-writing class were greater and accounted for a much larger percentage of the class. Not only did the participants in the journal-writing class demonstrate a much greater positive change in attitudes toward mathematics than the comparison groups, but also results from the two comparison groups were very similar to each other. Because the two comparison classes were taught by two different instructors, this suggests that perhaps some element or elements that were present in the study class but not in the comparison classes affected this change.

*Interviews: Positive Change Scores*

Question two also focused on those participants whose attitudes were altered and asked to what these participants attributed the change. Six participants had positive change scores greater that one standard deviation above the mean change score, which reflected a change score of at least 35 points. The four participants with the greatest positive change scores were interviewed in order to explore to what these participants attributed their positive attitude change. In addition, six participants had negative change scores greater than one standard deviation below the mean change score. Because the mean was so high, this reflected change scores of less than -0.56. These negative change scores ranged from -12 to -1. Although these change scores were negative, the difference between pre-course and post-course attitude scores was very small. Such minor variations could be explained by contextual variables or measurement error. Even though the
magnitude of their change scores was small compared to those of the positive change score interviewees, three of these participants were also interviewed. All of these interviews took place four to six weeks after the completion of the methods course and submission of final grades.

All four of the participants with positive attitude changes who were interviewed had mean response pre-course survey scores of between 2.2 and 2.8 per item. These scores reflected attitudes that were slightly to moderately negative as they were below the neutral position of 3.0. All four post-course mean response survey scores were between 3.3 and 4.0 per item, reflecting somewhat positive attitudes to positive attitudes. These four participants not only improved their attitudes, but they went from having somewhat negative attitudes toward mathematics to having positive attitudes toward mathematics. In addition, all four interviewees improved their attitudes toward mathematics in all four of the components being measured.

Before being informed of the results, all four of these participants said that they believed their attitudes toward mathematics had improved since the start of the methods course. They all had previously struggled with mathematics, felt uncomfortable with mathematics, dreaded mathematics, and lacked self-confidence with mathematics. Three of them said that they now had a more positive attitude toward teaching mathematics as well.

When asked which aspects of the course they thought had affected their attitudes toward mathematics, three of these participants mentioned the use of manipulatives. They felt that using manipulatives had increased their conceptual understanding. Showing a classmate how to use the manipulatives increased their self-confidence about teaching
mathematics. Two of the four also mentioned the journals. They appreciated the prompts relating to attitudes and experiences with mathematics and the instructor’s time in responding to their journals. One mentioned the format of the course and the copies of overhead transparencies that were provided, allowing her to pay attention to the class discussion rather than worrying about taking notes (samples found in Appendix P). One of these participants also talked about the benefit of having a classmate who was a close friend. They were able to help each other understand the concepts.

The four participants with the greatest improvement in attitude were all very positive about the use of manipulatives in teaching mathematics and said that manipulatives were “useful” and “necessary.” When discussing the use of manipulatives in the methods course, they all found them “very helpful” in understanding and making sense of the mathematical concepts.

All of these participants expressed positive views about the use of cooperative learning in the mathematics classroom. They all found the cooperative learning activities in the methods course “helpful” and “beneficial” because they could ask their classmates for help when needed.

All four talked about their previous struggles with problem solving. They all said that their problem-solving skills had greatly improved as a result of the methods course. While discussing this, they all made comments that indicated that their self-confidence with problem solving had increased. Tessa expressed this the most clearly:

I was frustrated 'cause that was the only way that I knew how to do that problem and if I couldn't get it, then I felt dumb or I felt stupid or I felt that I wasn't good in math, but at the end [of the methods course], I was [thinking], 'Oh, I got it!' and
then 'Oh, I could do it this way or this way!' and I was [thinking], 'Oh, you know what? I can do math!'

When asked about the use of journals in teaching mathematics, the interviewees said that journals were a “useful” and an “important” form of assessment. Two of them mentioned that journals were usually used with English rather than mathematics. They all said that they “liked,” “loved,” or “enjoyed” writing journals for the methods course. They felt that the journals were a great way to communicate with the instructor and also a good way to reflect on their past experiences with mathematics. As Erin said:

In the course, I thought [journal writing] was good because you [instructor] were able to see how we came to feel about certain subjects in math by the questions that you asked, and it was very good for me because I had forgotten about some things and having to think about it, why my attitudes were a certain way, I was [thinking], 'Oh, yeah. THAT'S why I don't enjoy math.'

After learning that their attitude scores had increased so dramatically, all four interviewees said that they were not at all surprised. They all expressed an increased self-confidence with mathematics and with teaching mathematics. As Jennifer said:

...coming into here [methods course], I still was kind of uneasy, but now after [completion of methods course], I felt like, 'All right, I can do math, no question about it.' I'm even willing to get up and teach kids math when before I would say that was the one subject that I did not want to teach…. But now I feel like I could step in there and actually teach math.
Interviews: Negative Change Scores

The three participants with negative change scores who were interviewed had mean change scores of -12, -10, and -5. These change scores were much smaller in magnitude than those of the interviewees with positive change scores, which ranged from 41 to 58. This is because 82% of the participants had positive change scores, and none of the six negative change scores was very extreme, with -12 being the largest negative change. Nevertheless, these participants were interviewed in order to determine if their decrease in attitude scores was due to anything other than measurement error.

It is informative to look at the pre-course and post-course mean response survey scores of these participants. The first participant, Stephanie, went from a pre-course score of 3.5 per item to a post-course score of 3.2 per item. The second participant, Shelly, went from 3.9 per item to 3.6 per item. Both of these participants started with moderately positive attitudes and ended with attitudes that were still somewhat positive, as they were above the neutral position of 3.0. Therefore, perhaps it is more appropriate to describe these change scores as less strong positive rather than negative. It is important to note that both Stephanie and Shelly were surprised when they learned that their attitude scores had decreased. The third interviewee, Yezania, began with a score of 2.0 per item and finished with a score of 1.9 per item. Her attitude toward mathematics began in the negative range, and it ended slightly more negative.

Before being informed of the results, Stephanie said that she “definitely” thought her attitude toward mathematics had improved since the start of the methods. Shelly said that she was not sure if her attitude had changed. She explained that her attitude toward mathematics was “constantly changing,” depending on the mathematics topic being
discussed. Yezania said that she thought her attitude had improved in some ways and not in others. She explained that she thought her attitudes had improved because the manipulatives used in the course had increased her conceptual understanding. However, she also said, “I am still kind of nervous when it comes to math. I’m not secure of myself.” It is interesting to note that both Shelly and Yezania were initially conflicted as to whether or not their attitudes had changed, but Stephanie was initially convinced that her attitudes had improved. However, both Stephanie and Shelly expressed surprise when they learned that their attitude scores had decreased.

When asked which aspects of the methods course they thought had affected their attitudes, none of the three thought of anything that had negatively influenced their attitudes. Two of the three mentioned that the use of manipulatives was an aspect of the course that had positively affected their attitudes. Both Stephanie and Yezania explained that they work with elementary school students in after-school programs, and they both have had success using manipulatives with their students as a result of the course. One of the interviewees said that the journals were “really, really helpful.” Another said that the organized format of the course had positively influenced her attitude. There were “no surprises … [everything] was really clearly stated.” One also mentioned that the textbook was useful and had positively affected her attitude.

The three interviewees described the use of manipulatives in teaching mathematics as “really awesome” and “great.” They all had positive comments about the use of manipulatives in the methods course as well. One interviewee said that she benefited from watching the instructor model the manipulatives on the overhead projector. Another interviewee said that she “loved” using the manipulatives and was
already “thinking of so many ways [to use] the manipulatives” with her future students. The third interviewee, Yezania, said that the manipulatives really helped her with problem solving because she is “not very good with word problems.”

The interviewees believed that cooperative learning was “really great,” “very important,” and “needed” when teaching mathematics to children. Their comments about the use of cooperative learning in the methods course were more conditional. Stephanie said that the cooperative learning activities in the methods course were “good,” but she made it clear that she does not like cooperative learning when it involves assignments because “someone ends up always doing more” than the others in the group. It is unlikely that this view was a factor in her small negative change score because there was only one assignment in the methods course that could have been done as a group assignment, and participants had the choice of working in groups of up to four or working alone. Shelly said that the cooperative learning activities “wouldn’t ever bring my attitude down,” but she also said that cooperative learning should not be “a constant thing.” She explained that sometimes students want to “work on their own and get their own answer.” This view could have been a factor in Shelly’s change score as the methods course included many activities where participants were encouraged to work together in class. Yezania’s response to this question was very revealing. She said that maybe she would have benefited more from the cooperative learning activities in the methods course if she had been more focused: “I think because we did too much talking instead of actually doing the work. So, you know, I’m being honest. Sometimes you get kind of sidetracked.”

Stephanie said that she felt that she would use what she had learned about problem solving. Yezania also said that she had “learned a lot of new ways to solve”
problems in the methods course. She explained that this was “good” for her because she had struggled with problem solving in the past. Shelly said that she had also struggled with problem solving and sometimes found it “intimidating.” This view could have been a factor in Shelly’s change score because the methods course included many problem-solving activities.

All three of the negative-change-score interviewees said that they had benefited from the journals. Stephanie said that she found it “very helpful” not only to write them, but also to go back and read what she had previously written. She said, “They made me think about a lot of stuff that I probably wouldn’t have thought about unless you prompted me.” Shelly also said that the journals were helpful because they “make you not forget your own little history, like your personal math diary…. It reminds you of the ups and downs and the positives and negatives, the things that are important.”

After learning that their attitude scores had decreased, two of the interviewees reacted with surprise. Perhaps this was not unexpected since their change scores were so small in magnitude and also because they both began and ended the methods course with somewhat positive attitudes toward mathematics. Stephanie was amazed to learn that her score had decreased. At the beginning of the interview, she had said that she believed her attitude toward mathematics had improved, and she reiterated that at this time. She looked at her second survey and observed that she had not answered ‘strongly agree’ to any of the items. Stephanie then reminded the researcher that Stephanie’s mother had passed away only a few weeks before she had completed the second survey. She suggested that perhaps this had influenced her responses on the post-course survey. It is interesting to note that Stephanie had the largest negative attitude change of all the
participants in the methods course, although her score still reflected positive attitudes. It appears quite conceivable that her small change in attitude could have been influenced by her mother’s recent death rather than by anything that occurred in the methods course. This seems even more plausible because Stephanie herself felt that her attitude toward mathematics had greatly improved.

At the beginning of the interview, Shelly had said that she was not sure if her attitude had changed or not. However, upon learning that her attitude score had decreased, Shelly said that she was “surprised.” She added:

I really think that it probably would have gone the other way. I do, and I think that it has to do with the way that you've taught me how to teach children which may have been different than the way that I learned … I've picked up a lot from your class and I think that my attitudes would've gotten better just because a lot more makes sense now and that's just kind of surprising to hear that it went the other direction.

Perhaps comments that Shelly made during her interview concerning cooperative learning and problem solving could help explain her slightly less positive attitude score.

Yezania had said at the beginning of the interview that she thought her attitude toward mathematics had improved in some ways and not in others. When she learned that her attitude score had decreased, Yezania said that she believed that these results could have been related to the distractions she had mentioned earlier involving sitting with her friends in class. As she said, “I think it did [affect the scores] …. sometimes I wouldn't be grasping [a concept], but I would be too involved in [chitchat noises] so I wouldn't grasp
it too well.” It is interesting to note that both Stephanie and Yezania had theories as to why their attitude scores had decreased, while Shelly did not.

Themes Across Interviews

Twenty-seven participants in the methods course, or 82%, had positive change scores, indicating improved attitudes toward mathematics. These positive change scores ranged from 1 to 58. Only six participants had negative change scores, ranging from -12 to -1. Those interviewees with positive attitude change scores had change scores that ranged from 41 to 58, which reflected large changes in attitude. All four of them began with somewhat negative attitudes and ended with attitudes in the positive range. Those interviewees with negative attitude change scores had changes that were much smaller in magnitude and lacked practical significance. The two who began with moderately positive attitudes ended with attitudes that were still somewhat positive, and the one who began with negative attitudes ended slightly more negative. Therefore, comparisons between those interviewees with positive change scores and those with negative change scores are difficult to make. We are comparing participants with large positive changes to those with very small negative changes.

Perhaps this explains why there are not many differences in the responses of the two groups. In fact, it seems to make more sense to look across all interviewees to determine which aspects of the methods course participants think have positively influenced their attitudes. Of the seven interviewees, five mentioned manipulatives when asked which aspect or aspects of the methods course they thought had influenced their attitudes toward mathematics. Three of the seven said that the journals had positively
affected their attitudes. Two of the seven said that the organized format of the course had
influenced their attitudes in a positive manner. It is interesting to note that the two
comparison classes also used manipulatives, but they did not use journals or the same
format where participants were provided with copies of overhead transparencies.

When asked about specific aspects of the methods course, responses across
interviewees were similar. All seven of those interviewed were very positive about the
use of manipulatives in teaching mathematics and also in the methods course. All seven
expressed positive views about the use of cooperative learning in teaching mathematics
and in the methods course, although three of the interviewees qualified their responses.

Six of the seven who were interviewed said that they had struggled with problem
solving. Stephanie was the only one who did not mention this. Six of the seven also said
that their problem-solving skills had improved as a result of the methods course. Shelly
was the only one who did not express this view.

All seven interviewees had very positive comments about journals. They
described journal writing as “useful,” and “important.” When discussing the journals in
the methods course, they said that they “liked,” “loved,” and “enjoyed” journal writing
and found it “helpful” and beneficial to reflect on their past experiences with
mathematics.

It is interesting to note that there are plausible explanations for all three of the
interviewees’ small negative change scores. One was most likely due to the recent death
of the participant’s mother. The second could have been a result of the extensive use of
cooperative learning activities and problem solving in the methods course. That
participant had some negative views about both of these. The third participant with a
negative change score believed that her own lack of focus in the course was a factor in her slightly negative change in attitude score.

Several studies have demonstrated success in improving attitudes toward mathematics of preservice elementary teachers enrolled in mathematics methods courses (Anderson and Piazza, 1996; Gibson and Van Strat, 2001; Huinker and Madison, 1997; McGinnis et al., 1998; Philippou and Christou, 1998; Quinn, 1997; Sherman and Christian, 1999). These methods courses utilized constructivist instructional methods such as the use of hands-on manipulatives, cooperative group work, and problem solving. However, none of these studies used the additional tool of reflective journals where participants reflected on their own attitudes toward and experiences with mathematics. In this study, participants from all three classes used manipulatives, cooperative group work, and problem solving. However, only the journal-writing class experienced significant positive attitude changes. This suggests that the use of manipulatives, cooperative group work, and problem solving is not the sole explanation for positive changes in attitude toward mathematics.

*Research Question Three: Relationship Between Attitudes and Achievement*

A Pearson correlation coefficient was found in order to determine the relationship between initial attitude survey scores and scores on the methods course departmental final examination. A statistically significant Pearson Correlation Coefficient of \( r = 0.5321 \) was found, indicating a moderately strong positive correlation \( (p = 0.0014 \ < \ 0.05, \ n = 33) \).
These findings are strengthened by the use of the Mathematics Education departmental final examination as the measure of achievement. This examination is a 50-item instrument that includes questions about both mathematics content and pedagogy. All students who are enrolled in any section of the methods course take the same final examination. This test was used as a measure of course achievement rather than the final course grade in an effort to minimize bias. The test is a multiple-choice instrument, so grading is not subjective. In addition, the test was not written by the researcher. A Mathematics Education faculty member who has taught the methods course for many years oversaw the writing of the departmental exam, but all methods-course instructors were invited to contribute problems to the test. Therefore the final exam was a collaboration of several professionals with expertise in the field of mathematics education. Information about the content of the final exam is found in Table 4 and in Appendix J. A reliability coefficient of 0.71 (n=17) was found for Exam Form A and a coefficient of 0.73 (n=16) was found for Exam Form B. The use of the final exam as a measure of achievement provided validity and reliability of the results.

There has been little consensus in the research literature concerning the relationship between attitudes toward mathematics and achievement in mathematics. Some researchers have found the correlation between the two to be quite low, while others have found statistically significant correlations ranging from 0.20 to 0.40. Still others have found quite strong correlations above 0.40 (Ma and Kishor, 1997). In their meta-analysis of 113 studies, Ma and Kishor (1997) also found that the correlation tended to become stronger as students reached high school. Participants in grades 1-4 showed a Pearson Correlation Coefficient of $r = 0.03$, and students in grades 5-6 showed a
correlation of $r = 0.14$. However, the relationship strengthened even more as students reached secondary school, with secondary students showing a correlation of $r = 0.26$.

The results from this study support the notion that attitudes toward mathematics and achievement in mathematics are related. The moderate correlation of 0.53 found in this study also appears to support previous findings that the correlation between attitudes and achievement strengthens as students get older. Participants in this study were university students, so they were older than the students in Ma and Kishor’s meta-analysis. The previously established pattern of increasing correlation with age and grade level is supported in these findings.

**Research Question Four: Themes from Journals**

Analysis of the reflective journals involved looking for patterns using Hycner’s guidelines (Appendix K). After reading a journal entry for a sense of the whole, units of general meaning were delineated. When a journal expressed multiple themes, these themes were analyzed separately. Once units of meaning had been identified for each journal entry for a given prompt, units of meaning from all journal entries responding to that prompt were examined. Units of meaning relevant to the research questions were then clustered and common themes identified from the data.

**Journal One: Feelings at Beginning of Course**

Table 10 (page 130) shows five themes that reflected positive feelings at the beginning of the course and two themes that reflected negative feelings about the course. The 27 instances of positive feelings came from 21 of the 33 participants and represented
17.5% of all comments made for this prompt. These participants said that they were looking forward to the course, excited about it, intrigued by the manipulatives, confident, and interested. The 18 negative feelings came from 15 participants and represented 11.7% of all comments made for this prompt. These participants said that they were nervous, worried, apprehensive, and disliked mathematics.

Some participants expressed attitudes toward mathematics that were not specific to the methods course. There were 30 instances of positive attitudes and experiences cited. These comments came from 15 participants and represented 19.5% of all comments made for this prompt. Participants said that they liked mathematics, had done well with mathematics, looked forward to teaching mathematics, and had positive memories of elementary school mathematics. There were 46 instances, from 24 participants and representing 29.9% of all comments made for this prompt, of negative attitudes and experiences cited, such as being horrible in mathematics, disliking mathematics, not being interested in mathematics, and being intimidated by mathematics. Some were worried about teaching mathematics. Fourteen of these negative experiences were of mathematics classrooms, mostly in high school and college. These involved struggling with mathematics and not doing well, feeling intimidated, memorizing procedures rather than understanding concepts, and horrible teachers.

Journal one also asked participants what they were hoping to gain from the course. Table 13 (pages 135-136) summarizes the themes that were identified in addressing this question. There were 11 themes identified with a frequency of 95; these came from all of the 33 participants and represented 100% of all comments made for this prompt. There were 24 instances where participants said that they wanted to learn
strategies and tools for teaching mathematics. Participants said that they wanted to learn to like and appreciate mathematics, to help their future students develop positive attitudes toward mathematics, to gain a better understanding of mathematics, and to gain confidence with mathematics. They also wanted to learn how to accommodate different learning styles, to help students view mathematics as relevant, and to make mathematics interesting for their future students.

There were more positive feelings about the methods course at the beginning than negative feelings. However, while explaining their feelings at the beginning of the course, participants expressed more negative attitudes and memories than positive ones. One might find this a bit conflicting. However, the participants’ responses concerning what they hoped to gain from the course offered an explanation for this. Many of them said that they were looking forward to the course and excited about it because they wanted to learn to like and appreciate mathematics in order to help their future students develop positive attitudes toward mathematics. Several said that they did not want their students to have the same negative attitudes toward mathematics that they had. Many of these participants expressed negative attitudes toward and experiences with mathematics, but they were motivated to improve these attitudes in order to develop more positive attitudes toward mathematics in their future students.

Journal Two: Memories of Mathematics in Elementary School

Those journal entries reflecting positive memories of elementary school mathematics are summarized in Table 14 (pages 138-139). There were 14 themes, with a frequency of 53, which reflected positive memories of elementary school. These
comments came from 21 participants and represented 34.2% of all comments made for this prompt. Eleven participants positively recalled rewards associated with learning specific topics, especially multiplication facts. Seven remembered feeling successful with mathematics and enjoying it. Four had fond memories of specific projects that related to “real life.” Six participants remembered feeling positive, confident, and motivated with elementary school mathematics and the fun of sharing mathematics with their parents. Eight recalled how much they enjoyed the use of manipulatives, cooperative learning groups, and mathematics games.

Those journal entries reflecting positive memories of elementary school mathematics teachers are summarized in Table 15 (page 140). There were 8 themes, with a frequency of 15. These comments came from 7 participants and represented 9.7% of all comments made for this prompt. Participants fondly remembered elementary school math teachers who took the time to give them extra help when needed, made mathematics class interesting and relevant, and who were patient, supportive, and encouraging. They also appreciated teachers who taught mathematics in many different ways and varied their lessons, and those who encouraged group work and were great at explaining things.

Those journal entries reflecting negative memories of elementary school mathematics are summarized in Table 16 (pages 142-143). There were 16 themes, with a total frequency of 50, that reflected negative memories of elementary school mathematics. These comments came from 16 participants and represented 32.3% of all comments made for this prompt. Four participants recalled elementary school mathematics as boring, not relevant or needed, and being mostly drill work. Four recalled games that they dreaded and teachers who would not provide extra help when needed.
Three remembered only being taught one way to solve problems, difficult homework, and struggles with mathematics that became even worse after moving to a new school. In addition, five participants mentioned elementary school teachers who were bitter, lacked compassion for students and excitement about mathematics, and were unwilling to help when students asked questions. These responses about elementary school teachers represented 3.2% of all comments made for this prompt.

It is interesting to note that there were more positive memories of elementary school mathematics and elementary school mathematics teachers, representing 43.9% of the comments made for this prompt, than negative memories, representing 35.5% of the comments. Studies have shown that children typically begin school with positive attitudes toward mathematics (McLeod, 1992), and these memories of elementary school seem to support those findings.

Although journal two asked about memories of elementary school mathematics, some participants discussed their memories of mathematics at other levels as well. Two participants said that they began to like mathematics more once they were out of elementary school. However, five participants said that they liked mathematics in elementary school but began to struggle with it and dislike it once they reached middle or high school. Four participants remembered specific mathematics teachers after elementary school who were discouraging, extremely rigid, horrible, and teachers who created tense classrooms and made students feel stupid when they asked for help.

Journal two also asked participants what they, as future teachers, had learned from the experiences they had cited. Table 18 (pages 147-149) summarizes their responses. There were 16 themes identified with a frequency of 72; these came from all of the 33
participants and represented 100% of all comments made for this prompt. Many of the participants said that they had learned that teachers should provide extra help to struggling students. Teachers should make mathematics fun, interesting, and relevant. Mathematics teachers should foster positive attitudes toward mathematics in their students, build students’ confidence with mathematics, help students feel successful, and create a comfortable classroom environment for their students. In addition, participants learned that mathematics teachers should understand the mathematics content they are teaching, accommodate different learning styles, let students know that there is more than one way to solve a problem, not use too many worksheets, integrate mathematics with other subjects, and use manipulatives and group work with their students. They should also ask a colleague for help when needed.

Journal Three: Feelings About Mathematics

Those journal entries reflecting positive feelings about mathematics are summarized in Table 19 (page 151). There were six themes, with a frequency of 31, which reflected positive feelings about mathematics. These comments came from 19 participants and represented 14.8% of all comments made for this prompt. Participants said that they enjoyed mathematics and found it useful and relevant to their lives. They also felt that they had learned the best techniques and strategies for them to approach or deal with mathematics, and they liked the constancy of mathematics where the correct steps always lead to the correct answer. It is informative to note that this algorithmic view of mathematics runs counter to the perspective that the NCTM is trying to encourage. One participant expressed confidence about mathematics. Five participants expressed
positive feelings related to the methods course. The most common of these was that they liked the constructivist teaching methods that they were learning about in the methods course.

Those journal entries reflecting the experiences that participants associated with positive feelings about mathematics are summarized in Table 20 (page 152). There were seven themes, with a frequency of 28, which reflected experiences associated with positive feelings. These comments came from 18 participants and represented 13.4% of all comments made for this prompt. Eight of these experiences referred to mathematics teachers who helped their students embrace mathematics, understand mathematics, see the relevance of mathematics, not fear mathematics, and teachers who were patient with their students, made learning fun, and boosted the confidence of their students. Participants also recalled events where they experienced success with mathematics and felt that it came easily to them. They remembered specific experiences in elementary school and also in college when they were able to understand mathematics and feel successful with it. Three participants recalled specific incidents where success and recognition led to feelings of confidence about mathematics.

Journal entries reflecting negative feelings about mathematics are summarized in Table 22 (pages 155-156). There were 10 themes, with a frequency of 47, reflecting negative feelings. These comments came from 14 participants and represented 22.5% of all comments made for this prompt. Many of these participants said that they disliked, hated, and feared mathematics. They said that mathematics made them feel intimidated, nervous, and frustrated. They did not enjoy, were not good at, and lacked confidence with mathematics. Three said that they did not see the need for studying advanced
mathematics. They viewed mathematics as unneeded, and they try to avoid mathematics whenever possible. Three participants said that they did not like the nature of mathematics, where new concepts are built upon previous ones.

Table 23 (pages 157-158) shows the experiences that participants associated with negative feelings about mathematics. There were 11 themes, with a frequency of 48, recalling experiences that were associated with negative feelings. These comments came from 22 participants and represented 23% of all comments made for this prompt. The vast majority of these were experiences where participants cited their struggles with mathematics as an explanation for their negative feelings. Many remembered bad teachers, feeling stupid when they could not understand, and doubting themselves when they did not perform well on tests. They said that struggles with mathematics made them feel frustrated and traumatized, and they did not like the quick pace of mathematics classes. Others mentioned that they disliked ‘traditional’ teaching methods that their previous mathematics teachers had used.

While describing their feelings about mathematics, seven participants said that they wanted to improve their own negative attitudes toward mathematics. They recognized that, as future mathematics teachers, they should have more positive attitudes toward the subject they will soon be teaching. Participants also wrote about their desires to develop positive attitudes toward mathematics in their future students by making mathematics fun and enjoyable for the students.

It is interesting to note that there were more negative feelings about mathematics, representing 45.5% of the comments made for this prompt, than positive feelings, representing 28.2% of the comments. Studies have shown that many preservice
elementary school teachers at the university have negative attitudes toward mathematics (Christian, 1999; Cornell, 1999; Hungerford, 1994; Philippou and Christou, 1998; Rech et al., 1993). Participants’ responses to Journal Three seem to support those findings.

*Journal Four: Memorable Experience with Mathematics*

Experiences were categorized as either positive or negative. Table 25 (page 162) lists the frequencies of these positive and negative memories. Positive memories came from 21 of the 33 participants and represented 56.8% of all comments made for this prompt. Negative memories came from 16 of the 33 participants and represented 43.2% of all comments made for this prompt.

Eight participants recalled one special teacher or tutor whose individual help and encouragement positively affected their attitudes toward mathematics. In addition, four participants recalled experiences that changed their attitudes toward mathematics in a positive way, and three of these also involved a special teacher or tutor. These excerpts recalled teachers who were sensitive to the student’s struggles, often initiated help, and who expressed faith and confidence in the student’s ability. The successes that followed and the teacher’s or tutor’s stated confidence in the student led to the student’s increased self-confidence.

Four participants recalled positive situations where they experienced success with mathematics after struggling with it. They described feelings of exhilaration and confidence. They talked about how good it felt to understand the concepts and feel pride in this accomplishment.
Four participants remembered positive memorable experiences that involved the use of tricks, drill exercises, and games for learning basic facts. They all mentioned the positive recognition, in the form of certificates, rewards, and verbal encouragement that the participant received for being successful with the drills and games. This success led to feelings of self-confidence. All four of these participants found these activities to be fun and enjoyable. However, one participant had a negative experience with this type of activity. She hated the memorization and timed tests involved with learning basic facts. They produced anxiety and feelings of failure for her.

Six participants recalled negative experiences involving individual teachers. In addition, three participants recalled experiences involving individual teachers that they said negatively changed their attitudes toward mathematics. These excerpts recalled teachers who singled out students who were struggling. The teachers embarrassed or punished the students for not knowing the answer. Students felt dumb or stupid when they could not understand the concept, and the teacher appeared unwilling to take the time to help. This left the students feeling frustrated and unimportant. Participants also remembered teachers who admitted disliking mathematics, who stressed memorization rather than understanding, and who did not have control of the class.

Four participants recalled negative experiences where they felt stupid or not very smart. These all stemmed from incidents where the participant thought that he or she should have known the answer or answers but didn’t. They involved tests, homework, and class work. These struggles seemed to diminish self-confidence.

Five participants had memories related to changing schools or classes. Two of these were positive. The first involved moving to a new school. The participant was
scared about the possibility that the curriculum she had been studying in her previous school would be behind that of her new classmates, but her confidence soared when she realized that she was actually ahead of them and able to help some of them with mathematics. The other positive memory involved being tested for the gifted class, failing the test, and then being retested the next year and passing the test. This was a motivating force for this participant. The three negative memories of changing schools or classes involved moving to a new school or class that was more advanced or further along in the curriculum than the former school or class. This brought on feelings of failure, frustration, and intimidation.

Studies have shown that children typically begin school with positive attitudes toward mathematics, but these attitudes tend to become less positive as they get older. By the time students reach high school, their attitudes toward mathematics have frequently become negative (McLeod, 1992). When participants responding to Journal Three mentioned experiences that were associated with either positive or negative feelings about mathematics, some referred to specific levels of schooling. It is interesting to note that four of the eight positive experiences mentioned occurred in elementary school, none in middle school, and one in high school. However, only two of the fifteen negative experiences cited took place in elementary school. Three occurred in middle school, and seven in high school. These results seem to support McLeod’s findings that attitudes toward mathematics tend to become more negative by the time students reach high school. Results from Journal Four further reinforced this notion. When describing a memorable event that had influenced their attitudes toward mathematics, the highest
frequency of positive memories occurred in elementary school while the highest
frequency of negative memories took place in high school.

_Journal Eight: The Use of Reflective Journals in the Methods Course_

Those journal entries reflecting benefits of journals are summarized in Table 26
(pages 177-181). There were 27 themes, with a frequency of 181, which reflected
benefits of journals. These comments came from all 33 participants and represented
89.2% of all comments made for this prompt. Twenty-six of the participants said that
they had benefited from reflecting on their past experiences with mathematics. Twenty-
six also said that they had benefited from reflecting on their future teaching of
mathematics. Twenty of the thirty-three participants said that they had gained insights
about their attitudes toward and struggles with mathematics. As they remembered their
former experiences with mathematics, eighteen of the participants said that they had
reflected on the differences between good and bad teaching, and they made specific plans
as future teachers based on these reflections. They wanted to be like their favorite
teachers and to avoid the qualities and practices of their least-favorite teachers. Nine of
the participants said that they had made specific plans as future teachers regarding being
sensitive to and trying to improve their students’ attitudes toward mathematics. Six said
that they had realized through journal writing that teachers have a large impact on their
students’ attitudes toward mathematics.

Seventeen of the participants said that they liked, loved, and enjoyed the journals,
and that they thought the journals were a good idea. They found them helpful and
beneficial. After reflecting on their own mathematics classroom experiences as students,
participants planned to use the teaching methods and strategies that they found helpful and to avoid those that they did not find helpful. They were determined to make their mathematics classrooms fun and to use journal writing with their own students.

Four of the participants said that they had negative feelings about the journals at first, but all four said that after writing one or two, they changed their minds. Four participants said that the researcher’s responses to the journals were a positive aspect of journal writing. Not only did they appreciate the researcher’s time and care in responding to their journals, but they also felt that the researcher’s responses added to their insights. Three participants said that the journals made them think about things they might not have without journaling. Three felt that the journals were a good means of communication with the instructor because journals offer an opportunity for a student to be more open and bring up questions and issues that might not have been expressed face-to-face. Participants recognized the benefits of reflection and the realization that their concerns were not so different from those of others in the class.

There were five themes from eight participants, representing 3.9% of the comments made for this prompt, which reflected drawbacks of journals. Two participants found it unpleasant to relive bad experiences with mathematics. Two said that realizing through reflection that they had not experienced many good mathematics teachers to serve as role models made them feel uneasy about teaching mathematics in the future. Two participants mentioned that the journal prompts seemed a bit repetitious. One participant said that she had a hard time remembering things that happened when she was in school. The only other drawback mentioned was a technical problem that interfered with the participant’s ability to send and receive emails.
Despite these few drawbacks, participants were overwhelmingly favorable in their views about writing journals. The journals helped them determine the type of mathematics teachers they wanted to become by allowing them to reflect on their own mathematics teachers and classroom experiences. They realized that teachers can have a huge impact on their students’ attitudes toward mathematics, and these future teachers want to encourage the development of positive attitudes in their own students. If their future students have negative attitudes toward mathematics, these participants want to be sensitive to this and to try to improve these negative attitudes. Perhaps this type of reflection will help them become better teachers by increasing their awareness about these issues.

Rose (1989) cited teacher response as an important benefit of journal writing. “As the teacher writes back to the students, students realize the teacher hears and cares” (p. 26). Responses from participants in this study reinforced this notion. Several participants mentioned the researcher’s responses as they reflected on journal writing. They appreciated the researcher’s time and care in responding and the insights that the responses provided. It is interesting to note that in recalling memories of former mathematics teachers, participants often related positive experiences and attitudes to teachers who took time to help them and who seemed to care about them. Negative experiences and attitudes were often associated with teachers who were not willing to give struggling students their time and who gave their students the impression that they did not care.

Many participants said that they had gained a great deal of insight about their own
attitudes toward mathematics and the experiences that had influenced the development of those attitudes. Perhaps the participants’ own words offer the best view of this result:

• “I thought the use of reflective journals was beneficial in this class because I didn't realize how I felt about math until I wrote them.”

• “I think that the benefit to me of keeping a reflective journal in this class is that it has caused me to consider my attitude toward the subject of mathematics and possible causes for the development of this attitude.”

• “From these journals, I have learned a great deal about why I have the feelings I do for math. They allowed me to think back through my life and pinpoint events or people that influenced my feelings and attitudes. I was able to recall events or people that I think shaped why I don't like math today. I was also able to recall the events and people that were positive and didn't make me totally turned off from math.”

• “It made me realize that I don't truly dislike the subject, but it was the teachers who were not helpful and patient that made me feel that way.”

• “By reflecting I have really come to terms with how comfortable I am with math and how I want my students to feel about math.”

Journals Five, Six, Seven: Relevant Excerpts

When asked how they, as future educators, would help boost the confidence of students with low self-confidence regarding mathematics, eleven participants responded with comments that related to their own experiences and feelings of low self-confidence with mathematics. They said that they knew what it was like to have low self-confidence
and feel intimidated by mathematics, and they believed that a lot of children and adults lack self-confidence with mathematics. They said that teachers do not realize how great an impact they can have on students’ self-confidence with mathematics. Two participants said that they had been encouraged to believe that mathematics was just for “boys or smart kids,” and they would try to show their students that this was not the case.

When asked to reflect on the qualities of the best mathematics teacher they ever had, 21 participants responded with comments that were pertinent to the research questions of this study. They remembered teachers who had positive attitudes toward mathematics themselves and who modeled this for their students. These positive teachers made learning mathematics fun and exciting. They helped their students believe in themselves and their abilities to do mathematics. They would patiently answer questions without making their students feel stupid. One participant said that she had never had a very good mathematics teacher.

When asked about the qualities of the worst mathematics teacher they ever had, 17 participants responded with comments that were relevant to the study. They recalled teachers who did not seem to care about their students and their learning. They were not willing to take time to help students who were struggling. They were impatient and difficult to approach, and students were afraid to ask for help. When students did ask a question, these teachers would embarrass them in front of the whole class and make them feel dumb. Some of these teachers would call on students for answers without giving them time to process new material. When the students could not answer the question, the teachers would embarrass them and make them feel stupid. These teachers lacked enthusiasm for mathematics and would always use the same boring teaching methods.
Nearly all of these 17 participants said that their worst teachers had a lasting negative effect on them and their attitudes toward mathematics. They said that as a result of having this teacher, they disliked or even hated mathematics and tried to avoid it or take easier courses whenever possible. Participants said that their self-confidence suffered as a result of these teachers and some felt worthless and incompetent.

Beliefs Expressed in Journals

Although this study focused on attitudes toward mathematics, it is also important to look at the relevant beliefs that participants expressed in their journals. Studies have shown that teachers who have negative attitudes toward mathematics are more likely to view and teach mathematics in a more traditional manner (Philippou and Christou, 1998; Stipek, Givvin, Salmon, and MacGyvers, 2001). The participants in this study had initial attitudes that were somewhat negative, especially enjoyment, self-confidence, and motivation. However, the beliefs that they expressed were not particularly indicative of traditional beliefs. In fact, many of them seemed to reflect ideas that were being promoted in the methods course. It is important to remember that the initial attitudes were measured at the beginning of the semester, but the journals were written throughout the semester. This may indicate that as participants’ attitudes toward mathematics were changing, perhaps their beliefs were as well.

Themes Across Journals

In reviewing themes from the journals, it is interesting to compare responses of participants with positive memories to those with negative memories and to observe their
contrasting relationship. Those with positive memories talked about feeling successful with mathematics and enjoying it, while those with negative memories recalled struggling with mathematics and finding it boring. Positive memories referred to real-life projects, manipulatives, cooperative learning, and games, whereas negative memories referred to mathematics content that was not relevant to real life and class work that was mostly drill. Although some said that they liked mathematics and found it useful, many talked about how they disliked and feared mathematics. They found that it made them feel nervous, intimidated, and frustrated, and they thought it was unneeded, especially advanced mathematics. Although some wrote about feelings of confidence, others said that they lacked confidence with mathematics.

Those with positive memories recalled mathematics teachers who were always available for extra help when needed and who were patient, supportive, and encouraging. They were very sensitive to their students’ struggles and expressed faith in their students’ abilities to succeed. These teachers helped their students understand and appreciate mathematics and boosted their self-confidence. Those with negative memories referred to teachers who were not willing to take time to help them when they were struggling and who were bitter and lacked compassion. These teachers would single out struggling students to answer questions in class without giving them time to process the new information. This left their students feeling embarrassed, frustrated, and stupid.

Research Question Five: Experiences of Those with Most Extreme Attitudes

The two participants with the most negative initial attitude scores, Mary and Lisa, and the two with the most positive initial attitude scores, Hermione and Torri, were asked
about their attitudes toward and experiences with mathematics in individual interviews. As might be expected, the two participants with extremely positive attitudes had memories and experiences that were much more pleasant than those of the two with extremely negative attitudes. Like the memories and experiences that all the participants shared in their journals, there was a contrasting relationship between the two types of experiences. On the one hand, the two participants with the most positive initial attitude scores remembered mathematics classes throughout their schooling as easy and fun. They remembered feeling successful with and confident about mathematics. On the other hand, the two participants with the most negative initial attitudes remembered mathematics classes throughout their schooling as tough and stressful. They remembered struggling with mathematics, feeling unsuccessful, and lacking self-confidence about mathematics.

The two participants with the highest attitude scores took upper-level mathematics courses every year of high school and in college. The two with the lowest attitude scores took only the three required courses in high school and had to retake required college courses several times before passing. The high-scoring participants had a good understanding of the concepts, and even when they were confused, they were eventually able to make sense of the mathematics on their own. The low-scoring participants had trouble understanding concepts and had to rely on memorization when the teacher would not explain.

The two with the most positive attitude scores were both excited at the beginning of the methods course, while the two with the lowest scores were nervous and worried about the methods course. They both felt better about the course once it had started
because they were learning new strategies that were helping their conceptual understanding.

From these interviews, it appears that conceptual understanding was a key difference between the two participants with extremely high attitude scores and the two with extremely low attitude scores. On the one hand, Hermione and Torri both talked about their abilities to figure out and make sense of mathematics, even when they may have initially been confused. On the other hand, Mary and Lisa referred repeatedly to their struggles with understanding mathematics concepts. It is interesting to note that those participants with the highest attitude scores did not always make the highest grades. However, even when their grades were somewhat low, they still felt confident in their understanding of the concepts. In contrast, when Lisa received good grades in high school, she felt that she did not deserve them because she did not have conceptual understanding of the content from those courses. Perhaps developing self-confidence with mathematics begins with developing conceptual understanding of the mathematics. One would expect self-confident students to have experienced prior success with mathematics, and one would usually look at grades as a measure of success. However, it appears that these interviewees related their self-confidence and success with mathematics to conceptual understanding rather than to grades.

The importance of conceptual understanding in developing positive attitudes toward mathematics is especially important for preservice teachers because it seems to affect their teaching self-efficacy. Both Mary and Lisa concluded their interviews by saying that they were concerned about teaching mathematics. They said that they feared
they would not be able to teach children mathematical concepts that they had trouble understanding themselves.

One of the common experiences that the two participants with extremely negative attitudes shared was especially noteworthy. They both mentioned having one special teacher in high school who helped them. Both of these teachers made themselves available to their struggling students as much as possible. Students could come for help any time including lunch periods as well as before and after school; one of them was even available for tutoring outside of school. These special teachers helped their students by teaching them strategies and helping them catch up with basics they had missed. Mary said that she felt “comfortable and confident” because of the strategies this teacher had taught her. This reinforces the notion that students relate positively to teachers who demonstrate that they care about their students by taking time to help them.

Torri’s experiences in elementary schools here in the U.S. and overseas were also interesting. When she attended a U.S. military elementary school in Germany, she remembered mathematics being fun. She recalled manipulatives, hands-on activities, using different techniques to solve problems, and group work. When she returned to the U.S. in fifth grade, she remembered that the focus was on algorithms, worksheets, and textbooks. Torri also benefited from a summer program in middle school where they used problem-solving activities and focused on student strategies. Perhaps these early exposures to constructivist-teaching methods might have influenced Torri’s ability to make sense of mathematical concepts and her positive attitudes toward mathematics.

Studies have suggested that a positive attitude toward mathematics may increase one’s tendency to elect mathematics courses in high school and college (Haladyna,
Shaughnessy, & Shaughnessy, 1983). Findings from Question Five seem to support this. The two participants with the highest attitude scores took upper-level mathematics courses every year of high school and in college. The two with the lowest attitude scores took only the required mathematics in high school. They both had to retake required college courses several times before passing.

Implications and Recommendations for Practice

The reform movement in mathematics education has recognized the importance of affective issues and the connection between these issues and higher-order thinking. The National Council of Teachers of Mathematics has established goals involving students’ dispositions toward mathematics that include value, self-confidence, interest, and perseverance. Results from this study lead to some implications and recommendations for teacher educators who seek to improve the attitudes toward mathematics of preservice elementary school teachers. By studying preservice elementary teachers’ attitudes toward mathematics and the experiences that have played a crucial role in the development of these attitudes, teacher educators can use this information to develop training programs aimed at improving these attitudes. These results also provide some implications and recommendations for mathematics teachers at all levels.

Mathematics Teacher Educators

The literature tells us that many preservice elementary school teachers have negative attitudes toward mathematics (Rech et al., 1993; Cornell, 1999; Philippou and Christou, 1998). The results from this study support these previous findings. Teacher
educators need to do more to improve the attitudes toward mathematics of future
elementary school teachers, especially their self-confidence, enjoyment, and motivation. It is important for teacher educators to realize that many of their students who have negative attitudes toward mathematics are motivated to improve their attitudes in order to be better teachers. The preservice teachers in this study wanted to gain confidence with mathematics and develop positive attitudes toward mathematics in their future students. Teacher educators should also know that these preservice teachers wanted to learn how to accommodate different learning styles, how to help their future students view mathematics as relevant, and how to make mathematics interesting for their future students. Teacher educators must do all they can to provide preservice teachers with the opportunity to accomplish all of these goals.

The contrasting relationship between key elements of positive memories and those of negative memories offered a clear view of the types of experiences that encouraged the development of positive and negative attitudes in these participants. In their memories of elementary school, participants associated the use of manipulatives, cooperative learning, games, and real-life projects with positive memories. They recalled classrooms where mathematics was interesting and enjoyable, and the teacher taught concepts in different ways. They remembered feeling successful with mathematics. It is important for teacher educators to stress the use of these teaching methods with their preservice teachers. However, this is not enough. Participants also associated positive memories with teachers who were patient, supportive, and encouraging. These teachers were always available to help struggling students. By making themselves available for help, these teachers let their students know that they cared. Preservice teachers should be
encouraged to be patient and supportive with their students, providing them with a positive classroom environment where they can feel confident about mathematics. Perhaps a discussion concerning the development of attitudes toward mathematics should become a part of mathematics methods courses.

Nearly all of the participants who were interviewed said that they had always struggled with problem solving, and nearly all of them said that their problem-solving skills had improved as a result of the methods course. Problem solving is an essential component of the reform movement in mathematics education, and teacher educators should model teaching with problems in their methods courses whenever possible. By encouraging preservice teachers to invent and share their own solution strategies, perhaps future teachers will not only improve their own problem-solving skills, but also feel more confident about problem solving and be more likely to use problem solving with their own students.

All of the participants were very positive about journal writing. They enjoyed writing them, and they found it beneficial to reflect on both their past experiences with mathematics and on their future teaching of mathematics. Many articulated that they had gained a great deal of insight about their own attitudes toward mathematics and the experiences that had influenced the development of those attitudes. They thought that journals provided an excellent means of communication with the course instructor. Although reading and responding to student journals is quite time consuming, it is a worthwhile practice. If teacher educators do not have enough time to read and respond to eight journals as the researcher did, perhaps assigning fewer would still be useful. Participants thought that the researcher’s responses to their journals were another positive
aspect of journal writing. This indicates that teacher educators should not assign journal writing unless they will read and respond to each journal.

*Mathematics Teachers at All Levels*

These findings provide implications not only for teacher educators, but also for mathematics teachers at all levels. Students associated positive memories with feelings of success with mathematics. They recalled the confidence and pride that accompanied success. It is important for teachers to help their students experience feelings of confidence and success rather than feeling frustrated, intimidated, and stupid as many of the participants described.

Many participants associated positive feelings about mathematics with positive teachers who were patient and supportive. Unfortunately many participants remembered mathematics teachers who were much different. These teachers were not willing to provide extra help to students who were struggling. Some teachers even singled out struggling students, causing them to feel embarrassed and humiliated. Some teachers would ridicule, embarrass, and even punish students when they asked a question or could not respond correctly to the teacher’s question. All mathematics teachers should provide a positive classroom environment where students feel supported and can ask questions without fear of embarrassment.

It is also important for mathematics teachers to note that participants remembered benefiting from the use of manipulatives, cooperative learning, real-life projects, games, and teachers who taught concepts in more than one way. Many remembered mathematics classes that used these methods as fun and enjoyable. However, many others had negative
memories of mathematics classes that were boring, not relevant to real life, and mostly drill work. Mathematics teachers at all levels must work harder to create classrooms where students are actively engaged and interested.

Conceptual understanding was a key difference between the two participants with extremely high attitude scores and the two with extremely low attitude scores. Those with the highest scores talked about their abilities to figure out and make sense of mathematics, while the two participants with the lowest scores referred repeatedly to their struggles with understanding mathematics concepts. This suggests that perhaps developing self-confidence with mathematics begins with developing conceptual understanding of the mathematics. Teachers must provide students with learning experiences in which they experience the excitement that comes from making sense of mathematics instead of memorizing formulas and rules. This focus on making sense of mathematics is an essential component of the reform movement in mathematics education.

Teachers also need to develop students’ motivation toward mathematics. It is important for teachers to help students understand the role mathematics plays in fields that they might find interesting or challenging, such as engineering, science, and technology, so that they will be more motivated to take more upper-level mathematics classes. Helping students realize these types of connections between the mathematics they are learning in school and its applications in the outside world is also strongly encouraged by the reform movement.

Although most of the interviewees were very positive about the use of cooperative learning in teaching mathematics and in the methods course, three of the seven had some
reservations. Two said that they did not like group assignments because someone in the
group usually ended up doing more of the work while others did not do their share.
Another interviewee said that cooperative learning should not be “a constant thing,” and
that students sometimes like to figure things out for themselves. These perspectives
should inform all teachers that cooperative learning may not always be right for every
student, and that some students may benefit from working alone. When using a group
assignment, teachers should devise a means for students to assess their own role and level
of participation in the group project so that no one will feel that they have done all the
work.

Results from this study are encouraging. However, improving preservice teachers’
attitudes toward mathematics is not enough. Mathematics educators should be focused on
developing positive attitudes in our youngest students and then doing all we can to help
them maintain these positive attitudes as they get older. We mathematics educators must
ask ourselves why so many of our students have negative attitudes toward mathematics,
and what we can do to avoid this with future students. In journals and interviews from
this study, participants repeatedly recalled one special mathematics teacher or tutor who
stood out from all of their other teachers. These special teachers were able to help their
students feel positive about mathematics and about themselves with mathematics. I would
encourage all mathematics educators to strive to be that special teacher to all of their
students, as this research indicates that one special teacher has the capacity to influence
his or her students for many years to come. Throughout their journals and interviews,
participants in this study have consistently connected positive memories and feelings
about mathematics with special teachers who treated them with care and respect and who
helped them understand and feel confident about mathematics. I urge all mathematics educators to adopt the following practices that were associated with special teachers who made a positive difference in the lives of their students:

- Show students that you care about them and their learning by being willing to take time to provide extra help for struggling students.
- Be patient, approachable, and create a comfortable classroom environment where students feel comfortable asking questions. Do not ever embarrass them or make them feel stupid.
- Encourage students to embrace mathematics rather than fear it. Model a positive attitude toward mathematics for your students.
- Help students feel successful and confident with mathematics.
- Help students understand mathematical concepts and allow enough class time for them to process new concepts.
- Make mathematics fun, interesting, and relevant.
- Use teaching methods that accommodate different learning styles, including manipulatives and group work.
- Let students know that there is more than one way to solve problems and encourage them to share their own solution strategies.

These results raise a number of questions about which mathematics educators at all levels should be concerned:

1. Why does the memory of one special teacher who offered individual help and encouragement, was sensitive to students’ struggles, and expressed confidence in students’ abilities seem to be the exception rather than the rule?
2. Results from this study indicated that participants valued mathematics, but, as a whole, they did not enjoy mathematics or feel self-confident or motivated about mathematics. Do students really value mathematics, or are they merely mimicking what they have been told by teachers regarding the importance of mathematics?

3. Do mathematics teachers themselves genuinely value and enjoy mathematics? How can we encourage students to experience the excitement and appreciate the relevance of mathematics if we, as teachers, do not feel this way ourselves?

4. Journal and interview comments indicated that some students had very positive memories about competitive games and drills, although others remembered such activities as stressful and anxiety producing. How can teachers find the balance needed to help all of their students develop positive attitudes toward mathematics?

5. Several participants recalled mathematics classes as “boring” and “dull.” How do we, as teachers, share our enthusiasm about and love of mathematics with our students?

6. The vast majority of preservice elementary school teachers are females. Only one of the participants in this study was a male. How do females’ attitudes toward and experiences with mathematics compare with those of males?

7. Previous studies have shown that many preservice elementary school teachers have negative attitudes toward mathematics (Cornell, 1999; Hungerford, 1994; Philippou and Christou, 1998). This study supports these findings. Rech, Hartzell, and Stephens (1993) found that preservice elementary teachers have less favorable attitudes toward mathematics than the general university population.
Why are so many students with negative attitudes toward mathematics choosing the field of elementary education?

Professionals in the field of mathematics education must find answers to these questions if we want our students to value and enjoy mathematics and feel motivated and self-confident about mathematics.

Implications and Recommendations for Future Research.

Several studies involving teacher-training programs that utilized constructivist instructional methods have shown positive results in improving the attitudes and teacher self-efficacy of preservice elementary teachers (Anderson and Piazza, 1996; Gibson and Van Strat, 2001; Huinker and Madison, 1997; McGinnis et al., 1998; Philippou and Christou, 1998; Quinn, 1997; Sherman and Christian, 1999). All of these studies used constructivist methods including collaborative group work, problem solving, and manipulatives. Results from this study seem to both support and contradict these prior findings. All three classes in this study utilized constructivist-teaching methods, but only those participants in the journal-writing class showed a significant positive change in attitudes toward mathematics.

Because this study was not experimental in nature or design, it is not possible to determine if journal writing was the reason why the attitudes toward mathematics for one class improved dramatically while the others did not. Perhaps the opportunity for preservice teachers to reflect on their attitudes toward and experiences with mathematics was a factor in their positive attitude change. A future study that was experimental in nature would help shed light on this issue. If random assignment were not possible due to
university scheduling, perhaps a random choice of which existing classes would be designated as the experimental group and control group would be beneficial. In order to minimize the effects of irrelevant variables, course activities and procedures could be more standardized than they were in this study. Another possibility would be to have the same instructor teach two classes, one with journal writing and one without journals. This would eliminate the instructor variable.

Further studies could also investigate other possible factors that could have influenced these results. University student evaluation forms offered one possible explanation. At the end of each semester, university students are asked to complete an anonymous evaluation of each course and instructor, and the instructor is able to view them after the course is completed. Twelve participants wrote comments on their evaluation of the methods course, and nine of the comments were relevant to this study. It was interesting that five of the nine anonymously-made comments referred to the organization of the course:

- I really liked the course because it was so well organized and the new ideas were presented so well.
- [Instructor] really is clear about her wants and expectations from students. She represents materials clearly and instructs clearly, very organized.
- [Instructor] was very clear on instructions and assignments.
- [Instructor] makes everything easy to understand. She is well organized.
- I like how we knew about everything we had to do—helped keep things organized.
These comments were especially noteworthy because Jennifer, the participant with the second highest positive attitude change score, immediately referred to the organized format of the methods course when asked which aspects of the course she thought had influenced her attitude change. Perhaps students with negative attitudes toward mathematics feel more comfortable with mathematics and more in control when they feel organized. Further research is needed in this area.

Two of the student evaluation comments suggested another possible factor that could have influenced the large positive attitude change that the participants demonstrated:

- [Instructor] really provides a comfortable and secure environment and really cares about the students!
- She was a great instructor—very concerned and considerate of students.

Student journals from this study and from previous classes taught by the researcher clearly spelled out those teacher behaviors that had a negative effect on students’ attitudes toward mathematics and those that had a positive effect. Creating a comfortable classroom environment and showing care, concern, and consideration for students were all included in the positive category. Perhaps reading students’ reflective journals over the past four years has influenced the researcher’s teaching style and ways of interacting with students and has increased the researcher’s awareness of and sensitivity to students’ attitudes toward mathematics. Reflections from the researcher’s journal (p. 203) offer some insight into this. Further studies are needed to investigate the effects of teacher behavior on students’ attitudes toward mathematics.
Results from this study supported the view that attitudes toward mathematics and achievement in mathematics are related. The strong correlation of 0.53 found in this study also supported previous findings that the correlation between attitudes and achievement strengthens as students get older. More research is needed in order to investigate further this pattern of increasing correlation between attitudes and achievement as students get older.

Studies have shown that teachers who have negative attitudes toward mathematics are more likely to view and teach mathematics in a more traditional manner (Philippou and Christou, 1998; Stipek, Givvin, Salmon, and MacGyvers, 2001). The participants in this study had initial attitudes that were somewhat negative, but the beliefs that they expressed were not particularly indicative of traditional beliefs. In fact, many of them seemed to reflect constructivist ideas that were being promoted in the methods course. It is important to remember that the initial attitudes were measured at the beginning of the semester, but the journals were written throughout the semester. This may indicate that as participants’ attitudes toward mathematics were changing, perhaps their beliefs were as well. Further research is needed to see if this is the case. Because the ATMI measures the attitudes of value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics and not beliefs about teaching and learning mathematics, a similar study is needed where a pre-course and post-course belief survey is used in addition to a pre- and post-course attitude survey.

Studies have shown that children typically begin school with positive attitudes toward mathematics, but these attitudes tend to become less positive as they get older. By the time students reach high school, their attitudes toward mathematics have frequently
become negative (McLeod, 1992). Results from this study seem to support McLeod’s findings. Further research is needed to explore why students’ attitudes toward mathematics tend to be positive in elementary school and become more negative as they progress through secondary school.

Although these results of improved attitudes toward mathematics are encouraging, future studies that follow these preservice teachers past their teacher training programs and into their first few years of teaching would be useful. Exploring how their reflection about their attitudes influences their teaching strategies and investigating if their attitude changes remain stable over time would both be beneficial to the field of mathematics education.
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APPENDICES
Appendix A: Pilot Study I

Purpose of Study

The purpose of this study was to examine the attitudes toward mathematics of preservice elementary school teachers enrolled in an introductory mathematics methods course and to explore these attitudes and the experiences that have led to the development of these attitudes through reflective journals and interviews. The study sought to answer the following questions:

1. What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course?
2. What do the reflective journals of preservice elementary school teachers enrolled in an introductory mathematics methods course reveal about their attitudes toward and experiences with mathematics?
3. What are the attitudes toward and experiences with mathematics of those preservice elementary school teachers identified as having the most negative attitudes?
4. What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

Methods

Participants

The participants in this study were 31 university students enrolled in one section of a mathematics methods course at a major research university in the southeastern
Appendix A (Continued)

United States during the spring semester, 2003. Students enrolled in this course typically are juniors and seniors who are working toward state certification as teachers of grades kindergarten through six. Thirty of the students were females and one was male. Twenty-seven of the participants were between the ages of 20 and 30, three were between ages 31 and 40, and one was between ages 41 and 50. The researcher was the instructor for this course.

Procedure

Each student completed the Attitudes Toward Mathematics Inventory (ATMI) at the beginning of the semester. The survey scores were used to identify those students with the most negative attitudes. The ATMI (Appendix E) contains 40 items, and students are asked to indicate their degree of agreement with each statement using a Likert-type scale from one to five, from strongly disagree to strongly agree. The instrument has been tested for internal consistency and construct validity and measures the following four components: (1) student’s self-confidence, (2) value of mathematics, (3) motivation, and (4) enjoyment of mathematics (Tapia & Marsh, 1996).

Throughout the semester participants submitted reflective journal entries as part of their course assignments. Journal entries were submitted by e-mail, and the instructor responded to each entry by e-mail. Students were not asked to sign consent forms for the use of journals until the end of the semester. Therefore, at the time they wrote them, students were unaware that their journals would be used in a research study. However,
they had signed consent forms for the survey and knew that the survey results would be part of a research study. The following journal prompts were among those given and were the focus of this research project:

1. Discuss any feelings (positive or negative) that you have about taking this course. What are you hoping to gain from the course?

2. What are your memories of learning mathematics in elementary school (attitudes, success, etc.)? What can you, as a future teacher, learn from these experiences?

The two students with the lowest scores on the ATMI participated in individual interviews where their attitudes toward and experiences with mathematics were further explored. The *Experiences with Mathematics Interviews* took place during week twelve of a fifteen-week semester. They were audio taped and later transcribed.

In addition, two students were interviewed six months after the completion of the methods course. These *Changed Attitudes Interviews* focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. The *Changed Attitudes Interview* protocol (Appendix I) asked participants how they felt about the use of manipulatives, cooperative learning, problem solving, and journals in the methods course and also in teaching mathematics in general. These interviews were also audio taped and then transcribed.
Appendix A (Continued)

Data Analysis

Surveys. Scores for each participant on each of the four attitudinal components, as well as a composite attitude score, were calculated using the software program SAS. Scores on the ATMI range from 40 to 200. There are 10 items dealing with Value, 10 with Enjoyment, 15 with Self-Confidence, and 5 with Motivation. Because there were unequal numbers of items for each attitude factor, the average score per attitude factor was calculated in order to make comparisons more easily. These average per-item scores range from one to five.

Journals. After reading each student journal entry related to a given prompt or listening to and reading the transcription of an interview for a sense of the whole, units of general meaning (Hycner, 1985) were delineated. Themes were then identified from the data and recorded using the computer software program Ethnograph.

Results

Surveys: Initial Attitudes Toward Mathematics

Participants’ initial survey scores were highest or most positive for Value of Mathematics, with a mean score of 4.17 on the 5-point scale ranging from strongly disagree to strongly agree. A score of five represents the most positive attitude, a score of three represents a neutral position, and a score of one represents the most negative attitude. The lowest or most negative scores were for Motivation, with a mean score of 2.65. Results from the initial survey are found in Table A-1.
Appendix A (Continued)

Table A-1

*Initial Attitudes Toward Mathematics*

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
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<tbody>
<tr>
<td>Value</td>
<td>4.17</td>
<td>0.57</td>
<td>-0.31</td>
<td>-0.68</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>3.10</td>
<td>1.20</td>
<td>-0.34</td>
<td>-1.48</td>
</tr>
<tr>
<td>Self- Confidence</td>
<td>3.23</td>
<td>1.15</td>
<td>-0.30</td>
<td>-1.43</td>
</tr>
<tr>
<td>Motivation</td>
<td>2.65</td>
<td>0.96</td>
<td>0.31</td>
<td>-1.45</td>
</tr>
<tr>
<td>Composite</td>
<td>3.36</td>
<td>0.91</td>
<td>-0.20</td>
<td>-1.58</td>
</tr>
</tbody>
</table>

*Note.* Scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.

*Surveys: Relationship Between Initial Attitudes and Final Exam Grade*

A Pearson correlation coefficient was found using the software program, SAS, in order to determine the relationship between initial attitudes toward mathematics and achievement in the methods course. Achievement was measured using the methods course final examination. This departmental test is a 50-item multiple-choice instrument that includes questions about both mathematics content and pedagogy. The composite attitude score was used as the independent variable and the methods course final examination grade was used as the dependent variable. An alpha level of 0.05 was used to indicate whether the obtained correlation was statistically significant. A statistically significant Pearson Correlation Coefficient of $r = 0.39508$ was found, indicating a moderately strong positive correlation ($p = 0.0278 < .05$, $n = 31$).
Appendix A (Continued)

*Journal One: Feelings About Course*

The first journal entry asked students to discuss any feelings, positive or negative, that they had about taking the methods course. Responses were analyzed and positive, negative, and neutral themes were identified. Some of the journal entries expressed multiple themes, and these themes were analyzed separately. Therefore, frequencies may total more than 31. Table A-2 shows the themes that were identified at the beginning of the course.

The following journal excerpts are representative of data responses for each of these themes:

- *Positive themes about course.* “I’m excited about taking this course. I always enjoyed math when I was in elementary school, and I am excited to teach it.”
- “I am very excited about this course. It is my first Elementary Education course, and I am glad to finally be starting on classes towards my major.”
- “The feelings I have about taking this course are all positive. I am so excited to learn how to teach my students to become better in mathematics.”
- *Negative themes about course.* “Prior to attending class, I was filled with anxiety about being forced to take another math class.”
- “I was very nervous about taking this class at first. I have never been good at math and I was afraid we would be relearning everything at a quick pace. I definitely was not looking forward to starting this class.”
Appendix A (Continued)

Table A-2

Themes Identified at Beginning of Elementary Mathematics Methods Course

<table>
<thead>
<tr>
<th>Feelings</th>
<th>Frequency^a</th>
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</thead>
<tbody>
<tr>
<td><strong>Positive Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>Excited about course</td>
<td>10</td>
</tr>
<tr>
<td>Feel positive, Look forward to</td>
<td>9</td>
</tr>
<tr>
<td><strong>Negative Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>Nervous, worried, apprehensive</td>
<td>9</td>
</tr>
<tr>
<td>Don’t enjoy mathematics</td>
<td>2</td>
</tr>
<tr>
<td><strong>Neutral Feelings</strong></td>
<td></td>
</tr>
<tr>
<td>No feelings yet</td>
<td>3</td>
</tr>
</tbody>
</table>

^aTotal frequency of 33. Total frequency of 19 positive feelings came from 17 of the 31 participants. This represented 46.3% of all comments made for this prompt. Total frequency of 11 negative feelings came from 8 of the 31 participants. This represented 26.8% of all comments made for this prompt. Total frequency of 3 neutral feelings came from 3 of the 31 participants. This represented 7.3% of all comments made for this prompt.

- **Negative themes about course (continued).** “I have a few negative feelings about this course simply because I don’t enjoy math and never have.”

- **Neutral themes about course.** “I truly do not have any feelings for this class yet.”

Some students expressed negative attitudes toward mathematics that were not specific to the methods course. The following are representative of these attitudes:

- “I have really never been a very good math student. I just don’t get it.”
Appendix A (Continued)

- “I made an A in my last math class, but deep down in my heart, I felt that it must have been a fluke.”
- “Mathematics has never been one of my favorite subjects, nor has it been one of my strongest.”
- “I am sorry to say I do have a very negative attitude about math that goes way, way back to really bad teachers that probably felt like I do about math.”

Journal One also asked the students what they were hoping to gain from the course. Table A-3 summarizes the themes that were identified in addressing this question and the frequencies with which these themes were cited. The journal excerpts that are given for each theme are representative of data responses given.

Journal 2: Memories of Mathematics in Elementary School

The second journal entry asked students to reflect on their memories of learning mathematics in elementary school. Initially, 13 distinct units of meaning associated with positive memories and 27 units associated with negative memories were identified. As themes emerged, those representing similar concepts were combined. For example, several students had negative memories that focused on learning a specific mathematics concept. Initially these were grouped by topic, but they were later combined into one category, which was called ‘Negative Memory about Learning Specific Topics.’

The following excerpt was initially categorized as ‘Negative Memory about Multiplication Facts’:
Table A-3

*Themes from Journal Prompt: What Do You Hope to Gain From the Course?*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Better understand</td>
<td></td>
<td>“I am hoping to gain a better understanding of math from your advice and teachings. I find the more people who help me with math, the better.”</td>
</tr>
<tr>
<td>math, sharpen</td>
<td></td>
<td></td>
</tr>
<tr>
<td>math skills</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I am hoping that this class will give me some confidence so that I am not so scared of math and that I am confident in my abilities to be able to teach it well.”</td>
</tr>
<tr>
<td>Gain confidence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>in math</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>“I want to learn how to create a safe environment for those ‘afraid’ of math. I want students in class to not be intimidated by the math process.”</td>
</tr>
<tr>
<td>Help students to:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>be confident</td>
<td>1</td>
<td>“I want to be able to reach students like me who have a harder time in math or children who give up too easily, never finding the answer.”</td>
</tr>
<tr>
<td>about math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>not give up</td>
<td>1</td>
<td>“I want to learn how to create a safe environment for those ‘afraid’ of math. I want students in class to not be intimidated by the math process.”</td>
</tr>
<tr>
<td>be comfortable</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>with math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>not be intimidated</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>by math</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Continued on the next page
Table A-3 (Continued)

Themes from Journal Prompt: What Do You Hope to Gain From the Course?

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency$^a$</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop teaching</td>
<td></td>
<td>“I would like to learn effective ways to teach math. I would also like to know about mistakes that can be made so I can avoid them.”</td>
</tr>
<tr>
<td>strategies</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>Make math:</td>
<td></td>
<td>“I’m hoping to learn how to teach math in a fun and interesting way.”</td>
</tr>
<tr>
<td>interesting</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>fun</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Meet needs of students</td>
<td></td>
<td>“I hope to gain a better understanding about what kids need, how to use the materials around me, and to become the kind of teacher that all kids learn from!”</td>
</tr>
<tr>
<td>Change own</td>
<td></td>
<td>“I need to change the way that I view math. I have an academic lifetime of negative feelings towards math, and I do not want to bring that to my instruction with my students.”</td>
</tr>
<tr>
<td>negative attitude</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

$^a$Total frequency of 40 came from all of the 31 participants. This represented 100% of all comments made for this prompt.

“I remember that I could not remember my multiplication [basic facts]. I had always been an ‘A’ student in math, but I just could not figure them out.”

The following excerpt was initially categorized as ‘Negative Memory about Multiplication Facts’ and also ‘Negative Memory about Fractions.’ It was later counted as two instances of ‘Negative Memory about Learning Specific Topics.’

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Appendix A (Continued)

“The first thing that jumped into my mind when I thought of my elementary school math days was ‘multiplication tables’ and ‘ugh, fractions’.”

Those journal entries reflecting positive memories are summarized in Table A-4. In addition, the following positive memories of mathematics teachers in elementary school were each mentioned once:

- Teacher as facilitator: “[The teacher] lets you figure it out without telling you the answer. This worked very well, because then you figure out where you went wrong on your own, you are more likely to remember the next time.”

- Teacher provided individual help: “[The teacher] helped me to understand things that I was having problems with by …working with me one on one when necessary.”

- Teacher was patient: “[The teacher] was very patient, and he never embarrassed anyone. I was not afraid to try in his class.”

- Teacher provided repetition: “I can remember my math teachers as being very repetitive…. For me, this was great. I learn well doing repetition.”

- Teacher helped students understand: “[The teacher] had a way of making everyone understand the math we had to do in class.”
Table A-4

*Positive Memories of Mathematics in Elementary School*

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fun</td>
<td>4</td>
<td>“[Math] was fun. It seemed like I wasn’t doing work, just playing.”</td>
</tr>
<tr>
<td>Good at it</td>
<td>9</td>
<td>“I was always good at math when I was younger. I wanted to practice it all the time. The thing I remember the most is how proud my third grade teacher was of me when I memorized my times tables.”</td>
</tr>
<tr>
<td>Enjoyed it</td>
<td>3</td>
<td>“I think I enjoyed it because I understood it and I made good grades in it.”</td>
</tr>
<tr>
<td>Use of songs</td>
<td></td>
<td>“I did enjoy math in elementary school because I like the use of manipulatives … It was almost like playing with toys.”</td>
</tr>
<tr>
<td>Work in groups</td>
<td>2</td>
<td>“We got to do lots of group work which I feel can be helpful to students.”</td>
</tr>
<tr>
<td>Speed tests</td>
<td>1</td>
<td>“I liked the speed test because it was a race against your friends.”</td>
</tr>
<tr>
<td>General</td>
<td>1</td>
<td>“I have great memories of mathematics from elementary school, even though some students may have hated it.”</td>
</tr>
</tbody>
</table>

<sup>a</sup>Total frequency of 23 came from 13 of the 31 participants. This represented 23.5% of all comments made for this prompt.
Appendix A (Continued)

Those journal entries reflecting negative memories from elementary school are summarized in Table A-5. Students’ negative memories of mathematics teachers are summarized in Table A-6.

Some students expressed beliefs about mathematics, teaching mathematics, and learning mathematics. The following are representative of these beliefs:

- “Personally I feel that math is one of the most important subjects for students to learn. Unfortunately, math is usually the subject that most students hate.”
- “Math is a very difficult subject to teach in my opinion.”
- “Many kids and even adults hate math and give up.”
- “Because I struggled with math, my attitude set me up to fail.”
- Math should not be a subject to be intimidated by, but for so many people (including myself), it is.”
### Table A-5

**Negative Memories of Mathematics in Elementary School**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequencya</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did not do well</td>
<td>13</td>
<td>“On my report cards, I excelled in everything but math (and cutting on the lines!)”</td>
</tr>
<tr>
<td>Did not like</td>
<td>3</td>
<td>“I remember math being one of my least favorite subjects.”</td>
</tr>
<tr>
<td>Frustrating</td>
<td>3</td>
<td>“I remember being very frustrated with math and often giving up.”</td>
</tr>
<tr>
<td>Boring</td>
<td>2</td>
<td>“In elementary school, I remember math being very boring and not very fun.”</td>
</tr>
<tr>
<td>Confusing</td>
<td>3</td>
<td>“To a child, it was confusing. I guess I need a concrete strategy to go with my particular learning style.”</td>
</tr>
<tr>
<td>Too much drill</td>
<td>3</td>
<td>“I remember having to write out the “times tables” again and again, drill and practice. I HATED doing that!! I started zoning out when the teacher said, ‘Open your math books to page …’ and didn’t tune back in until science.”</td>
</tr>
<tr>
<td>Specific topics, especially mult. facts</td>
<td>11</td>
<td>“In elementary school I remember that I could not remember my multiplication [facts]. I just could not figure them out.”</td>
</tr>
<tr>
<td>Not challenging</td>
<td>1</td>
<td>“I remember it as being fun but not challenging.”</td>
</tr>
<tr>
<td>Too much pressure</td>
<td>3</td>
<td>“I think I never really liked it because I tend to be slower when it comes to figuring things out. I can’t think well under pressure.”</td>
</tr>
</tbody>
</table>

*Total frequency of 42 came from 21 of the 31 participants. This represented 42.9% of all comments made for this prompt.*
Table A-6

**Negative Memories of Mathematics Teachers**

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Only taught</td>
<td>4</td>
<td>“The math teachers I had in elementary school only had one way of teaching the lessons. This made it difficult for me because I did not always understand the way my teacher was teaching the lessons.”</td>
</tr>
<tr>
<td>Would not help</td>
<td>4</td>
<td>“She gave us bookwork and told us to read and figure it out. As a result, I had no clue what was going on and I completely lost interest.”</td>
</tr>
<tr>
<td>Boring, old, lazy, drab</td>
<td>5</td>
<td>“One teacher severely hindered my ability to excel because she was burned out and lazy!”</td>
</tr>
<tr>
<td>Impatient, moved on too quickly, intimidating</td>
<td>3</td>
<td>“In fifth grade I remember my teacher was very intimidating and I was always asking friends for help when I didn’t understand something.”</td>
</tr>
<tr>
<td>Lack of content knowledge</td>
<td>1</td>
<td>“It really was a shame how badly I was taught math, by a teacher who didn’t know much math herself.”</td>
</tr>
<tr>
<td>Generally negative memory</td>
<td>3</td>
<td>“The teacher didn’t seem to know what to do to help either. She said that teaching math was her weakness.”</td>
</tr>
</tbody>
</table>

*aTotal frequency of 20 came from 11 of the 31 participants. This represented 20.4% of all comments made for this prompt.*
Appendix A (Continued)

Journal Two also asked students what they, as future teachers, had learned from these experiences. Table A-7 summarizes their responses.

Table A-7

Themes from Journal Prompt: What Did You Learn as a Future Teacher?

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Want to make math fun,</td>
<td>11</td>
<td>“What I want my students to learn is that even if math isn’t their strongest subject it can still be fun.”</td>
</tr>
<tr>
<td>Want students to feel confident, positive</td>
<td>8</td>
<td>“The most important thing that I learned from my experiences is that I do a lot better in a class if my teacher and I have confidence in me.”</td>
</tr>
<tr>
<td>Use manipulatives, rhymes, songs</td>
<td>4</td>
<td>“I learned well with manipulatives so I will use those a lot especially since they have so much more to choose from.”</td>
</tr>
<tr>
<td>Use cooperative learning</td>
<td>3</td>
<td>“Using cooperative learning is very important in math. Students seem to learn better when they have help from their peers or watching their peers solve problems.”</td>
</tr>
<tr>
<td>Make math relevant</td>
<td>7</td>
<td>“Practical applications, how and why will they need to know this; this is what I want to emphasize to my students.”</td>
</tr>
</tbody>
</table>

Continued on the next page
Table A-7 (Continued)

Themes from Journal Prompt: What Did You Learn as a Future Teacher?

<table>
<thead>
<tr>
<th>Theme</th>
<th>Frequencya</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accommodate</td>
<td>4</td>
<td>“I have learned how to teach using all different kinds of different learning methods so the students may learn in a way that is easiest styles for them.”</td>
</tr>
<tr>
<td>Make math</td>
<td>3</td>
<td>“Math does not have to be worksheet after worksheet, timed more than tests, and drills. My goal as a teacher is to look both just drill inside and outside the box.”</td>
</tr>
<tr>
<td>Be patient</td>
<td>4</td>
<td>“As a future teacher, I will strive for patience with my students when I am teaching math.”</td>
</tr>
</tbody>
</table>

aTotal frequency of 44 came from all of the 31 participants. This represented 100% of all comments made for this prompt.

Experiences with Mathematics Interviews

‘Sandra.’ Sandra’s score on the ATMI was the lowest in the class, indicating the most negative attitude toward mathematics. One of Sandra’s most vivid memories of elementary school mathematics was of learning multiplication and division basic facts in third grade. She remembered enjoying practicing at home with her sisters as they played school. Her other memory of elementary school occurred in fifth grade. She was doing well in her mathematics class, so the teacher moved her to a more advanced class. She
immediately felt lost when she realized that the new class was working on material that she had not yet seen:

   The first day I knew I was lost and I think I stayed maybe a week in there. And they had already passed what we knew, and to me, it was like, ‘I’m not going to try and catch up,’ you know, I was already lost, so I went back to the class and enjoyed the fact that I had the highest grade in the class!

Sandra’s problems with mathematics began in seventh grade. She began having trouble understanding the concepts:

   If I didn’t get it after two times of her explaining, I would get so frustrated that I would start crying and give up. I didn’t want to know it anymore. In 8th grade I had a better teacher, but still, by that time, there were so many things that I had lost from 7th grade, that it was frustrating for me to try and keep going with it. And even if I caught on in class, by the time I went home to do the homework, I already lost it.

Sandra continued to have problems understanding mathematics in high school and college. She viewed this as a result of falling behind in middle school. When discussing her second attempt to pass a college statistics course, she recalled, “They went so fast and it was too hard to understand for me.”

Sandra was “very scared” at the start of the methods course. She was afraid that she would be “the stupid one.” When asked if her feelings had changed since the start of the course, Sandra seemed somewhat relieved:

   Sandra: Yes. It’s not like you’re testing us on our abilities; you’re teaching us how to teach and how to make sense of it, and to me, I’ve
Appendix A (Continued)

learned a lot of stuff.

JS: So, are you finding it stressful? Like you anticipated?

SE: Not necessarily. The tests are always stressful … and then today
when we were doing those questions, as a pair, and [my partner] … came
up with an answer and I said, ‘Well, I don’t understand it,’ and it
frustrated me, that she could get it and I couldn’t. But it turned out … she
was wrong, but we worked together to do it and it made sense at the end.

She had her way and I had my way.

When asked if there was anything else she would like to say about her attitudes
toward mathematics, Sandra replied:

I’m hoping I don’t have to teach a lot of it when I become a teacher …I
know I have negative attitudes still about it and I don’t want that to reflect
on the students that I’m teaching. I want them to have their own
experiences. And I’m not sure that I could overcome that … I’m hoping if
I have to that I can forget about that and move on, but…it’s something I
don’t want to do. I’m a little nervous about it.

‘Debbie.’ Debbie’s score on the ATMI was the second lowest in the class.

Debbie remembered loving mathematics in elementary school. She recalled, “I didn’t
struggle with it; it came easily, and I enjoyed it.” Middle school mathematics was also a
positive experience for her. Her troubles began in high school when she took Algebra:

When I got to Algebra, that’s, that’s when it all happened….I didn’t
understand it…. You asked [the teacher] a question and she would tell you
Appendix A (Continued)

how to do it, but she didn’t explain... It was kind of like you were a bother to her, a burden, you know? It’s like, ‘Well, you don’t get it so you’re not wasting my time,’ and that’s how I felt, so everyday when I’d go into that class, I …I dreaded it. I dreaded walking through the door. I can still see her face now, but I just, I dreaded it.

She remembered college mathematics courses in much the same way. She had to take remedial courses before she could take the college level courses. She remembered one course in particular:

I actually ended up taking it 3 times before I passed it, 3! And that is very, very hard … it was hard for me like in high school….I was so used to excelling at things and then when I got to high school, I didn’t and so … my self esteem started getting really low as far as academics go.

When asked to complete the sentence, ‘I do not enjoy or I feel negative about mathematics because … ,” Debbie’s response was: “Because it’s scary! …‘Cause I don’t always understand it… I don’t understand why or how it happened.” Debbie described herself at the start of the methods course as “a nervous wreck.” She added, “Just the word math scares me.” When asked if her feelings had changed any since the start of the class, she said, “No, not a lot. I can’t honestly say that they have changed…It just makes me nervous. Math makes me nervous.”
Appendix A (Continued)

*Changed Attitudes Interviews*

The *Changed Attitudes Interviews* took place six months after the completion of the course and focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. Interviewees were asked if they thought their attitudes toward mathematics had changed since the beginning of the methods course. Both said that they believed their attitudes had improved as a result of the course. They were then asked about those aspects of the methods course that may have influenced their attitudes toward mathematics.

‘Lynn.’ Lynn’s score on the ATMI was one of the lowest in the class, with only five of the 31 students scoring lower. When asked what aspects of the course she thought had influenced her attitudes, she immediately thought of the use of manipulatives:

What I got most out of [the methods course] was the ‘bag of tricks’ [manipulatives kit] as I call it, and how to use them. When I went to school, it was worksheets. There wasn’t even much modeling going on or anything to help you learn. That’s what I got most out of it, and that’s what I will bring into my teaching. Using the manipulatives definitely helped my own understanding.

When asked about the use of problem solving, Lynn said:

I remember a couple of times I got frustrated because I wasn’t one of the ones who got it. I could see though [how others solved it]. Solving something on your own definitely makes you feel better about math.

Reflecting on the use of journal writing in the methods course, Lynn said,
I loved them and I will use them [when teaching] in all subjects…. I think it got some of my negative attitudes out. I remember that I had made a comment in class that you overheard that I would stay home before I would teach math. I really felt that. But I’m teaching math now [in internship], so obviously my attitudes did change.

‘Brenda.’ Brenda’s score on the ATMI was the third lowest in the class. When asked about the aspects of the course that may have influenced her attitudes toward mathematics, she said:

We used manipulatives. Each step was explained, why we do this to get this. That is what gives the confidence, and with the confidence comes liking it better. I like understanding why I’m doing something, not just mindlessly doing something.

Brenda found the cooperative learning in the methods course “helpful.” She explained:

[The instructor] had time to go around and help. I could be talking to someone next to me about the problem instead of waiting for [the instructor] to go to each individual person. Maybe one or two words from someone and I get the whole thing; I understand it.

When asked about the use of problem solving in the methods course, Brenda said:

It was sometimes fun. If it’s challenging, but something [students] could achieve, for me at least, it boosts confidence, like, ‘Wow! I solved the problem. I’m a mathematician.’
Reflecting on the use of journal writing in the methods course, Brenda said:

It definitely got us to think about different aspects of things, instead of just seeing it one way. If I was remembering a bad teacher, it could make me start hating math again, but I think it’s good to remember those things so you know you are progressing or digressing in your attitudes. You know where you stand and if you’ve changed any from where you were.

Discussion

The majority of the students said that they were excited and positive about the methods course. However, many of the students expressed feelings of nervousness, worry, and apprehension at the start of the semester. They had encountered negative experiences with mathematics in the past that included not understanding the mathematics, not doing well in mathematics, and disliking mathematics. Many of the students, including those with positive and those with negative feelings about the course, hoped to develop effective teaching strategies that would allow them to make mathematics fun and interesting for their students. Several revealed that they hoped to gain confidence in their own mathematical abilities. Others said that they wanted to change their negative attitudes toward mathematics in order to avoid passing them on to their future students.

When reflecting on memories from their own elementary school mathematics experiences, several students had positive memories. Many recalled mathematics class as fun and enjoyable. These results are in line with the literature, which says that children
Appendix A (Continued)

typically have positive attitudes toward mathematics when they begin school. However, thirteen students said that they did not do well in elementary school mathematics. Many remembered feeling frustrated, confused, and pressured in mathematics class. Others remembered it as boring, with too much drill and practice. Eight students specifically recalled negative memories associated with learning the basic facts for multiplication.

When considering memories of elementary school mathematics teachers, students referred to teachers who were boring and lazy, who would not offer help when needed, who offered only one approach to concepts, who were impatient, intimidating, and who lacked content knowledge. Because the literature shows that students’ attitudes typically tend to become more negative as they get older, it is noteworthy that so many of these future teachers seem to have developed negative attitudes toward mathematics while still in elementary school.

Several students made statements that reflected their own beliefs about mathematics and teaching mathematics. Although they seemed to view mathematics as an important subject for students to learn, they also saw it as a subject that is difficult to teach and is disliked by many, if not most, people.

As students reflected on their elementary school experiences and considered what they, as future teachers, could learn from these experiences, several participants said that they wanted to make mathematics fun and interesting for their students, that they wanted their students to feel confident and positive about mathematics, and that they hoped to help their students see the relevance of the mathematics they were learning. They stressed the importance of helping students understand mathematics and providing extra help.
when needed. These future teachers felt that they had benefited from using manipulatives, songs and rhymes, cooperative learning, and activities other than drill and worksheets. They also hoped to be patient with their students, as well as accommodating of their different learning styles.

Implications

The reform movement in mathematics education has recognized the importance of affective issues and the connection between these issues and higher-order thinking. The National Council of Teachers of Mathematics has established goals involving students’ dispositions toward mathematics that include value, self-confidence, and interest. By studying preservice elementary teachers’ attitudes toward mathematics and the experiences that have played a crucial role in the development of these attitudes, teacher educators can use this information to develop training programs aimed at improving these attitudes. Using manipulatives, songs and rhymes, cooperative learning, and activities other than drill and worksheets were practices that these preservice teachers associated with positive memories and should be stressed in an elementary mathematics methods course. The methods course should focus on strategies that teachers can use to make mathematics relevant to their students’ lives, to help their students develop conceptual understanding of the material, and to accommodate their individual learning styles. Preservice teachers should be encouraged to be patient with their students, providing them with a positive classroom environment where they can feel confident about mathematics.
Appendix A (Continued)

By identifying patterns of teacher behaviors, teaching methods, and other memorable incidents that students identify as significant contributors to negative attitudes toward mathematics and by focusing methods courses on alternative teaching methods and teacher behaviors, perhaps students will complete these courses with more positive attitudes. Perhaps they will then be more likely to pass on to their future students more positive attitudes toward mathematics. In this way, perhaps the cycle of elementary school teachers with negative attitudes toward mathematics fostering negative attitudes in their own students can be broken.

These findings provide implications not only for teacher educators, but also for mathematics teachers at all levels. Students associated positive memories with feelings of success and enjoyment of mathematics. It is important for teachers to provide a positive environment for their students, where they can feel comfortable rather than intimidated, engaged and interested rather than bored, confident rather than frustrated, and successful rather than defeated. It is up to mathematics teachers at all levels to provide such an environment.
Appendix B: Pilot Study II

Purpose of Study

The purpose of the second pilot study was to determine if any changes in preservice elementary school teachers’ attitudes toward mathematics occurred during a mathematics methods course. The pilot study sought to answer the following questions:

- What are the attitudes toward mathematics of preservice elementary school teachers entering an introductory mathematics methods course? In particular, how do preservice teachers score on each of the four attitudinal components being measured: value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics?

- To what extent do attitudes toward mathematics of preservice elementary school teachers change during the mathematics methods course?

- To what do preservice teachers whose attitudes toward mathematics were altered attribute this change?

- What is the relationship between preservice elementary teachers’ initial attitudes toward mathematics and their grade on the methods course final examination?

The participants in this study were 38 university students enrolled in one section of a mathematics methods course at a major research university in the southeastern United States during the spring semester, 2004. Students enrolled in this course typically are juniors and seniors who are working toward state certification as teachers of grades kindergarten through six. Twenty-nine of the participants were between the ages of 18
and 25, three were between ages 26 and 35, four were between ages 36 and 45, and two were over the age of 45. The researcher was the instructor for this course.

Methods

Each student completed the Attitudes Toward Mathematics Inventory (ATMI) at the beginning of the semester and again during week 12 of a 15-week semester. This allowed the researcher to measure each participant’s initial attitudes toward mathematics and to assess any changes that may have taken place during the first 11 weeks of the semester. The ATMI (Appendix E) contains 40 items, and students are asked to indicate their degree of agreement with each statement using a Likert-type scale from one to five, from strongly disagree to strongly agree. The instrument has been tested for internal consistency and construct validity and measures the following four components: (1) student’s self-confidence, (2) value of mathematics, (3) motivation, and (4) enjoyment of mathematics (Tapia & Marsh, 1996).

Composite attitude scores were calculated at both the beginning and during the twelfth week of the semester. These scores were used for statistical analyses using the software program SAS. Participants’ change scores, which were their post-course scores minus their pre-course scores, were calculated. Pre-course and post-course scores are not independent, so a t-test for repeated measures was conducted to determine if a statistically significant change in attitude occurred.

Those participants with change scores greater than one standard deviation above or below the mean change score were considered for individual interviews. These
Appendix B (Continued)

Changed Attitudes Interviews focused on participants’ ideas about those aspects of the methods course that may have influenced their attitudes toward mathematics. The Changed Attitudes Interview protocol (Appendix I) asked participants how they thought their attitudes toward mathematics had changed since the start of the course. Participants were also asked how they felt about the use of manipulatives, cooperative learning, problem solving, and journal writing in the methods course and also in teaching mathematics in general. These interviews were audio taped and then transcribed. Interviews took place during the week following the completion of the methods course and submission of final grades.

Results

Surveys: Initial Attitudes Toward Mathematics

Participants’ survey scores were highest or most positive for Value of Mathematics, with a mean score of 3.64 on the 5-point scale ranging from strongly disagree to strongly agree. A score of five represents the most positive attitude, a score of three represents a neutral position, and a score of one represents the most negative attitude. The lowest or most negative scores were for Motivation, with a mean score of 2.61. Results from the survey are found in Table B-1.
Table B-1

Initial Attitudes Toward Mathematics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
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<tbody>
<tr>
<td>Value</td>
<td>3.64</td>
<td>0.73</td>
<td>-1.33</td>
<td>2.25</td>
</tr>
<tr>
<td>Enjoyment</td>
<td>2.72</td>
<td>1.10</td>
<td>0.12</td>
<td>-1.22</td>
</tr>
<tr>
<td>Self- Confidence</td>
<td>3.08</td>
<td>1.12</td>
<td>-0.28</td>
<td>-1.10</td>
</tr>
<tr>
<td>Motivation</td>
<td>2.61</td>
<td>1.01</td>
<td>-0.15</td>
<td>-1.35</td>
</tr>
<tr>
<td>Composite</td>
<td>3.07</td>
<td>0.90</td>
<td>-0.08</td>
<td>-1.28</td>
</tr>
</tbody>
</table>

Note. Scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.

Surveys: Relationship Between Initial Attitudes and Final Exam Grade

A Pearson correlation coefficient was found using the software program, SAS, in order to determine the relationship between initial attitudes toward mathematics and achievement in the methods course. Achievement was measured using the methods course final examination. This departmental test is a 50-item multiple-choice instrument that includes questions about both mathematics content and pedagogy. The composite attitude score was used as the independent variable and the methods course final examination grade was used as the dependent variable. An alpha level of 0.05 was used to indicate whether the obtained correlation was statistically significant. A statistically significant Pearson Correlation Coefficient of $r = 0.41638$ was found, indicating a moderately strong positive correlation ($p=0.0093 < .05, n = 38$).
Surveys: Changed Attitudes

The mean change score for the 38 participants was 9.08, with a standard deviation of 16.44. The median change score was 5.5, and there were four modes with a count of 3. These were -2, -1, 1, and 15. The change scores were positively skewed (Sk=1.145). The kurtosis was 2.809, indicating that the distribution was leptokurtic. The repeated measures t-test was used to test the null hypothesis that the mean change score in the population was zero. Because $t = 3.403 > 2.02$ (t_crit), and $p = .0016 < .05$, the null hypothesis was rejected.

The validity of the repeated measures t-test depends on the assumptions of independence and normality. Although the pre-course and post-course survey scores were dependent or repeated measures, the change scores were independent. The distribution of change scores was positively skewed. However, because $n (38) > 20$, the repeated measures t-test is relatively robust to violations of the normality assumption. The effect size, $d = \frac{X_{\text{diff}}}{S_{\text{diff}}}$, was .5521, indicating a medium effect size. In summary, it was possible to reject the null hypothesis of a mean change score of zero ($t(37)= 3.403$, $p = .0016$). There was a statistically significant positive attitude change.

Changed Attitudes Interviews

Statistical analysis revealed that six participants had positive change scores greater than one standard deviation above the mean change score. This reflected a change score of at least 26 points. The participant with the greatest change score, 66 points, had to leave town immediately after the final exam and was therefore unavailable for an
interview. The participants with the second largest change score, ‘Jasmine,’ and the third largest change score, ‘Linda,’ were interviewed three days after the final examination.

‘Jasmine.’ Jasmine’s score on the pre-course ATMI was 64. This represented a mean response of 1.6 per survey item where one was the most negative response and five was the most positive response. Her post-course ATMI score was 103, representing a mean response of 2.6 per item. When asked how she thought her attitudes toward mathematics had changed, she responded:

My attitudes changed [positively] by all the activities we did in class, all the hands-on activities, because I’m a hands-on person, and it helped me understand ... like with fractions. I can’t stand fractions, but using the manipulatives helped me understand what I was doing.

When asked how she felt about the use of cooperative learning, Jasmine said:

When I grew up, I didn’t do a lot of stuff with my hands with math. So trying to memorize it, I was like, ‘huh.’ I didn’t understand what I was trying to formulate when it came to math. Working together with other people [in the methods course] helped me, because I didn’t have that when I was little.

When asked about problem solving, Jasmine connected problem solving to the use of manipulatives:

It was the way that we got to solve the problem [that influenced an attitude change], not the original problem because I always have trouble with problem solving with math problems, but now I know how to look at it in a different way.
Appendix B (Continued)

You know, like think of something [to represent] the amount you’re looking for, like the [fraction] circles or base ten blocks helped also.

Reflecting on the use of reflective journal writing, Jasmine said,

The journals made me realize that in order to be an effective teacher in a subject that I really don’t like, I have to not just pretend I like the subject, but at least give an effort to help [my students] understand mathematics, which is hard for any kid. A lot of kids can pick it up, for others it’s a slow process.

‘Linda.’ Linda’s score on the pre-course ATMI was 113. This represented a mean response of 2.8 per survey item where one was the most negative response and five was the most positive response. Her post-course ATMI score was 144, representing a mean response of 3.6 per item. When asked how she thought her attitudes toward mathematics had changed, she responded:

I think my attitudes got more positive. At the beginning, before I took the course, I felt kind of negative towards math. I think that I wasn’t taught it well. After the course, I learned different ways to teach kids and help them have a more positive attitude about math.

When asked which aspects of the course she thought had affected her attitudes, Linda said:

The manipulatives really helped me see things better, and I think that they would help kids see things better. If I had been taught that way, maybe my attitude [toward math] wouldn’t have been so negative. I was just taught to know the rule
and that’s just how it is, so you never really understand why you’re doing it, but the manipulatives help you see it. That was probably the biggest thing for me.

When asked how she felt about the use of cooperative learning, Linda said:

I think it was really good because sometimes I couldn’t see something, but my group member next to me could. Then she could explain it to me in a different way and show me with the manipulatives and stuff, so I really liked that.

When asked about problem solving, Linda responded:

I think it’s a really important skill to teach kids. I think it’s harder to teach, but I think that it’s really important that kids get it, because it’s something they’ll use all through life.

Reflecting on the use of journals, Linda replied:

I think that the journals were really good. It’s probably something I would use in my own classroom. I think that journals are a good way for [students] to reflect, even if it’s not math. They can talk about why they don’t understand something. I think journals are really a good way for [students] to think more about what they’re doing. Maybe they can share them if they want, but they don’t have to if it’s private.

When asked specifically about the use of reflective journals in the methods course, Linda said:

I think they were really good in the course too. It helped me think things through more than just, you know, not thinking about it and just doing it. They help you think about it more.
Three participants had negative change scores greater than one standard deviation below the mean. These participants had change scores of -23, -18, and -9. The two with the most negative change scores were asked to participate in interviews. The participant with the largest change score, -23 points, declined the researcher’s request for an interview. The second participant, ‘Nancy,’ was interviewed four days after the final examination. All interviews took place after final grades had been submitted to the Dean’s office.

‘Nancy.’ Nancy’s score on the pre-course ATMI was 144. This represented a mean response of 3.6 per survey item where one was the most negative response and five was the most positive response. Her post-course ATMI score was 126, representing a mean response of 3.2 per item. However, shortly after the beginning of the interview, it became apparent that a mistake had been made. When asked how she thought her attitudes toward mathematics had changed, Nancy responded:

I think [my attitudes] are more positive toward math. When I was in school, [the teachers said] ‘OK, do it. Here’s the problem.’ If you didn’t understand it or you had a problem with the problem, [the teacher would say] ‘Well, watch real closely and I’ll show you again. Three plus three equals six,’ without saying, ‘You can count them’ or ‘Here’s how we do it.’

The researcher then asked Nancy if she thought her attitudes toward mathematics had changed in a positive way. Her response was, “Yes, definitely.” At this point, the researcher explained that Nancy’s surveys had shown an 18-point negative change in
Appendix B (Continued)

attitude score. Nancy was quite surprised to hear this, so the researcher showed her the actual surveys. After briefly examining them, Nancy said that she had used the ranking scale incorrectly on the first survey. She had chosen “A” to represent “Strongly Agree” when the survey used “A” to represent “Strongly Disagree.” The researcher rescored Nancy’s first survey and found that she actually showed a 56-point positive change in attitude score. Nancy confirmed that this sounded accurate to her. At this point, the researcher returned to the interview protocol and asked Nancy which aspects of the course she thought might have affected her attitudes. She responded:

The use of the manipulatives, actually having hands-on and being able to move things… I think a lot of it had to do with the presentation, the scenarios, [problem-solving activities] and just having the students in class share their invented strategies. There were some [problems] that I was confused on, and one of the other students said, ‘Oh, well this is how I did it.’ I thought, ‘OK’ because it made a lot of sense to hear that there is more than one way to do it.

When asked how she felt about the use of cooperative learning, Nancy said:

I feel [cooperative learning] is important because [students] can feed off each other with their strategy sharing, and sometimes it’s easier to hear from a classmate versus the teacher. If the teacher’s busy, they can say, ‘How did you come up with this?’ or ‘Do you know how to do this?’

When asked about problem solving, Nancy responded:

Personally I was confused with a lot of it. Word problems have always been a big issue with me. I did like the children’s literature lesson plans that we had to write,
and the way you incorporated children’s literature into the course. I feel that would be essential with the problem solving to give them real situations, give them a menu and saying, ‘We’re going to learn about money. This is how much money you have. What can you buy?’ … Basically just presenting real life situations for the students.

Reflecting on the use of journals, Nancy said:

In general, I think it’s a great idea. It incorporates writing as well as math, cross-curricular. I think it’s important for students to reflect on what they did and gives them an opportunity to rethink. They can think about it; you did it, now what did you do?

When asked specifically about the use of reflective journals in the methods course, Nancy replied:

I was a little hesitant at first. I thought, ‘I don’t remember. I’ve been out of high school eleven years.’ Having to think back to elementary school, and most of my [memorable] experiences with math were in elementary school, was difficult. But after the first couple weeks of journal entries, I thought they were great. I thought, ‘Wow! OK, [my elementary school teacher] never did that, or [another elementary school teacher] always did something one way because the right way was his way or this is how the math books say to do it.’ So, it gave me another perspective on how I want to work with my students. Let me not just say, ‘OK, this is the only way it can be done.’

Nancy was asked if there were anything else she would like to add about her positive
Appendix B (Continued)

change in attitude. She said:

[At the beginning of the semester] I was terrified that I had another math class.
Although it was learning how to teach it, that scared me even more than me just 
having to do it. So, then coming in and [the instructor] was very personable and I 
really enjoyed the overheads [demonstration of using manipulatives]…. Just the 
explanations and everything made it so much easier to say, ‘OK, that makes sense 
now.’ If my teachers had done this in second or third grade, maybe I would have 
enjoyed my math a little more than I did.

Discussion

Participants showed a statistically significant improvement in attitudes toward 
mathematics since the start of the methods course. It should be noted that even though 
Nancy said that she had made a mistake when completing the pre-course survey and that 
her pre-course ATMI score should have been much lower and her change score much 
higher, the statistical analysis was not recalculated. The reported p-value of 0.0016 
included Nancy’s incorrect change score of −18 rather than what she said was her true 
change score of 56. It was the researcher’s view that because the error was found by 
chance, no changes in data should be made.

When asked how they thought their attitudes toward mathematics had changed 
since the start of the methods course, all three interviewees said that they believed their 
attitudes had become more positive. In considering which aspects of the course might 
have affected their attitudes, all three mentioned the use of manipulatives. They felt that
the manipulatives helped them understand the mathematical concepts rather than just memorizing a rule. Two of them said that they also benefited from watching the instructor’s overhead projector demonstrations with manipulatives.

The interviewees found cooperative learning beneficial. They discussed experiences in class when they were struggling, but a classmate was able to help by offering another perspective. When discussing problem solving, interviewees talked about how important it was for teachers to present problems that are relevant to their students’ lives. Two of them said that they benefited from hearing other students explain their own solution strategies to problems.

All three interviewees expressed positive views concerning the reflective journals. Two of them said that they would like to use journal writing with their own students and that they appreciated the value of reflection. Two of them said that they thought the journals that they wrote for the methods course provided them with insights that would help them become better teachers. All three interviewees expressed the notion that if they had been taught mathematics using the methods prescribed in this course, their own attitudes toward mathematics would have been much more positive.
Appendix C: Course Syllabus

MAE 4310: Teaching Elementary School Mathematics I

Instructor: Joy Schackow

Office: EDU 308-O

Office hours: TBA

E-Mail: Joys31999@aol.com

Prerequisites: Two college level mathematics courses


Course Packet available at ProCopy, 5219 E. Fowler Ave, www.procopycoursematerial.com

Recommended: *Principles and Standards for School Mathematics* (NCTM, 2000) [http://www.enc.org/reform/journals/ENC2280/nf 280toc1.htm](http://www.enc.org/reform/journals/ENC2280/nf%20280toc1.htm)

*Sunshine State Standards for Mathematics* (Available at Pro-Copy) [http://www.firn.edu/doi/curric/prek12/frame2.htm](http://www.firn.edu/doi/curric/prek12/frame2.htm)

Other Resources: *Professional Standards for Teaching Mathematics* (NCTM, 1991)

*Assessment Standards for School Mathematics* (NCTM, 1995)

Florida Comprehensive Assessment Standards (FCAT)

Elementary school mathematics textbooks (various)

Journals (e.g. *Teaching Children Mathematics, Mathematics Teaching in the Middle School, Teaching Exceptional Learners, Computing Teacher, Mathematics Teacher, Instructor, School Science and Mathematics, Childhood Education*)
**Purpose:** This course is required in the undergraduate program in Elementary Education. The course provides for the development of knowledge and skills necessary to prepare students to assume roles as teachers of mathematics in elementary classrooms. Such a course is recommended by the National Council of Teachers of Mathematics (NCTM) in its *Guidelines for the Preparation of Teachers.*

**Goal:** **Know How and also Know Why.** That is, you should focus on discovering the reasons behind the actions in mathematics.

The vision of mathematics learning espoused by the National Council of Teachers of Mathematics assumes the following:

"Knowing mathematics means being able to use it in purposeful ways. To learn mathematics, students must be engaged in exploring, conjecturing, and thinking rather than only in rote learning of rules and procedures. Mathematics learning is not a spectator sport. When students construct personal knowledge derived from meaningful experiences, they are much more likely to retain and use what they have learned. This fact underlies teachers’ new roles in providing experiences that help students make sense of mathematics, to view and use it as a tool for reasoning and problem solving."


Thus, the purpose of this course is to provide opportunities for preservice teachers to examine their understanding of various mathematics topics and to construct a vision of mathematics that considers the goals and assumptions of the current reform movement in mathematics education. Content, methods, and materials for teaching elementary school mathematics will be examined with a focus on Problem Solving, Whole Number concepts, and Rational Number concepts.

“From the perspective of attaining mathematical competence, teaching elementary mathematics does not mean bringing students merely to the end of arithmetic or to the beginning of ‘pre-algebra.’ Rather, it means providing them with a ground work on which to build future mathematics learning” (p. 117). (Ma, L. (1999). *Knowing and Teaching Elementary Mathematics.* Mahwah, NJ: Lawrence Erlbaum Associates.)
Appendix C (Continued)

Objectives:

Upon completion of this course, students will have demonstrated the following:

1. Knowledge of the major goals and characteristics, including scope and sequence, of elementary school mathematics programs, and aspects of theories of learning as applied to the planning of instruction for the teaching of elementary school mathematics.

2. Knowledge of the current developments in education, including research, that may affect the elementary school mathematics curriculum.

3. Knowledge of the properties of a number system and their application in the teaching of elementary school mathematics.

4. Knowledge of pre-number concepts and ideas and their application in the teaching of elementary school mathematics.

5. Knowledge of numeration concepts and principles and their application within the Hindu-Arabic System.

6. Knowledge of whole number concepts and principles and computational skills (algorithms) and their application in the teaching of elementary school mathematics.

7. Knowledge of number theory concepts and principles and their application in the teaching of elementary school mathematics.

8. Knowledge of rational number (fractions and decimals) concepts, principles and computational skills (algorithms) and their application in the teaching of elementary school mathematics.


Instructional Design

A variety of teaching/learning techniques may be used. The activities include lectures, discussions, cooperative learning activities, question and answer sessions, student demonstrations/explanations, and role-playing. Assigned reading will supplement classroom activities. Be prepared to present results and solutions to your peers.

We will discuss the content of the stated chapters in your textbook and will do many activities that are appropriate to do with children. You should not expect, however, that we will be able to cover every item that is mentioned in your textbook. Therefore, you should read the textbook chapters carefully and stop by my office if there is anything that is unclear.
Appendix C (Continued)

Course Requirement/Responsibilities
1. Professionalism
Because this course is part of an accredited program that leads to professional certification, students must demonstrate behavior consistent with a professional career. Failure to demonstrate such conduct will impact a student’s grade, as noted in the course syllabus.

In particular, students are expected to
a. attend all class meetings.
b. prepare carefully for class. Your input into the class discussion is important. Thus, you are expected to be present at the beginning and conclusion of class.
c. complete all assignments on time. Students should maintain a file of all graded assignments until after receiving an official grade notification from the registrar.
d. collaborate responsibly with colleagues in coursework.
e. interact professionally with classmates. Students should demonstrate respectful standards of behavior during class discussions.

Students are expected to conduct themselves professionally by positively influencing the classroom environment. Students who come late, leave early, or are absent, rarely contribute ideas, appear to be participating in discussions extraneous to the class, are observed to be doing work not related to the class, are disruptive, or inattentive, or passive are not behaving professionally.

Attendance
Unexcused absences and extreme tardiness almost always adversely influence your grade. I reserve the right to lower the grade of any student with more than 1 absence. Medical emergencies will be handled on an individual basis. Students who anticipate being absent from class due to the observation of a major religious observance must provide notice of the date(s) to the instructor, in writing, by the second class meeting.

I will take attendance each week.

Students with Special Needs
The College of Education shares the university’s commitment to eliminating barriers to the education of all students accepted and enrolled in our programs and courses. Therefore, I will attempt to follow the policies outlined by the university and articulated by the Office of Disabled Student Academic Services.

It is your responsibility to notify me, in writing, by the second class of any disability that may affect your learning process. There should be documentation for any services/ accommodations from the Office of Disabled Student Academic Services.
Appendix C (Continued)

**Tentative Course Outline**

*This schedule is subject to change as we proceed through the semester.*

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<thead>
<tr>
<th>Date</th>
<th>Topic</th>
<th>From Kit:</th>
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<tbody>
<tr>
<td>August 25</td>
<td>Introduction</td>
<td>Chapters 1, 2, 5</td>
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<tr>
<td>September 1</td>
<td>Chapters 3, 4</td>
<td>Developing Understanding in Mathematics</td>
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<tr>
<td></td>
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<td>Problem Solving</td>
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<td><em>Journal #1 Due</em></td>
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<td>September 8</td>
<td>Chapter 9</td>
<td><em>Concepts and Number Sense</em></td>
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<td><em>Two-Color Counters</em></td>
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<td><em>Unifix Cubes</em></td>
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<td><em>Number Cubes</em></td>
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<td>September 15</td>
<td>Chapter 10 (p. 135-142)</td>
<td><em>From Kit:</em></td>
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<td><em>Pattern Blocks</em></td>
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<td><em>Base Ten Blocks</em></td>
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<td><em>Tangrams</em></td>
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<td>September 22</td>
<td>Review</td>
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<td><em>All We’ve Used</em></td>
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<td>September 29</td>
<td>Chapter 10 (p. 143-154)</td>
<td><em>From Kit:</em></td>
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<td>October 6</td>
<td>Chapter 12</td>
<td><em>From Kit:</em></td>
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<td><em>Coin Set</em></td>
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<td>October 13</td>
<td>Chapters 13, 14</td>
<td><em>From Kit:</em></td>
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<td>Date</td>
<td>Activity</td>
<td>Materials</td>
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<td>October 20</td>
<td>Review</td>
<td>From Kit: All We’ve Used</td>
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<td>Test 2</td>
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<td>October 27</td>
<td>Chapter 15 Developing Fraction Concepts</td>
<td>From Kit: Pattern Blocks Fraction Circles Fraction Tower Cubes Two-Color Counters Tangrams</td>
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<td>Journal #6 Due</td>
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<td>November 3</td>
<td>Chapter 16 Computation with Fractions</td>
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<td>November 10</td>
<td>Chapter 16, cont. Computation with Fractions</td>
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<td>Chapter 17 Decimals and Percents</td>
<td>From Kit: Base Ten Blocks</td>
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<td>Literature-Based Lesson Plan Due</td>
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<td>November 24</td>
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<td>December 1</td>
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<td>Test 3</td>
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<tr>
<td>December 6</td>
<td>Final Exam</td>
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Appendix C (Continued)

Assignments:

Assignments are due at the **beginning of class** on the assigned date, whether or not you are present in class. I reserve the right to refuse to accept late assignments. If accepted, it is likely there will be some loss of points. If unforeseen circumstances arise, it is better to talk with me sooner rather than later to attempt a solution acceptable to both of us.

Exams should be completed at the scheduled time. I will consider make-ups ONLY in special circumstances and ONLY IF you discuss absences prior to the time of the exam.

Grading Criteria:

*The following represents my current thinking about the evaluation for this course. I reserve the right to make changes and/or deletions as needed.*

<table>
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<th>Assignments</th>
<th>Points</th>
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<td>150</td>
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<tr>
<td>Final Exam: Departmental</td>
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<tr>
<td>Professional Journal Abstracts (2 @ 20 points each)</td>
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<tr>
<td>Literature Based Lesson Plan</td>
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<tr>
<td>Reflective Dialogue Journals (8 @ 5 points each)</td>
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**Grading Scale:**

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<tr>
<td>90-93%</td>
<td>A-</td>
<td>3.67</td>
<td>333-347 points</td>
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<tr>
<td>87-89%</td>
<td>B+</td>
<td>3.33</td>
<td>322-332 points</td>
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<tr>
<td>84-86%</td>
<td>B</td>
<td>3.0</td>
<td>311-321 points</td>
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<tr>
<td>80-83%</td>
<td>B-</td>
<td>2.67</td>
<td>296-310 points</td>
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<tr>
<td>77-79%</td>
<td>C+</td>
<td>2.33</td>
<td>285-295 points</td>
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<td>74-76%</td>
<td>C</td>
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<td>C-</td>
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<td>D</td>
<td>1.0</td>
<td>237-247 points</td>
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<td>D-</td>
<td>0.67</td>
<td>222-236 points</td>
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<td>0-59%</td>
<td>F</td>
<td>0.0</td>
<td>0 – 221 points</td>
</tr>
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</table>
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A distribution of grades from A to C is typical, with A representing outstanding performance and C representing minimally acceptable performance. The following description outlines general requirements for each grade.

A  Outstanding Performance
The student demonstrates solid conceptual understanding and insight as evidenced by participation during in-class discussions and activities. The student shows mastery of the course content and is able to make extensions or apply that knowledge to new situations. Assignments/papers/projects are of excellent quality. The student contributes substantially to class and shows strong development regarding the teaching of mathematics. The student earns an average score of A as indicated above.

B  Good Performance
The student demonstrates good mastery of the course content and is able to make some extensions or apply some of the knowledge to new situations as evidenced by participation during in-class discussions and activities. Assignments/papers/projects are of good quality but are not exceptional. The student contributes to class discussions. The student shows good development regarding the teaching of mathematics. The student earns an average score of B as indicated above.

C  Adequate Performance
The student demonstrates adequate understanding and mastery of the course content but has difficulty extending or applying the knowledge to new situations as evidenced by in-class discussions and activities. Assignments/papers/projects are acceptable. The student shows acceptable development toward becoming a teacher of mathematics. The student earns an average grade of C as indicated above.

D  Below Average Performance
The student demonstrates unacceptable understanding and mastery of the course content. Assignments/papers/projects are inadequate. The student shows poor development toward becoming a teacher of mathematics. The student earns a grade of D as indicated above.

F  Unacceptable Performance
The student demonstrates poor performance of the course content. Either some assignments are not completed, are often late, or are of poor quality. The student does not contribute to class discussions. The student lacks development toward becoming a teacher of mathematics.
Appendix C (Continued)

Journal Topics:

1. Discuss any feelings (positive or negative) that you have about taking this course. What are you hoping to gain from the course?

2. What are your memories of learning mathematics in elementary school (attitudes, success, etc.)? What can you, as a future teacher, learn from these experiences?

3. Complete each of the following. Explain your responses. Why do you think you feel this way? I enjoy or feel positive about mathematics because … and/or … I do not enjoy or I feel negative about mathematics because …

4. Describe in detail one experience from your past that is particularly memorable and influential in your attitudes about mathematics. Where were you? Who was there? What was said? What did you do? How did you feel?

5. Many students have low self-confidence when it comes to mathematics. What will you do as a teacher to boost the self-confidence of your students regarding mathematics?

6. What do you think are the qualities of the best mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?

7. What do you think are the qualities of the worst mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?

8. Discuss the use of reflective journals in this course. What benefits, if any, did they provide? What, if any, were the drawbacks?
Appendix C (Continued)

Professional Journal Abstract Summary

1. Select two articles to read and review. The articles should come from either *Teaching Children Mathematics* or the *Arithmetic Teacher*. Both journals are available in the University Library (2nd floor). Many articles from these journals are also available online through NCTM’s website.

2. Both articles should deal with a topic from the content of MAE 4310 (problem solving, place value, number sense, whole numbers, fractions, decimals, percents, proportions, estimation). If you are not sure an article meets this requirement, PLEASE ASK ME FIRST!!

3. Write a 1-2 page paper for each article.
   a. Summarize the article in your own words. Quotes should be clearly marked as such and page references should be given. Your summaries should contain the essence of each article in a broad sense.
   b. Provide a critique of the articles. This is your personal reaction. Did you like the article? Why or why not? To what extent do you think the article is usable in the elementary classroom? Justify your opinion.
   c. Provide a bibliographic citation of each article. This should include the name of the article, author’s name, name of the journal, volume number of the journal, year published, page numbers of the article.
   d. Your paper should be typed, double-spaced, 12 point font.

4. Grading (for each article)

18 - 20 points  The abstract contains all the essential features. The summaries are clear and the personal reaction is well justified. Your essay provides a reasoned opinion. The writing flows well, observing proper spelling and appropriate grammar.

16 – 17 points  At most one essential element is missing. The summaries are clear but the personal reaction is weak or not well justified. The essay lacks a flow of logic. The writing contains a small number of spelling or grammar errors.

14 – 15 points  At most two essential features are missing. The summaries are unclear or missing important information. The personal reaction is weak or not well justified. The writing contains awkward flow with numerous spelling or grammar errors.

If a grade of at least 14 points is not warranted, the assignment will be returned to you for resubmission. A penalty may be assessed should this be necessary.
Literature Based Lesson Plan

1. Each person or group (no more than four in a group) will write a literature based lesson plan that features a topic from this course. You may work together and write one lesson plan for the group or you may work alone.

2. Please choose from the following topics:
   - Number Sense, Counting, Addition, Subtraction, Multiplication, Division, Problem Solving, Fractions, Estimation

NOTE: Please ask me if you are not sure about a topic. Lesson plans that deal with any topics other than those listed above will not be accepted unless you have checked with me first.

3. The plan should include:
   - a short overview of a children’s book that deals with the chosen topic
   - objectives for the lesson
   - a list of materials for the lesson
   - a description of the mathematics based activities (at least 2) that the elementary school students will be doing
   - Indicate the target grade level for the activities you design.
   - Explain how you will evaluate the lesson.
   - ESOL modifications

4. Your lesson plan should be typed and should include a complete bibliographic citation. If you use any ideas that are not your own, please cite your sources.

Points will be deducted for any missing components listed above.
Elementary School Mathematics
Teaching Developmentally Second Custom Edition
John A. Van de Walle

Token from
Elementary and Middle School Mathematics: Teaching Developmentally, Fifth Edition
by John A. Van de Walle
Detailed Contents

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SECTION I

TEACHING MATHEMATICS: FOUNDATIONS AND PERSPECTIVES 1

The fundamental core of effective teaching of mathematics combines an understanding of how children learn, how to promote that learning by teaching through problem solving, and how to plan for and assess that learning on a daily basis. Introductory chapters in this section provide perspectives on trends in mathematics education and the process of doing mathematics and develop the core ideas of learning, teaching, assessment, and planning. Additional perspectives on mathematics for special children and the role of technology are also discussed.

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Demographic Information

Name ________________________________

Age: (check one) ___ 18-22
___ 23-27
___ 28-32
___ 33-37
___ 38 and over

Gender: ___ Male
___ Female

Mathematics courses taken since high school:

<table>
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<th>Course</th>
<th>Institute</th>
<th>Grade Received</th>
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Which education courses (if any) have you completed?

<table>
<thead>
<tr>
<th>Course</th>
<th>Institute</th>
<th>Year</th>
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</thead>
</table>

Are you part of a cohort? _____________
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ATTITUDES TOWARD MATHEMATICS INVENTORY

Directions: This inventory consists of statements about your attitude toward mathematics. There are no correct or incorrect responses. Read each item carefully. Please think about how you feel about each item. Circle the choice that most closely corresponds to how the statements best describe your feelings. Use the following response scale to respond to each item.

Complete your responses for all 40 statements.

1. Mathematics is a very worthwhile and necessary subject.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

2. I want to develop my mathematical skills.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

3. Mathematics helps develop the mind and teaches a person to think.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

4. Mathematics is important in everyday life.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

5. Mathematics is one of the most important subjects for people to study.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

6. Math courses would be very helpful no matter what grade level I teach.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

7. I can think of many ways that I use math outside of school.
   Strongly Disagree Disagree Neutral Agree Strongly Agree

8. I think studying advanced mathematics is useful.
   Strongly Disagree Disagree Neutral Agree Strongly Agree
9. I believe studying math helps me with problem solving in other areas.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

10. A strong math background could help me in my professional life.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

11. I get a great deal of satisfaction out of solving a mathematics problem.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

12. I have usually enjoyed studying mathematics in school.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

13. I like to solve new problems in mathematics.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

14. I would prefer to do an assignment in math than to write an essay.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

15. I really like mathematics.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

16. I am happier in a math class than in any other class.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

17. Mathematics is a very interesting subject.

   Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree
18. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

19. I am comfortable answering questions in math class.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

20. Mathematics is dull and boring.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

21. Mathematics is one of my most dreaded subjects.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

22. When I hear the word mathematics, I have a feeling of dislike.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

23. My mind goes blank and I am unable to think clearly when working with mathematics.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

24. Studying mathematics makes me feel nervous.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

25. Mathematics makes me feel uncomfortable.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**

26. I am always under a terrible strain in a math class.

**Strongly Disagree**  **Disagree**  **Neutral**  **Agree**  **Strongly Agree**
Appendix E (Continued)

27. It makes me nervous to even think about having to do a mathematics problem.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

28. I am always confused in my mathematics class.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

29. I feel a sense of insecurity when attempting mathematics.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

30. Mathematics does not scare me at all.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

31. I have a lot of self-confidence when it comes to mathematics.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

32. I am able to solve mathematics problems without too much difficulty.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

33. I expect to do fairly well in any math class I take.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

34. I learn mathematics easily.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

35. I believe I am good at solving math problems.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree

36. I am confident that I could learn advanced mathematics.
   Strongly Disagree    Disagree    Neutral    Agree    Strongly Agree
Appendix E (Continued)

37. I plan to take as much mathematics as I can during my education.

Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

38. The challenge of math appeals to me.

Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

39. I am willing to take more than the required amount of mathematics.

Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

40. I would like to avoid teaching mathematics.

Strongly Disagree  Disagree  Neutral  Agree  Strongly Agree

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Appendix F: Researcher’s Journal Responses

The following are samples of journals for each prompt and the researcher’s responses to those journals. All of these sample journals come from the four participants who had the largest positive changes in their attitude survey scores.

*Journal 1: Discuss any feelings (positive or negative) that you have about taking this course. What are you hoping to gain from the course?*

**Participant’s Journal Entry:**

I am, in a way hesitant to take this class because I know that math has had a big influence in my educational career. I have grown to be not fond of it, so it is very hard to look at math in a positive manner. I think that throughout my schooling years, especially high school and including college, I am intimidated by math and all of its subtopics. Going into the class, I feel that it is just hard trying to teach my students something that I am both not particularly interested in and do not like. I do know however, that math is a very important part of our daily lives and simple, common, and basic math procedures do need to be taught and learned. So, by the end of this course, I would like to gain several things. First, I would like to gain a new and positive outlook on math as a subject. I want to be able to look forward to teaching all the subjects to my students and this definitely includes math. Also, my outlook on certain topics or subjects are picked up on and mocked by students. If this is the case, I do not want them to also gain a negative experience from math like I did. Secondly, from this course I would like to discover and develop new and improved ways to teach math. I want it to be fun for my students to learn. By including manipulatives or other hands-on activities, they will be able to interact with math instead of just acquiring new information for memorization.

**Researcher’s Response:**

Your feelings and experiences with math are not uncommon. I hear these things frequently from students. I think it is very important that you and your classmates, as future teachers, focus on ways to make math fun, interesting and relevant for your students so that they will feel that they can do math and can enjoy doing math. We will be talking about these issues throughout the course, and hopefully you will leave with lots of ideas on how to accomplish this. I am glad to hear that you want to improve your attitudes toward math so that you don’t pass on negative attitudes to your students. That is certainly a problem that happens sometimes. I hope that this course will help you do that.
Journal 2: What are your memories of learning mathematics in elementary school (attitudes, success, etc.)? What can you, as a future teacher, learn from these experiences?

Participant’s Journal Entry:

In elementary school I loved math. I was very good at it and wasn’t afraid to let everyone know it. My teachers, for the most part, used creative ways to facilitate my learning. In elementary, there were some worksheets, but mostly fun activities. When I got in high school, it got a bit harder and I started to shut down from wanting to learn more math. I hope that as a future teacher, I will be able to use creative activities with my students. I think it is important to make sure that the children have fun while they learn. I know it made a big difference for me in my younger years. I want to make the same difference for my students.

Researcher’s Response:

Many kids do well in elementary school and then begin to have trouble when they get to middle and high school. That is one of the reasons why I believe that it is so important to introduce topics such as geometry and algebra in elementary school. You will learn more about teaching geometry and algebraic thinking in Math II. By exposing the kids to these concepts early, maybe they won’t have such a hard time when they get to middle and high school. I agree with you that it is important to make the math fun for kids. This can go a long way towards building positive attitudes toward math in students.

Journal 3: Complete each of the following. Explain your responses. Why do you think you feel this way? I enjoy or feel positive about mathematics because … and/or … I do not enjoy or I feel negative about mathematics because …

Participant’s Journal Entry:

I feel positive about mathematics because I have struggled with it in the past. I know this sounds funny, however, if I am going to teach math I need to have a positive attitude about it. I believe now is the time to turn my attitude toward math around. Children are able to recognize when you are uncomfortable with a subject. I feel when they do recognize this it in turn, makes them uncomfortable and that much harder to teach. I can’t wait to start teaching math because I feel the best way to overcome my attitude is to dive right into it!
Appendix F (Continued)

Researcher’s Response:

I’m glad to hear that you want to improve your attitude toward math. I agree with you that this is very important. I think that teachers need to try and make math class fun and relevant for their students. They need to encourage students to solve problems in ways that make sense to the student, even if it’s not the way the teacher solves it. I hope that this course will help you begin to see math in a different light. It is important for teachers to feel positive about the subjects they teach so they don’t pass on negative attitudes to their students.

Journal 4: Describe in detail one experience from your past that is particularly memorable and influential in your attitudes about mathematics. Where were you? Who was there? What was said? What did you do? How did you feel?

Participant’s Journal Entry:

An experience I had in math was when I was in elementary school. I remember [teacher’s name] was the nicest teacher ever. I remember every time she told us to get out our math books I would feel embarrassed because I knew we were about to start something that I wasn't very good at. I knew [teacher’s name] could tell that math made me uncomfortable because I was so eager with all the other subjects and I clammed up when it came to math. One day she took me aside and said, " [Student’s name], I can tell you are uncomfortable with math time but I knew that you are smart and I believe that you can really achieve a lot if you put your mind to it. I want to help you succeed, and I will do whatever it takes to help you get there." After [teacher’s name] said that I knew that there was no reason for me to feel uncomfortable because I was smart and if she had that much faith in me I must really be something.

Researcher’s Response:

WOW!! What a great story. It brings out a very important point that teachers of all grade levels should remember. A student will probably live up to (or down to) the teacher’s expectations. If you let a kid know that you think they can do the math, they probably will be able to do it because your confidence in them will give them self-confidence. Unfortunately, it often works the other way too. We as teachers need to let our students know that we have confidence in them and their ability to do math. You are very
Appendix F (Continued)

fortunate to have [teacher's name] as a role model for being this kind of teacher. You know firsthand what an impact it can have on a student.

Journal 5: Many students have low self-confidence when it comes to mathematics. What will you do as a teacher to boost the self-confidence of your students regarding mathematics?

Participant’s Journal Entry:

I agree with the statement that children grow to have a low self-confidence when it comes to math because I am living proof of those children. I like many children, grow to either not like mathematics as a whole or become intimidated by it entirely. This actually is not a good thing and needs to be corrected as soon as possible. I feel that it is up to the teachers now to change their methods of teaching to try to benefit the children and their attitudes about math, rather than hurt them. I also believe that it is the responsibility of the up and coming teachers to already have knowledge of this teaching method and use it constantly in their classrooms, especially math lessons. As an up and coming teacher I plan to use several techniques and strategies to make math more enjoyable for my students. Not only do I plan on making my math lessons fun and interesting, I plan on using as many manipulatives as [much as] possible. The more opportunities children get to work with their hands and touch objects to make connections, the easier it will be for them to grasp and understand difficult mathematical concepts. Also in my math classroom, I am going to incorporate other subjects into several lessons. For example, art is a great way to allow children to express their knowledge. It is so wonderful because not just one type of art could be used. There is visual, movement/dance, drama, and music. For example, math is all about numbers and getting the right beat just like music. These are only a few of my ideas for making math a less horrible subject. It is not horrible and this is what we need to get the children to realize. It can be fun, interesting, and quite exciting. Hopefully by using these forms of instruction, I can change the view points of most of my students in the future.

Researcher’s Response:

It sounds like you have some great ideas about how to increase your students’ self-confidence with math. Making math fun and interesting, using manipulatives, and connecting math to other subjects are excellent ways to accomplish this goal. Ultimately we want all students to feel confident in their ability to do math.
Appendix F (Continued)

Journal 6: What do you think are the qualities of the best mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?

Participant’s Journal Entry:

When I read this subject I got really excited because the best math teacher I’ve had accrued last year in college. I took social science stats, for my third math course, by this time I already took finite and liberal arts twice for grade forgiveness. Needless to say the last thing I wanted to do was take another math class. A friend recommended [professor’s name] so I thought what the heck, here goes another two semesters for the same math class. To my surprise he was amazing teacher, and I got an A in the course! My first ever A in a math class. The things that made him so amazing was that he really took time to make sure we understood what was going on (even if he had to explain things 5 times and 5 different ways.) He always found a way for us to understand what he was trying to teach. He always made a point to relate topics to real life and show why it is important to learn. He also set up a buddy group system with his past students. These students were TA’s who took time out of there [sic] days to meet up with us to review material. This helped tremendously because if you didn’t get it in class it wasn’t too late because someone else would be there to help you. He understood the needs of his students and provided the best learning environment for us. Still to this date I’ve turned around my view on math. It even shows this semester in your class. I’ve received 2 A’s on my test so far, and I really feel like a lot of that is a direct result from [professor’s name].

Researcher’s Response:

I definitely agree with you about the impact one teacher can have on the attitudes of his or her students. The qualities that you mentioned for your best math teacher are qualities that I hope you will remember when you begin teaching. Making sure students are understanding the concepts, making the math relevant to students’ lives, and encouraging students to work together are great ways to be the kind of teacher that students will recall as one of the best they’ve had.

Journal 7: What do you think are the qualities of the worst mathematics teacher you have ever had? What effect did this teacher have on you as a learner of mathematics?
Appendix F (Continued)

Participant’s Journal Entry:

As sad as this sounds I have had many more bad teachers than good. Or maybe it’s just that the bad times stick with me more than the good. What all of the teachers have in common is that they all seem to rush through curriculum. I always felt like I was not smart because they would move on so fast from concept to concept without properly assessing where I was. I feel that they just wanted to finish the book to say they finished the book. I really hope that I will never be a teacher who rushes my students. I want all of my future students to feel like they can take their time to understand the concept. I feel that if these teachers were to take their time with each student the outcome would be great.

Researcher’s Response:

Unfortunately, teachers have lots of pressures on them. One of these is covering a certain amount of material in a certain amount of time. However, I agree with you that rushing through it is not a good idea. Students need to make sense of the math before they move on to something new. If the majority of the class does understand a concept, then I believe that the teacher should find a way to work with those who don’t. This could be before or after school or while others are working on another problem or activity. I know that you will be sensitive to students in this situation because of your own experiences.

Journal 8: Discuss the use of reflective journals in this course. What benefits, if any, did they provide? What, if any, were the drawbacks?

Participant’s Journal Entry:

I have really enjoyed doing these reflective journals. I think that they really help us, as students, to look back on our past math experience and see what we can learn from them. As future educators, our students are going to be in the same position we were and go through the exact same (or different) experiences we did. Looking back on our good and bad professors, we now know what to do and not do in our own classrooms. Our goal is to allow the students to get a positive outlook and attitude towards math and not a negative one like most of us did growing up. Also through these math journals, I have been able to see where I stand on the topic of math and use this for my classroom as well. I have really and truly learned a lot about myself, my future, and my future students and classroom through these reflective journals. Thank you for this opportunity and I will use my acquired knowledge to the best of my ability.
Appendix F (Continued)

Researcher’s Response:

I am glad that you have enjoyed the journals. I think that it is very important for future math teachers to reflect on their own experiences as learners of mathematics, as well as other important issues they will face as teachers. As you said, this type of reflection can help you achieve the goal of developing positive attitudes toward math in your students, and I think that is wonderful!!
Appendix G: Observer Protocol

In observing the class and recording your observations of both instructional activities and students’ activities, please make special note of any observation that might reflect students’ attitudes toward mathematics. These attitudes should include value of mathematics, enjoyment of mathematics, motivation for mathematics, and self-confidence with mathematics.

<table>
<thead>
<tr>
<th>Observed Activity and Approximate Time Spent</th>
<th>Personal Insights, Interpretations</th>
</tr>
</thead>
</table>
Appendix H: Experiences with Mathematics Interview Protocol

Experiences that have Influenced Attitudes

1. Why did you decide to become a teacher?

2. Tell me about your own experiences as a student in mathematics classrooms in elementary school.

3. Describe your feelings about the methods course prior to the start of the course.

4. Have your feelings about the course changed since the start of the methods class?
   (a) If so, how have they changed? What has influenced the change?
   (b) If not, what (if anything) has reinforced these feelings?

5. Tell me about your own experiences as a student in mathematics classrooms in middle school.

6. What are some things that a teacher can do to help his/her students develop a good attitude toward mathematics?

7. Tell me about your own experiences as a student in mathematics classrooms in high school.

8. How did you do on the CLAST test? Do you remember your score? How many times did you take it before passing it?

9. Tell me about your own experiences as a student in mathematics classrooms in college.

10. What else would you like me to know concerning your attitudes toward mathematics?
Appendix I: Changed Attitudes Interview Protocol

Effect of Course on Attitudes

1. The survey that you recently completed in class showed a change in your attitudes toward mathematics since the start of this course. How do you think your attitudes toward mathematics have changed?

2. Which aspects of the course do you think affected your attitudes toward mathematics? How did it affect your attitudes?

Ask remaining questions only if that aspect of the course has not been mentioned.

3. How do you feel about the use of manipulatives in teaching mathematics?

4. How do you feel about the use of manipulatives in this course?

5. How do you feel about the use of cooperative learning in teaching mathematics?

6. How do you feel about the use of cooperative learning in this course?

7. How do you feel about the use of problem solving in teaching mathematics?

8. How do you feel about the use of problem solving in this course?

9. How do you feel about the use of journals in teaching mathematics?

10. How do you feel about the use of journals in this course?

11. Is there anything else you would like to tell me about your attitude change or to what you attribute this change?
Appendix J: Final Examination

The departmental final examination consists of 50 multiple-choice items. Due to security issues, a description of the test items has been included rather than the actual exam questions.

1. Use pattern blocks to represent a fraction.

2. Represent a portion of a rectangular region by a decimal.

3. Identify strategies for learning basic addition facts.

4. Recognize appropriate invented strategies for multiplication.

5. Using given digits, find the largest whole number possible, given that one of the digits must hold a specified place value.

6. Use pattern blocks to represent fraction subtraction.

7. Given a number in exponential expanded form, identify the number in standard form.

8. Determine properties of place value.

9. Recognize when a particular estimation strategy is appropriate.

10. Identify interpretations for subtraction.

11. Identify estimation methods.

12. Recognize under which operations the set of Natural Numbers is closed.

13. Identify an example of the Cardinality Principle.

14. Model a division problem with fraction circles.

15. Identify the product of two fractions geometrically on a number line.

16. Identify methods of diagnosing student errors.
17. Identify appropriate ways to introduce mathematical ideas to elementary school students.

18. Diagnose a student error involving writing a number represented by Base Ten Blocks.

19. Identify a property of multiplication geometrically.

20. Identify properties of equivalent fractions.

21. Determine which rational number best identifies a point marked on a number line.

22. Identify instructional approaches involving invented strategies.

23. Identify a property about unit fractions.

24. Identify fractions that have a terminating decimal equivalent.

25. Given a sample of a student’s work, diagnose the student’s problem.

26. Identify an anticipated issue for students who are developing subtraction algorithms.

27. Given the beginning of a word problem involving subtraction of fractions, identify an appropriate question.

28. Given a word problem for subtraction, identify an appropriate interpretation.

29. Given a particular manipulative, identify which type of fraction model it represents.

30. Make judgments about appropriate estimation strategies.

31. Use pattern blocks to represent a given fraction.

32. Identify which fraction, decimal, and percent expressions are equivalent to a given fraction.
Appendix J (Continued)

33. Identify appropriate models for representing decimals.

34. Given a pictorial model, identify which operation or operations are being modeled.

35. Given a word problem involving fractions, choose the appropriate operation needed to solve it.

36. Use pattern blocks to model fractions.

37. Choose which manipulatives would be useful to model ordering of fractions.

38. Use pattern blocks to model fractions.

39. Choose which of five decimal numbers has the greatest value.

40. Model a fraction subtraction problem with Fraction Tower pieces.

41. Given a scenario involving estimation, identify which estimation strategy was used.

42. Given five subtraction word problems, identify which model or interpretation of subtraction is being used.

43. Given a scenario involving an elementary school class activity, identify which type of learning activity is taking place.

44. Given a word problem involving fractions, choose a number sentence that can be used to solve it.

45. Diagnose a student’s error involving fraction concepts.

46. Diagnose a student’s error involving a fraction set model.

47. Identify which fraction operation is illustrated by an area model.

48. Identify an appropriate purpose for using a specific manipulative.
Appendix J (Continued)

49. Diagnose a student’s error with two-digit addition.

50. Identify the problem that is being modeled on a decimal grid.
Hycner’s (1985) guidelines for phenomenological analysis of interview data include the following 15 steps:

1. **Transcription.** This involves not only the literal statements, but also non-verbal and para-linguistic communication.

2. **Bracketing and phenomenological reduction.** This involves listing and then suspending the researcher’s own presuppositions.

3. **Listening to the interview for a sense of the whole.** This requires listening to the tape and reading the transcript several times.

4. **Delineating units of general meaning.** The researcher reviews each word, phrase, and sentence in order to identify unique units of meaning.

5. **Delineating units of meaning relevant to the research question.** The researcher reviews each unit of meaning in order to determine whether it responds to or illuminates the research question.

6. **Training independent judges to verify the units of relevant meaning.** This adds reliability.

7. **Eliminating redundancies.** Previously listed units of meaning can now be eliminated, although their frequencies should be noted.

8. **Clustering units of meaning.** This involves grouping together those units of meaning that naturally cluster together.
Appendix K (Continued)

9. *Determining themes from clusters of meaning.* The researcher examines the clusters of meaning and determines if there are one or more central themes that express the essence of the clusters.

10. *Write a summary for each individual.* The summary should incorporate the identified themes.

11. *Return to the participant with the summary and themes.* The researcher conducts a second interview with the participant so that the participant can determine whether the essence of the first interview has been accurately captured.

12. *Modify themes and summary.* If needed, modifications can be made based on any new data that was collected from the second interview.

13. *Identify general and unique themes for all the interviews.* The researcher looks for themes that are common to most or all of the participants as well as individual variations.

14. *Contextualization of themes.* The researcher may find it helpful to then place these themes back into their original contexts.

15. *Composite summary.* A composite summary is then written that accurately captures the essence of the phenomenon being investigated.
Appendix L: Computation of Inter-Rater Reliability

Pilot Study

Five journal entries from Pilot Study I were used for training and determining inter-rater reliability between the researcher and the coder in identifying units of meaning. The researcher identified 40 units of meaning from the five journals, and the coder identified 33 units of meaning. Together they identified six common themes. Prior to collaboration, a comparison of identified units of meaning for the five journals produced an 83% inter-rater reliability.

While comparing the researcher’s identified units of meaning with those of the coder, a pattern emerged. In nearly every case, one coder had interpreted a statement as one unit of meaning, and the other coder had viewed it as two units of meaning. The following journal excerpt is an example of this tendency:

“ I do remember [math] being one of my least favorite and weakest subjects in school.”

The researcher had coded this as two units of meaning: math was one of least favorite subjects, and math was one of weakest subjects. The coder had coded this statement as only one unit of meaning: participant felt unsuccessful with math. After a brief discussion, both the researcher and the coder agreed to consider this excerpt as two units of meaning: math was one of least favorite subjects, and math was one of weakest subjects. The researcher and the coder agreed that this statement should be categorized as two instances of a negative memory of elementary school. After collaboration between the researcher and the coder, 100% agreement was reached on both units of meaning and common themes.
The researcher and the coder independently identified both units of meaning and common themes on a sample of 18 journals from one prompt. Journal One was randomly selected for double coding. A stratified random sample of responses to this prompt was chosen using subgroups based on the participants’ ages and lengths of response. The researcher identified 165 units of meaning and 11 themes from the 18 journals, and the coder identified 129 units of meaning and 12 themes. The researcher and the coder collaborated to identify 169 units of meaning and 11 themes.

Prior to collaboration, a comparison of identified units of meaning for the 18 journals produced an overall inter-rater reliability of 71.6%. Differences fell into five categories. Both the researcher and the coder agreed that the first category was an ‘actual miss,’ and the other four categories were ‘conditional misses.’ The five categories were:

- **Actual Miss:** One coder identified a unit of meaning and the other did not
- **R-2/C-1:** Researcher separated the excerpt into two units of meaning and coder kept it together and identified only one
- **R-1/C-2:** Researcher kept the excerpt together and identified only one unit of meaning and coder separated the excerpt into two units of meaning
- **DC:** Researcher double-coded an excerpt. This means that the entire excerpt was coded as two different units of meaning. The coder did not realize that she could do this, so she did not do any double coding.
Appendix L (Continued)

- Sub-theme: Researcher and Coder both categorized unit of meaning as same theme, but differed on sub-theme

There were 17 ‘actual misses’ where one coder identified a unit of meaning and the other did not. Examples of the four ‘conditional misses’ and their frequencies are found in Table K-1 below.

Table K-1

*Inter-rater Reliability: Conditional Misses*

<table>
<thead>
<tr>
<th>Type of Miss</th>
<th>Frequency</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>R-2/C-1:</td>
<td>15</td>
<td>“I have never had a problem with math and have always liked it.”</td>
</tr>
<tr>
<td>Researcher:</td>
<td></td>
<td>R: Separated and coded as two instances of Pos. Attitude Toward Math (never had a problem and always liked)</td>
</tr>
<tr>
<td>Coder:</td>
<td></td>
<td>C: Coded as one instance of Pos. Attitude Toward Math (liked math)</td>
</tr>
<tr>
<td>2 units of meaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-1/C-2:</td>
<td>4</td>
<td>“I am very apprehensive about taking this course, considering my math skills aren't the greatest.”</td>
</tr>
<tr>
<td>Researcher:</td>
<td></td>
<td>R: Coded as Neg. Attitude about Course (apprehensive)</td>
</tr>
<tr>
<td>Coder:</td>
<td></td>
<td>C: Separated and coded as Neg. Attitude about Course (apprehensive) and also Neg. Feelings about Self with Math (poor math skills)</td>
</tr>
<tr>
<td>1 unit of meaning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continued on the next page</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix L (Continued)

Table K-1 (Continued)

*Inter-rater Reliability: Conditional Misses*

<table>
<thead>
<tr>
<th>Type of Miss</th>
<th>Frequency(^a)</th>
<th>Representative Journal Excerpt</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC:</td>
<td>6</td>
<td>“If I can learn how to teach my students and have them really learn and enjoy the subject that idea makes me so happy.”</td>
</tr>
<tr>
<td>Researcher:</td>
<td></td>
<td>R: Coded twice: Once as Positive Attitude about Course (happy about idea of learning how to have students learn and enjoy math) and also as Hope to Gain from Course (help students learn and enjoy math)</td>
</tr>
<tr>
<td>Double-coded</td>
<td></td>
<td>C: Coded only once: Hope to Gain from Course (helping children learn and enjoy math)</td>
</tr>
<tr>
<td>Coder:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coded excerpt</td>
<td></td>
<td></td>
</tr>
<tr>
<td>only once</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sub-theme:</td>
<td>6</td>
<td>“I am eager to learn to adapt to different ways of thinking.”</td>
</tr>
<tr>
<td>Researcher and Coder</td>
<td></td>
<td>Both coded as Hope to Gain from Course, but coded differently as sub-theme.</td>
</tr>
<tr>
<td>same theme, but different sub-theme</td>
<td></td>
<td>R: Sub-coded as: Hope to Gain: Accommodate Different Learning Styles and Needs (learn to adapt to different ways of thinking)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C: Sub-coded as: Hope to Gain: Regaining Personal Understanding of Math (adapt to new thinking)</td>
</tr>
</tbody>
</table>

\(^a\) n = 31
Appendix L (Continued)

It should be noted that 31 of the 48 overall ‘misses’ (65%) fell into the ‘conditional misses’ category. Counting only the ‘actual misses’ produced an inter-rater reliability of 90%.
Appendix M: Researcher’s Possible Biases and Preconceptions

Researcher’s Assumptions:

- Preservice elementary school teachers are capable journal writers.
- Participants will be willing to share their experiences with me honestly and openly through their journals and interviews.
- Participants will take time to reflect on each of the journal prompts, survey items, and interview questions and honestly share their attitudes toward mathematics rather than responding in the manner in which they think I want them to respond.
- Participants will be able to remember significant events that have influenced their development of attitudes toward mathematics.

Researcher’s Expectations:

- Although many of the preservice teachers will have positive attitudes toward and experiences with mathematics, there will also be many with negative attitudes and experiences.
- The majority of the participants will have a positive view of journal writing in the methods course.
- Participants with positive attitudes toward mathematics will have experienced success with mathematics, and those with negative attitudes will have been largely unsuccessful with mathematics.
### Table N-1

**Means and Standard Deviations on Items from the Post-Course Attitudes Toward Mathematics Inventory**

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Mathematics is a very worthwhile and necessary subject.</td>
<td>4.58</td>
<td>0.56</td>
<td>-0.88</td>
<td>-0.20</td>
</tr>
<tr>
<td>2. I want to develop my mathematical skills.</td>
<td>4.58</td>
<td>0.50</td>
<td>-0.32</td>
<td>-2.02</td>
</tr>
<tr>
<td>3. Mathematics helps develop the mind and teaches a person to think.</td>
<td>4.42</td>
<td>0.61</td>
<td>-0.56</td>
<td>-0.52</td>
</tr>
<tr>
<td>4. Mathematics is important in everyday life.</td>
<td>4.33</td>
<td>0.69</td>
<td>-1.16</td>
<td>2.57</td>
</tr>
<tr>
<td>5. Mathematics is one of the most important subjects for people to study.</td>
<td>3.94</td>
<td>0.83</td>
<td>-0.59</td>
<td>0.17</td>
</tr>
<tr>
<td>6. Math courses would be very helpful no matter what grade level I teach.</td>
<td>4.39</td>
<td>0.61</td>
<td>-0.45</td>
<td>-0.58</td>
</tr>
<tr>
<td>7. I can think of many ways that I use math outside of school.</td>
<td>4.39</td>
<td>0.70</td>
<td>-1.31</td>
<td>2.69</td>
</tr>
<tr>
<td>8. I think studying advanced mathematics is useful.</td>
<td>3.30</td>
<td>1.07</td>
<td>-0.34</td>
<td>-0.97</td>
</tr>
<tr>
<td>9. I believe studying math helps me with problem solving in other areas.</td>
<td>4.15</td>
<td>0.83</td>
<td>-0.99</td>
<td>0.94</td>
</tr>
</tbody>
</table>

*Continued on the next page*
<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>10. A strong math background could help me in my professional life.</td>
<td>4.15</td>
<td>0.76</td>
<td>-0.73</td>
<td>0.66</td>
</tr>
<tr>
<td>Enjoyment of Mathematics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I get a great deal of satisfaction out of solving a mathematics problem.</td>
<td>3.64</td>
<td>1.06</td>
<td>-0.89</td>
<td>0.75</td>
</tr>
<tr>
<td>12. I have usually enjoyed studying mathematics in school.</td>
<td>2.97</td>
<td>1.16</td>
<td>0.06</td>
<td>-0.90</td>
</tr>
<tr>
<td>13. I like to solve new problems in mathematics.</td>
<td>3.45</td>
<td>0.97</td>
<td>-0.41</td>
<td>0.03</td>
</tr>
<tr>
<td>14. I would prefer to do an assignment in math than to write an essay.</td>
<td>2.61</td>
<td>1.58</td>
<td>0.40</td>
<td>-1.48</td>
</tr>
<tr>
<td>15. I really like mathematics.</td>
<td>3.45</td>
<td>1.09</td>
<td>-0.26</td>
<td>-0.69</td>
</tr>
<tr>
<td>16. I am happier in a math class than in any other class.</td>
<td>2.55</td>
<td>1.20</td>
<td>0.52</td>
<td>-0.34</td>
</tr>
<tr>
<td>17. Mathematics is a very interesting subject.</td>
<td>3.52</td>
<td>0.91</td>
<td>-0.72</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Continued on the next page
### Individual Survey Items

<table>
<thead>
<tr>
<th>Enjoyment of Mathematics (Continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td>18. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.</td>
</tr>
<tr>
<td>19. I am comfortable answering questions in math class.</td>
</tr>
<tr>
<td>20. Mathematics is dull and boring.*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Self Confidence with Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>21. Mathematics is one of my most dreaded subjects.*</td>
</tr>
<tr>
<td>22. When I hear the word mathematics, I have a feeling of dislike.*</td>
</tr>
<tr>
<td>23. My mind goes blank and I am unable to think clearly when working with mathematics.*</td>
</tr>
<tr>
<td>24. Studying mathematics makes me feel nervous.*</td>
</tr>
<tr>
<td>25. Mathematics makes me feel uncomfortable.*</td>
</tr>
</tbody>
</table>
### Individual Survey Items (Continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>26. I am always under a terrible strain in a math class.*</td>
<td>3.85</td>
<td>1.00</td>
<td>-1.45</td>
<td>2.55</td>
</tr>
<tr>
<td>27. It makes me nervous to even think about having to do a mathematics problem.*</td>
<td>3.76</td>
<td>1.09</td>
<td>-1.18</td>
<td>1.01</td>
</tr>
<tr>
<td>28. I am always confused in my mathematics class.*</td>
<td>3.85</td>
<td>0.97</td>
<td>-1.20</td>
<td>1.54</td>
</tr>
<tr>
<td>29. I feel a sense of insecurity when attempting mathematics.*</td>
<td>3.48</td>
<td>1.15</td>
<td>-0.42</td>
<td>-0.93</td>
</tr>
<tr>
<td>30. Mathematics does not scare me at all.</td>
<td>3.15</td>
<td>1.09</td>
<td>-0.01</td>
<td>-1.14</td>
</tr>
<tr>
<td>31. I have a lot of self-confidence when it comes to mathematics.</td>
<td>3.24</td>
<td>1.12</td>
<td>0.20</td>
<td>-1.39</td>
</tr>
<tr>
<td>32. I am able to solve mathematics problems without too much difficulty.</td>
<td>3.58</td>
<td>0.94</td>
<td>-0.23</td>
<td>-0.71</td>
</tr>
<tr>
<td>33. I expect to do fairly well in any math class I take.</td>
<td>3.55</td>
<td>0.90</td>
<td>-0.55</td>
<td>-0.55</td>
</tr>
</tbody>
</table>

Continued on the next page
Table N-1 (Continued)

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>34. I learn mathematics easily.</td>
<td>3.12</td>
<td>1.17</td>
<td>-0.25</td>
<td>-0.90</td>
</tr>
<tr>
<td>35. I believe I am good at solving math problems.</td>
<td>3.45</td>
<td>1.09</td>
<td>-0.72</td>
<td>-0.14</td>
</tr>
</tbody>
</table>

Motivation with Mathematics

<table>
<thead>
<tr>
<th>Item</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>36. I am confident that I could learn advanced mathematics.</td>
<td>3.12</td>
<td>1.27</td>
<td>-0.24</td>
<td>-1.11</td>
</tr>
<tr>
<td>37. I plan to take as much mathematics as I can during my education.</td>
<td>2.48</td>
<td>1.06</td>
<td>0.37</td>
<td>-0.46</td>
</tr>
<tr>
<td>38. The challenge of math appeals to me.</td>
<td>2.97</td>
<td>1.16</td>
<td>0.32</td>
<td>-0.87</td>
</tr>
<tr>
<td>39. I am willing to take more than the required amount of mathematics.</td>
<td>2.39</td>
<td>1.12</td>
<td>0.71</td>
<td>0.10</td>
</tr>
<tr>
<td>40. I would like to avoid teaching mathematics.*</td>
<td>3.91</td>
<td>0.77</td>
<td>-0.29</td>
<td>-0.15</td>
</tr>
</tbody>
</table>

Note. © Martha Tapia. ATMI used with permission of author. Scoring for most items uses anchors of 1: strongly disagree, 2: disagree, 3: neutral, 4: agree, and 5: strongly agree.

*Scoring for these items is reversed and uses anchors of 1: strongly agree, 2: agree, 3: neutral, 4: disagree, 5: strongly disagree. Therefore, on all items, scores range from 1 to 5, with 1 indicating the most negative attitude and 5 indicating the most positive attitude.
Appendix O: Relevant Excerpts from Researcher’s Journal

The following excerpts from the researcher’s journal are relevant to the study.

The portions relating to the researcher’s observations, actions, or thoughts that reflected consideration of participants’ attitudes toward mathematics are highlighted in bold font.

Please note that the data written in brackets reflect the researcher’s personal reactions and thoughts.

Week 1:
When I first walked into the room, about two-thirds of the class was there. The class has (presently enrolled) 34 students, and there were about 22-23 there already. **When I first got there, the class was very quiet, not really talking to each other very much. I came in and started talking to those in front very casually about the heavy traffic on first week of classes, parking situation, etc. [trying to establish rapport and put students at ease]**

While they were introducing each other, one of them said that her partner whom she was introducing hated math. **[I was delighted --great way to bring up ATM].** After we finished introductions, I asked how many really liked math. About six or seven raised their hands. Then I asked how many really disliked math; I would say that at least 20 raised their hand. **[I thought … GREAT!! Good class for the study. They are already willing to be open about it.] I asked if any of them would be willing to share their reasons why they disliked math, and several immediately raised their hands.**

The first to raise her hand said that she didn’t like math because she wasn’t good at it. She had always struggled with it.

One person said that she disliked it because there’s always only one right answer, and if you don’t get that answer and you don’t do it exactly the right way, then it’s wrong. **I explained that in the course we would have a different perspective about that and we would learn more about that in the course.**

Another student said that she had always liked math until she got one teacher. I think it was HS Geometry … not sure. This teacher was very mean and would look for things to take points off and she turned her against math. She never liked it after that. **I pointed out how one teacher or one bad experience could have that effect.**

Another person said that she had always liked math until she got to [university] and then she had 3 or 4 professors for math classes and all of them were horrible and turned her off to math.
Another one said that she had always hated math until she had a [university] professor (measurement course?) who was just absolutely wonderful. I asked her what he did that made him so different from the others she’d had, and she said that they worked in groups, .... I can’t remember what else she said, but they were all things that we will be talking about and promoting in the course, and I pointed that out to them. [I was thinking that they brought up some good things that I would probably see again in their journals-- hoping this will get others thinking and relating.]

I then gave them a problem to work, which was the pelicans and turtles problem.¹ For the most part, they seemed to get right to it. There was one group of 3-4 who didn’t know how to work it right away, so they had just put it aside and were talking. Another group of 3 and then 2 who were sitting next to each other … all 5 were sitting together, but 2 were working together and three were working together (including the one male). He came up with a rather unusual way to solve the problem and I noticed that the females, the 2 who were working with him and the other 2, had seemed to just kind of give up what they were trying to do because it wasn’t working and just telling me that he had figured it out for them. [gender issues … females just assuming that the male was better at math than they were?]

I also noticed that nobody had worked the problem with a drawing. I realized that we were running out of time (5 min. left), so I asked who wanted to share their solution with the class. Three or four were willing to [very happy about that!!], which is not always the case. The first one actually came up to the board and demonstrated [this was great to me]. She had used a guess and check method. Students seemed surprised to learn that this was OK with me. Another one had made a chart listing each possibility in a very systematic way, which was also a great way to do it. A third one just started by dividing 33 in half and then adjusting from there, which was also a great way to do it. I wanted to show them the drawing, but we ran out of time. [glad I got the opportunity early on to demonstrate the idea of using different solution strategies, sharing them with each other, cooperative group work.]

Week 2:
I asked about journals – if anyone had a problem emailing journals because sometimes they do. One did, but she had spoken to me before class, so no one raised their hand for that. [that is good … they sometimes get frustrated with the emailing when they have problems.]

¹The problem asks students to figure out how many pelicans and turtles there are if we have a total of 33 heads and 102 feet.
Appendix O: Continued

By about 9:05 it seemed like just about everyone was there, so I started class. As I began to start class, I remembered that I had received a couple of journals where students said that they were feeling overwhelmed with the amount of information in the first 5 chapters. When I brought this up, approximately 10 students agreed and said that they were feeling the same way. This was a good opportunity for me to point out where in the note packet the review questions were. We spent a few minutes talking about the idea that I wanted them to read all five chapters to get an overview of the philosophy of the course, but that as far as tests were concerned, they would be responsible primarily for things on the review sheet. [I thought that students seemed relieved by that. I remember thinking that this type of communication is another benefit of journals. Something like that might have never come up, but because they were writing that first journal about their concerns about the course, it did come up. This allowed me to address this issue with the whole class and probably alleviate the concerns of several students.]

When I got to the transparency on problem-solving strategies, I reminded them about the problem we did last week with the pelicans and turtles. As we went through the problem-solving strategies, I reminded them about how different people had shared their different solution strategies and how just about all of the strategies listed had been used and presented, with the exception of drawing a picture. I used this as an opportunity to show them a method of solving this problem with a picture. They seemed to really enjoy that when they realized that a young child could have actually solved that problem that way.

I then gave them the problem of using the numbers 1-6 on the triangle so that the sums of each side were equal. They seemed to be engaged … everyone I saw was actively involved in trying to solve the problem. After a few minutes, some still hadn’t come up with any of the four solutions, so I gave them the hint about the corners. I also suggested that those who had found just one solution look at the corners to give them a basis to theorize about the other solutions.

One person put one of the solutions on the board, and the class discussed it. Then I gave them some time to see if they could come up with the other solutions. Then volunteers put the other solutions on the board and we discussed them. [I was very happy about all the participation and involvement.]

Then I read them the book Benny’s Pennies. They seemed to stay with me. There wasn’t any talking or anything like sometimes happens in some classes. So far it seems like a pretty good class as far as that is concerned… interest level and involvement. We talked about ideas about how you could plan a lesson around the book, and they had some very good ideas. I was glad that we discussed this, as I thought it might get them started thinking about their lesson plans they will be writing.
Appendix O: Continued

When I got to the overhead about Why Teach With Problems, one student raised her hand and she said that she wasn’t sure that she agreed with the idea of invented strategies. She was questioning the idea of not teaching the traditional algorithm and wouldn’t it hurt the children if they never were taught it. I told them that some people believe that they don’t ever have to teach it … that it’s just one of many ways to do it. I said that I could understand her perspective though because the kid could have a teacher in the future who could require him/her to do it that way. I stressed though that this should come later, after they’ve had a chance to invent their own algorithms and it’s presented as just another way to do it, rather than THE way to do it. She seemed fairly satisfied with that response, but I wasn’t totally sure that she accepted what I had said. [I was glad she brought it up though because I want them to feel comfortable sharing their views even if they’re different from mine or the textbook’s.]

Week 3:
Classes were cancelled due to Hurricane Frances

Week 4:
When I got to class, I told the class that because we had missed the previous class due to Hurricane Frances, the first test would be put off a week. I told them that the journal abstracts that were due today could be handed in next week since many had been without power or Internet access. The majority of them did have theirs ready though. I asked them to go ahead and do journal 3 for next week so the journals would not get behind. [I thought that they might have some anxieties about getting behind, and I tried to address that right away and put them at ease by telling them that if they did not have their paper done, they could turn it in next week.]

I told them that we needed to figure out a way to make up the material from the missed class. We discussed the options, which were to do an hour of new material before the first two tests or an hour after the tests or to come the week of Thanksgiving. I distributed the ballots I had made for them so they could vote privately rather than raising hands. We discussed each of the options. I told them my own view of the pros and cons of each. They shared some comments and questions about them as well. Then they voted to have an extra hour of class before each of the first two tests. [I overheard a student say to another student that she was glad I let them decide rather than just telling them … I was hoping they would notice and appreciate that.]

We began class by talking about number sense and different ways that a teacher can use everyday classroom activities to develop number sense. They had some good ideas and then we went over the ones on the overhead. We talked about the three levels1 at which children are able to represent knowledge and the prenumber concepts. Then we did some activities involving prenumber concepts. We began with the Geopieces2 and sorting, then

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1 These are the Concrete, Pictorial, and Symbolic Levels
2 These are pieces of construction paper that differ in size, shape, and color.
we played the two-difference game. [We did 4 transparencies and then went to activities, which I thought was good. I have noticed in the past that with any more than that, they get restless. **They seemed very happy when they saw that we were going to be doing activities and using manipulatives. Several had mentioned in journals that they were looking forward to using the manipulatives.**]

After break, we got to the overhead on different types of counting and then we used the calculators. I showed them how to do the calculator races **[one student mentioned that she had read an article for the assignment about using calculators this way. She seemed pleased that we were doing something that she had read about … it was validated]*** and also we did the number relationships 1-10. One student mentioned that her 3-yr-old child was counting using rote counting. I mentioned that it would be interesting for her to watch him go through this development of number sense.  

**[relevance!!]**

I showed them how to use the calculators to do one and two more than and one or two less. We talked about 5 and 10 frames and using unifix cubes or groovy boards for part-part-whole relationships. They seemed to get that pretty well. I had them each pick a number between 1 and 10 and show how to get it using each of those different methods. 

**There were a few who seemed very confused about what I wanted them to do, but after I helped them a little, they seemed to get it.**

We did number relationships for 10-20 and then I told them that we were going to play a counting game.  

**[This is a board game designed for children who are learning to count. It involves rolling a number cube, counting that many spaces on a game board, and selecting that number of blocks.]**

I think that most of them enjoyed playing that game. There was a group of four sitting in the back next to (name) who was not really very engaged in the game. It looked like a couple were sort of playing it, but they were also talking about other things. When I came over, the one student sitting closest to the front was not playing at all. When I asked, she said that she was watching the others. I asked if she did not have her blocks with her, and she said that she did, so she took them out. [I am wondering if this is the one who wrote the journal about not liking to play games, etc. in these methods classes … I will find out next time when I figure out her name … she could already have a neg. attitude that is influencing her reaction to the course.]

The rest of the class seemed to be engaged in the activity.

After that, we did the M&M Counting Book. **They did seem to enjoy that, especially eating the M&M’s.** That was where class ended.
Appendix O: Continued

Week 5:
I reminded them about the test next week and that we would have class for an hour first. I told them how many questions were on it and reassured them that they should have plenty of time and that we would move to another location if they weren’t finished.

I started by talking about the properties for addition. Then I gave them 5 examples on the board for them to try and determine which properties were being used. Before going over them, we talked about the difference between commutative and associative. They shared some good strategies for determining one from the other. By the time we went over them, they seemed like they did know them. I remember mentioning or hinting that these would make a good test question, and I noticed that when I said that, they seemed a lot more interested in making sure they had it straight.

We did the zero facts and talked about some word problems that they could relate these to. They gave some good examples. Then we talked about relating addition and subtraction facts. Then we started on the different interpretations for addition and subtraction word problems. We started with the join (Van de Walle, 2004, p. 136). I had them work each of those types using base-ten blocks. I explained that we want the kids to make sense of these problems and this would be a good way for them to do it rather than focusing on whether they are adding or subtracting. One student (name) asked if you could have the kids act out the problem using actual pennies. I reminded them that acting out the problem was one of the problem-solving strategies we had listed, and that it was an excellent suggestion.

After the join, we did the same thing with separate (Van de Walle, p.137). It took quite a while, and I started realizing that time was going to be an issue today. Then we did the part-part-whole (Van de Walle, p. 137) and then the compare (Van de Walle, p. 137). I got a lot of good participation as far as sharing their methods, which I was glad of since it’s not always the case, but I was sensing that they had had enough of this. So, that’s when we took our break.

After the break, I had told them that I was going to give them some word problems to write, which I generally do next because I think it’s a good way for them to understand the different types and also helps them to identify each type when they share them. However, I decided that I better put that off until the end because I knew the test was next time and I didn’t want to get behind. They had seemed to be getting a bit restless with the problem types, so I decided to start the second half with a couple of activities. First we did the pattern blocks. I had them determine how the different pieces were related. Then I gave them the problem where the small green triangle is a cake that sells for $1. We talked about the different ways one could spend $3 on cakes. Then I asked them to see if they could find the 12 ways that one could spend $8 on cakes. I stressed that they should write equations or number sentences for this. Some of them thought...
Appendix O: Continued

they had found 13 ways, but when we went over it, they had one twice. I think it was a good challenge for them to know how many there were and to try and get them all. I didn’t have time to do tangrams there. I really wanted to, but I didn’t have time. I think I will do that next week.

After that I did the number line slide rule activity\(^1\) with them. They seemed to really like that. I heard several of them say, “Oh that’s cool!!” and things like that, so I was glad that I took the time for that. We did addition and subtraction and also talked about how it works.

I knew that we had to get to basic facts since that’s on the test next week. We did a couple of overheads about learning basic facts, different strategies and order of learning them. I tried to really reinforce what is and is not a basic fact. They came up with some great ideas when I asked them how they would do 6 + 8 mentally. They actually ended up bringing up many, if not most, of the different strategies that we were going to be discussing. That was great—a big time saver when we got there. Once we got to the chart, we had already talked about most of the strategies, so I was able to go through it rather quickly. I told them that they didn’t need to get it all down since it was in the book.

Then we talked about the “hard” subtraction facts, and they shared some great strategies about how they did those [such a good class!!]. Then I did have them write word problems, but we only had ten minutes left at that point. I told them to just write one or two and we would stop at 11:45 and share them. We shared maybe 3 or 4. I would have rather gotten to more, but I told them that we would take time next time before the test to go over more if they wanted or they could email me if they had questions. That was the end of class.

Week 6:
At about 8:40 a.m., I was sitting in the office, and one of the students (name) came in. She seemed very stressed and she said that she was nervous about the test and about having class before the test (as the class had voted to do in order to make up the missed day). She said that she wouldn’t hear a word I said because she would be tuning it out and trying to stay focused on the test material. I told her that I understood and that for that reason, I had decided not to cover the next new material, multiplication and division, because that would be too much like what was on the test. Instead we would jump ahead to place value, which would be something very different. That didn’t really seem to alleviate her stress, so I added that we would do about an hour

\(^1\)This activity involves making two number lines and lining them up so that they model addition and subtraction of whole numbers.
of new material and then we would take a long break. During the break, they would have time to ask questions, get refocused, and she seemed to be relieved about that. [This is why I didn’t want to have class on the same day as the test, but unfortunately with the hurricane, I had no choice.]

After she left, I decided that I better go to the classroom early because I figured there would probably be several who were stressed. When I got to the class, I could immediately tell that I was correct. One of them even said, “Can you feel the stress in the air?” and I could. I tried to reassure them. I asked them what they were nervous about. Several of them seemed to be saying the same thing, which was that they had never taken one of my tests before. They were concerned about the format. They pointed out that in the review notes, there were many pages that had five parts to this and six steps to that, and they were afraid that I would ask them to recall all of them. [I remember thinking that this was a valid concern and that as a student I would have felt the same way.]

Because I felt that so many of them were feeling this way and I wanted them to not be focused on that while we were covering new material, I actually got out a copy of the test. I told them that I would not tell them the actual questions, but I went through the short answer section and gave a general idea … name 2 or 3 of 7 steps, etc. They seemed relieved that they wouldn’t have to name all of them. They also seemed concerned that they would have to write long essays and I assured them that they wouldn’t. They did seem very relieved at that point, so I decided to go ahead and start the new material at about 9:15.

We started with tangrams since we didn’t have time to do them last week. I asked them to explore the different relationships between the pieces like we had done with the pattern blocks. We went over them and they seemed to be Ok with that, for the most part. Then we did the first 2 overheads about numeration systems, base ten system, and then the worksheet about the Roman Numerals, etc. They seemed to be interested in that and asked a lot of good questions [made me feel confident that they were getting something out of the lesson—that they weren’t so focused on the test that it was a waste of time. I did notice that a few of them were studying their notes instead, but I didn’t say anything.]

Then I introduced base ten blocks. I wanted to do that so that when we do get to the rest of the lesson on place value, they would have a basic understanding of how the blocks work. I had them model 2 or 3 numbers and then it was 10:00, so I stopped.

I decided to start the test at 10:20, so everybody took a 5 min. break. Then those who wanted to review could come back for review and those who didn’t want to review could take a longer break. When I got back at 10:05, most everyone was back.
Appendix O: Continued

We did review. They seemed to be worried about identifying different types of add and subtract word problems, so I made up some and they were to tell me which type it was. I was pleased that the group as a whole seemed to be getting them, which made me feel that they were prepared for the test.

At 10:20 we stopped and I passed out the test. At that point, we had about an hour and a half. Everyone finished within the time, although two students were there until 11:45. However, one of them had arrived and started the test late. During the test, it seemed like the majority of questions asked were about the pattern block equation problem. Most of those were people who had been absent last week. [I remember thinking that this was good -- hopefully they would get the message that just studying the book and notes isn’t enough—they do need to come to class as well.]

Week 7:
I began passing back tests. It seemed like there were more absent than there. I told them to help each other figure out what they had missed if possible. If they were stuck, I would answer questions. I walked around and answered questions individually because I have found that they are sometimes more likely to ask that way than in front of the whole class. Several more had arrived by this time. A few questions were asked and answered. There was a question about basic fact strategies and another about a multiple-choice question. There was one question regarding the next test. I decided to have it on the day it was scheduled, although it may not cover everything it would have. There was a question about whether new material covered that day would be on the test. I reassured them that it wouldn’t be.

We talked about the properties of multiplication and how they could reduce the number of basic facts a student has to learn. I said that they were similar to the addition properties, so the only really new one was the distributive property. I said that we would be discussing how elementary school students could use the distributive property later in the course. Then we talked about connecting multiplication and division and also division with zero. I showed them why it is sometimes defined and sometimes undefined. I think that most of them were with me, although I’m not sure how many. It may have been over the heads of some.

Then we began talking about the four types of word problems for mult/div. We went through each type, and I asked them to model the problem. Then we discussed why it was that type. Just like with the add/subt ones, they had good ideas and were willing to share their strategies. There are probably about 10 who are good about sharing with the class [so glad!]—not always that many in other classes.

Then we talked about the basic fact strategies. When we got to “nifty nines,” several shared their own strategies about nines. Many had not heard of some of these, and
they seemed intrigued. We talked about remediation and how failure to master basic facts should not be a barrier to doing real math. I asked what they thought that meant. One said that it referred to math about the real world. Another said that students should be able to use manipulatives, etc. to help. I said that they were both right, and that when the purpose and objective of a lesson was problem solving and not computation, students should be able to use calculators or manipulatives. I also told them that they might have students who were great at problem solving and logical thinking and reasoning who had trouble remembering basic facts due to learning disabilities.

Week 8:
We began by going back to place value. I refreshed their memories about what we had done before --expanded notation and base ten blocks. I asked them to model a number with blocks and also to write it in expanded notation. Then we talked about the number 323, and how the leftmost 3 was 100 times as large as the other three. We did a few more examples including one with a decimal point.

Then I had them cut out a Place Value Viewer and write the number 3647. We talked about the different ways someone could withdraw that much money from the bank. They tried to come up with all the different ways using denominations that reflect base 10 place value concepts. They seemed to “get it” for the most part. I told them that they could use a blank one on the test. I also said that we would skip Base-ten Riddles for now and come back. I wanted to make sure I got through the stuff for the test.

We did 3 overheads about invented vs. traditional algorithms. Then I gave them an addition problem to model with base ten blocks. After we went over that, I gave them another one to draw out on paper. I told them that they would have to do this on the test. I went around and looked at everyone’s problem and told them whether or not it would be acceptable on the test. I told them that I was looking for them to demonstrate modeling each of the numbers and also the regrouping. Then I showed them the low-stress algorithm for addition. One student said that she wished she had been shown that as a child because it was so much easier. We talked about how it enforced place value concepts rather than just being a mechanical process w/o understanding.

I gave them a subtraction problem to model with blocks. After we went over that, I gave them one to draw out, and I repeated the process of checking each one. Then we took a break.

After the break, we began mult. I gave them a problem to model with blocks. We talked about how you could do it two different ways: 13 groups of 4 or 4 groups of 13. All but one did 4 groups of 13. Then they drew it, and I checked them. We went over the low-
stress algorithm for mult. They seemed more concerned with how I might ask this on the test than how it worked. I showed that it could be done left to right or the other way, which was an advantage. Then we did the area or rectangular model. They did seem to grasp this faster than some classes in the past. I showed it to them on graph paper and encouraged them to try it on the graph paper in their notes.

Next we talked about the distributive property and how kids could use it. I asked them to use the distributive property to simplify 15 x 12. They had several different ways they had done it. I tried to reinforce that this was a good thing. Then we got to the lattice method. I told them that this was my favorite. [I think many of them were “wowed” as I had hoped.] I gave them one to try.

I skipped the rest of the stuff from this chapter and told them that we would cover it before the test. It would not be on the test, but it could be on the final. Then I skipped ahead to estimation strategies. We went through them and talked about how to make them relevant to kids. They should always be presented in a context of a situation where estimation is warranted. One student (name) gave some good examples.

I had covered everything for the test, so we went back and did Base-Ten Riddles. Most of them seemed to get them pretty well. I encouraged them to use the blocks, but it seemed like many, if not most, weren’t. [I think they were ready to go.]

Week 9:
Today was scheduled as a test day, but we had to have class before the test in order to get caught up from the missed hurricane day.

I got to class at about 8:45. I wanted to get there early due to the test. I walked around the room for about 15 minutes, answering individual questions. Most of them concerned review questions from the review sheets. At 9:00, I told the class that we would spend about 45 minutes on new material. This material would not be on this test or the last test, but it could be on the final exam. Someone asked if the last test would be harder since it covered more material. Actually I don’t think it does cover more material. I didn’t address that though. I just said that I had never received any feedback reflecting that point of view. I did remind them that usually the first test covers much more though. Someone said that they (the class) were giving me feedback that the way we had done it with two tests instead of one was much more desirable. No one disagreed, and several nodded their heads in agreement. I said that I also agreed with that.

I began with the overhead about thinking strategies. As I was going through that, I noticed that many were not paying any attention and were studying for the test. I stopped and said that I knew that they were studying instead of listening. I told them that I understood how difficult it was to focus on new material with a test
Appendix O: Continued

coming, and that I would never have planned it this way. I reminded them that it was Mother Nature who was responsible for the change in plans. I assured them that they would have plenty of time to study before the test. We would stop at 9:45 and break until 10:00. Then we would review until they were ready … probably about 15 min. They seemed a bit relieved and put their notes aside and were more attentive.

We modeled a division problem with Base Ten blocks and talked about how the model connected to the traditional algorithm. Several of them seemed quite interested in this. I have noticed that the long division algorithm is not very widely understood, and that students are often interested in better understanding it. Then we did the Arrow Math with the hundreds chart. Many seemed interested and challenged by this. They also seemed, as a group, to pick it up quickly.

The last thing we covered was Diagnosing Student Errors. I told them that this could be on the final … hint, hint … I wanted to make sure they didn’t overlook it since it wouldn’t be on any of their tests. They seemed to pick this up pretty quickly too. [I hope they aren’t just acting like they understand by not asking questions because they are distracted by the upcoming test … this reaffirms my practice to not teach class on test days … this is what happens if the test is after class, and if the test is first, they either leave or are unhappy because they either have to wait around for others to finish or feel rushed with the test because others are waiting.]

Week 10:
I began class by passing back test 2. Overall they did very well. This is the first time since switching to the new book that I have broken the first test into two tests. This has definitely proven to be a good idea and one that I will continue to use. I walked around the room and answered questions individually. There weren’t very many--just a few.

As I circulated among the class, one student said that she had a question about the lesson plan assignment. I said that I would address this with the whole class. I brought it up now. I referred them to the assignment sheet. I told them to be sure that they checked with me if they had any doubt if their book met the required topic and also to be sure and include each required component. I explained that they must include a summary of book and that points would be deducted if anything were missing.

We began by talking about rational numbers. They seemed to already know or pick up quickly the concept of rational numbers. We talked about the meaning of a fraction. Someone said that she wished she had learned this as a child. I used the opportunity to emphasize that kids need to have conceptual understanding of what a fraction means before getting to algorithms for computation, etc. They seemed to agree.
I asked them to figure out what each pattern block piece would equal if the yellow were the unit. We repeated this with two yellows as the unit, then with one red as the unit. Most of them seemed to realize that the blue would be 2/3, which usually causes confusion. Then we moved to tangrams and they figured out what each piece equaled if the big triangle were the unit. Someone asked why they were called tangrams. I told them that there was a story about that and they would learn that in math II. I once again had to admit to being ‘tangram challenged.’ They always enjoy that. [Maybe it makes me seem more “normal?” Unfortunately it is the truth!!]

We then went through the three types of fraction models, including fraction circles, graph paper, paper folding, Cuisenaire rods, fraction tower cubes, and two-color counters. By then they were ready for a break.

After the break, I passed out the Cuisenaire rods and told them to work together on the Parts and Whole worksheet. There were questions as I circulated about the Cuisenaire rods mostly, with a few on the pattern blocks and counters. When everyone was finished or nearly finished, I put the answers on the overhead. Two or three wanted to challenge an answer, which I welcomed. I tried to let them know that I certainly could have made a mistake, and that I welcomed their challenges. I was able to help them see where they were wrong, but I also tried to point out that they want their students to do this (challenging the teacher) and that it was a good thing.

There wasn’t too much time left, so I read them a story, Two Ways to Count to Ten. We talked about learning activities that could be used with that story to teach the concept of counting by 2’s or 5’s. Someone suggested using manipulatives to model ten and separating them into equal groups. I also suggested a follow-up activity of having the animals count to a bigger number, like 20 or 50, and the different ways they could do that. That was the end of class.

Week 11:
I decided to start with a couple of activities while we were waiting for latecomers. The first was Benny’s Cakes. They worked on them for about 5-10 minutes while I circulated around the room. I gave the class a couple of hints to get them thinking about some other ways to do this. After a few minutes, I put up the solution on the overhead. We discussed how you would know that the pieces were equal on some of them. I made the point that as a teacher, they wouldn’t necessarily have to think of all of these, but they should be able to see which are right if a student came up with these. [trying to alleviate their fears about not always knowing or thinking of all the possible answers]

Then we cut out the fraction circles and made the manipulative. They seemed to like that, which is the norm.
Next we went over a few overheads dealing with fraction number sense. I tried to stress the importance of developing number sense and estimation with fractions and related it to similar concepts we have discussed for whole numbers. The first dealt with ordering fractions that have numerator of 1, using a conceptual perspective rather than an algorithm. They shared their strategies and how they could help kids make sense of this. The next one used benchmarks of 0, ½, and 1 to determine which fractions were larger. The third used estimation for addition of mixed numbers. Again, they shared their strategies for each after doing the first together.

After the break, I read the story *Remainder of One*. They seemed to enjoy it [sometimes hard to tell if they like to hear stories or think it’s a waste of time. I try to discuss how they could plan a lesson around it to make it relevant to the course.] After the story, we did the equivalent fraction rule, which I tried to relate to algebra, and then we began the operations w/fractions problems.

The first was addition. They felt that the problem wasn’t worded quite right, so I changed it to reflect their suggestions. They were able to model the problem and share their strategies well. Many used fraction tower pieces and many used drawings. The subtraction one caused some confusion. Some of them thought it should be ½ of the ¾ rather than ½ of a whole. This is very common and happens in every class I teach. When we got to the multiplication problem, they seemed to better understand the difference. One of the girls in the group who talk in class and come in late from break every week seemed annoyed with me when I tried to explain to her that it was subtraction. She had the right answer, but she didn’t view it as subtraction. [It took a lot of patience on my part to keep patiently explaining it to her and not just say that maybe if she listened in class occasionally and showed up on time, she might better understand!!]

Week 12 (second survey given during this class):
I began by reminding them that lesson plans were due next week and I answered a few questions about that. I also reminded them that all 8 journals should be completed now and that if they were not all sent, they should take care of that this week. [I always like to begin class by making sure everyone knows where they should be and also answer any questions about upcoming assignments, tests, etc.]

At this point, we began new material. Today’s lesson was on computation with fractions. I once again pointed out that modeling and understanding should come before algorithms. We began with addition and subtraction. I gave them a problem to model w/pattern blocks and write a word problem. I stressed that w/addition and subtraction word problems, the unit must be the same. I gave them a few problems to try modeling as I circulated around the room. Most of them seemed to be getting it, although some had problems. I heard someone say that she wished they had done fractions this way when she was a kid … or something to that effect [YES!!!!].
When we got to multiplication, there were some problems. We began with the area or rectangular model. They seemed to understand the problems where the fractions were less than one. I have learned to do this on the board rather than the overhead so that they can see how I’m dividing each side of the unit rectangle. One student (name) mentioned that she really liked this and that I didn’t need to help her as usual because she was getting it. I told them how I could usually tell when people don’t understand this by the way they divide the sides on a test. This alerted them to the fact that this would most likely be on the test, so they were very attentive.

After break, I read the book *Betcha!!* We talked a little about lessons a teacher could plan around the book. One student (name) said that she was planning to use that book for her lesson plan.

After the story, we went back to multiplication of fractions. This time we were working with mixed numbers. I showed them the length x width idea and also the graph paper. I had never shown the graph paper before and had decided to add it the night before. At first they seemed confused and I regretted it, but then I realized that before, they had just been using the area formula to figure it out and now with the graph paper they were understanding it better. [Student’s name] made the comment that the other way was just using an algorithm and the graph paper actually showed you the area. I guess I will continue to use that. Even though it seemed to cause quite a bit of confusion, they asked for several more problems to try, and by the end, I think most of them had gotten it. I felt like I needed to move on in order to get through division, so I told one student who was struggling that I would show her more after class. She ended up telling me that she had gotten it by the time class ended.

Next we worked on division of fractions with pattern blocks. One student (name) asked if it was OK to use a different manipulative rather than pattern blocks. She was using fraction circles. I said that they were both area models, so it was OK. I reminded them that as teachers they would want to use all three types of models though. I also said that I could ask specifically about pattern blocks on the test [wanted to make sure they would study that so they wouldn’t be caught off guard]. They had a little trouble with the division, but eventually most of them seemed to be getting it. I noticed that (name) and also (name) were having problems with this. By the end of class, I think that they were understanding though. We ended class at about 11:50.
HOW CHILDREN LEARN MATHEMATICS

Three levels at which children are able to represent knowledge:

Level 1: __________ Level of Representation

Level 2: __________ Level of Representation

Level 3: __________ Level of Representation
COUNTING

1. ________Counting: number sequences are used to verbally recite numbers by rote, without referring to objects.

2. _________ or ____________ Counting: counting involves matching objects or events with a number name.

3. _________ Numbers: indicate the relative position of an object in an ordered set (ex. 1\textsuperscript{st}, 2\textsuperscript{nd}, 3\textsuperscript{rd}).

4. ___________ Principle: The understanding that the last count word names the quantity of the set. Ex: After counting six objects, a child is asked “how many are there?” If the child answers that there are six without recounting, he or she is said to have the ___________ principle.
Appendix P: Continued

Strategies for Learning Basic Facts

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Zero Facts    One-More-Than Facts    Two-More-Than Facts
Doubles       Near-Doubles          Make-Ten Facts    Ten-Facts

Can Use Make-Ten Extended, Counting On, Doubles Plus Two, or just memorize remaining
CONNECTING MULTIPLICATION AND DIVISION

If you know $6 \times 4$ is 24, then you also know:

•

•

•

DIVISION BY ZERO

• $0$ DIVIDED BY N = 0 ($0/n$) Why?

• N DIVIDED BY 0 IS NOT POSSIBLE ($n/0$) Why?

• 0 DIVIDED BY 0 IS NOT POSSIBLE ($0/0$) Why?

VOCABULARY

FACTOR X FACTOR = PRODUCT

DIVIDEND/DIVISOR = QUOTIENT
Review: Chapters 10, 11: Multiplication/Division

1. Identify the different types of word problems for multiplication and division and create a word problem for each interpretation or type. If given a word problem, be able to identify the appropriate type.

Some samples:
   a. Sarah has 5 bags of candy. Each bag has 6 pieces of candy in it. How many pieces of candy does Sarah have?
   b. Tom earned $6 this week. He saved 3 times as much money as he saved last week. How much did he save last week?
   c. An ice cream store has 3 types of cones and 4 flavors of ice cream. How many different combinations of one-scoop ice cream cones can you get?
   d. A rectangle has length of 3 cm and width of 4 cm. How many square centimeters are there in the rectangle?
   e. Amy has 30 pieces of candy to share with 5 friends. How many pieces will each friend get?
   f. Amy has 30 pieces of candy to share. She wants to give each of her friends 6 pieces. How many friends will get candy?
   g. Tom earned $2 last week. This week he earned 3 times as much. How much did he earn this week?
   h. Tom earned $6 this week. Last week he earned $2. How many times as much money did he earn this week as last week?
   i. An ice cream shop can make 12 different combinations of one-scoop ice cream cones. If they have four different flavors of ice cream, how many different types of cones do they have?

2. What two division sentences are related to the multiplication sentence 6 x 2 = 12?

3. a. Explain why 5 ÷ 0 and 0 ÷ 0 are both undefined.
   b. Why is 0 ÷ 5 defined?

4. Provide examples that illustrate that:
   a. division is not associative or commutative
   b. subtraction is not associative or commutative

5. Be able to identify and distinguish basic multiplication and division facts from those that are not considered basic facts.

6. For each multiplication fact strategy, list some facts for which the strategy can be used, and explain the thinking process involved in using that strategy.

7. How can you help children who have been drilling their basic facts for years and still have not mastered them?

8. Illustrate and explain how the distributive property can be useful in doing mental computations.

9. What does the author of your textbook say about speed drills (timed tests) for basic facts?
Appendix P: Continued

DECIMAL GRID

How would you represent:
   a. 0.05
   b. 0.2
   c. 0.18
ABOUT THE AUTHOR

Joy B. Schackow received a Bachelor's Degree in Elementary Education, with a minor in Mathematics, from the University of Iowa. She taught grades 4 and 5 for four years before receiving her Master’s Degree in Mathematics Education from the University of South Florida. She then taught high school mathematics for three years and community college mathematics for 15 years. During this time, she also worked as a mathematics tutor for a private college preparatory school where she tutored middle and high school students enrolled in various mathematics courses.

She entered the Ph.D. program at the University of South Florida in 1999 in order to pursue her interests in mathematics teacher education and attitudes toward mathematics. While in the Ph.D. program, she worked as a Graduate Teaching Assistant, as well as holding a two-year position as a Visiting Instructor. These positions involved teaching mathematics methods courses and supervising interns.